Improved Multipath LEACH with Energy saving Routing Algorithm for Wireless Sensor Network

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Abstract—LEACH is routing algorithm used in wireless sensor networks to reduce energy utilization by wireless sensor nodes. Still considerable energy consumption can be saved. To achieve this we have proposed enhanced MLEACH algorithm for energy efficient routing in WSN. In this procedure the area is divided into small groups. Each group sensor nodes communicate with cluster head and all cluster heads communicate to base station using shortest path routing algorithm. This proposed algorithm tested in Matlab simulation and result found that it reduces energy consumption and increases lifetime of sensor nodes.

Index Terms—WSN, LEACH, Improved Multipath LEACH, Energy efficient

I. INTRODUCTION

Wireless network have had significant impact on the world. A category of wireless network where energy efficient protocol is a major interest is wireless sensor network. Wireless sensor network have many applications like environmental study, military surveillance, security and medical field [1].Wireless sensor network is a combination of sensor nodes, gateway nodes, and sink nodes. Sensor nodes have to perform the operation such as sensing the data, process it and transmit it to the base station.

Most of the time sensor nodes are equipped with non rechargeable battery that is not replaceable in most of the cases [8]. In sensor nodes the major factor for energy consumption is the transmission of data. As the sensor nodes have limited power, it is necessary to introduce an energy efficient routing protocol.

The Low Energy Adaptive Clustering Hierarchy (LEACH) protocol proposed by Heinzelman, Chandrakasan, Balakrishnan is renowned for its success in extending lifetime of wireless sensor network [7]. In last few years LEACH protocol is improvised to extend lifetime of network.

The multipath routing is fabricated as a linear programming problem with an objective to maximize the time until first sensor node runs out of energy [2]. In this paper, we propose an enhanced multipath routing algorithm with an objective to increase the lifetime of network by utilizing the energy efficiently. Here, a shortest path search algorithm is introduced such that the energy utilization is less for transmitting the data from sensor nodes to the base station.

II. LEACH PROTOCOL

Wherever Hierarchical network routing divides the network into clusters to achieve energy-efficient, scalability and one of the famous hierarchical network routing protocol is low-energy adaptive clustering hierarchy (LEACH). During the creation of network topology, the process of setting up routes in WSNs is usually influenced by energy considerations [6]. LEACH is an adaptive clustering routing protocol [5].

In LEACH, Cluster-heads are randomly selected from deployed sensor nodes, biased by their experience in serving as Cluster-heads. It is a cluster based protocol adapting the stochastic model for randomized rotation of Cluster-heads for energy load balancing among sensor nodes in the network. It is based upon rounds in which sensor nodes transmit data to Cluster-head in their assigned time slot. Cluster-heads send aggregated data to Base Station by single hop transmission. The whole operation can be divided into two phases: set-up phase and steady state phase [7].

A. SET-UP PHASE

In this phase the CHs are selected based on an elective percentage of deployed nodes, also by considering a factor that so far how many times an individual node perform the role of cluster head. Each node from the group of deployed nodes G chooses a random number between 0 and 1. If the number is less than a set threshold T(i), the sensor node becomes a cluster head for the existing round. Where T (i) is calculated as

$$T(i) = \begin{cases} \dfrac{P}{1 - P\left(r \bmod \left(1/P\right)\right)} & if\ i \in G \\ 0 \quad otherwise \end{cases}$$

Where P is the probability of node becoming cluster head, r is the round index

G is the set of nodes not perform as CHs in last 1/P rounds.

The elected cluster head broadcasts an advertisement message to inform other nodes about their states. Based on the received signal strength of the advertisement, a non-cluster head node decides to which cluster it will belong for this round and sends a membership message to its cluster head. Based on the number of nodes in the cluster, a cluster head creates a TDMA schedule and assigns each node a time slot in which it can transmit. This schedule is broadcast to all the cluster nodes [9].

B. STEADY-STATE PHASE

In the steady state phase, the actual data transfer to the base station. During the steady-state phase, the sensor nodes can begin sensing and transmitting data to the cluster-heads. The cluster-head, after receiving all the data, aggregates it before sending it to the BS. The duration of the steady state phase is longer than the duration of the setup phase in order to minimize overhead. After a certain time, which is determined a

priori, the network goes back into the setup phase again and enters another round of selecting new CHs. Each cluster communicates using different CDMA codes to reduce interference from nodes belonging to other clusters.

LEACH achieves over a factor of 7x and 8x reduction in energy dissipation compared to direct communication. The major characteristics of this Protocol are as follow: The cluster heads are rotated in a randomized fashion to achieve balanced energy consumption. It is assumed that all the sensors have synchronized clocks so that they know the beginning of a new cycle. In LEACH sensors do not need to know location or distance information [10].

III. PROPOSED PROTOCOL

To overcome the boundaries of basic LEACH protocol this enhanced multipath protocol is proposed which utilizes shortest path amongst multiple paths to transmit the data. In this protocol, we propose a multipath routing algorithm based on LEACH to use energy efficiently by each node in wireless sensor network. In LEACH protocol, cluster heads plays an important role in communication. The sensor nodes will utilize more energy to transmit the data if they are far away from cluster head.

In this work, the sensor nodes are randomly deployed to form a sensor network. A particular no. of groups of sensor nodes is made and for each group a cluster head is selected randomly. There are two phases in LEACH: set up phase and steady state phase. In set up phase clustering is done in sensor network and in steady state phase actual data transmission is accomplished. For each round these phases are repeated.

In this proposed algorithm, for data transmission more than one path is utilized. This is done on the basis of how far the cluster head is from the particular sensor node. From this, nearest cluster head is selected by the sensor node which utilizes minimum energy for transmitting the data from sensor node to cluster head. The proposed algorithm is as follows:

1. Sensor nodes are deployed in a particular area.
2. The area is divided into number of groups consisting random number of sensor nodes.
3. For each group a cluster head is created randomly.
4. To minimize energy utilization, each node will communicate with its cluster head and that cluster head will communicate to the sink node through nearest cluster head.
5. This is repeated until all the nodes die.

IV. SIMULATION MODEL

In this system in an area A, N no. of sensor nodes are uniformly deployed. The network is made static and nodes are deployed randomly. Initially all the sensor nodes have same energy. The energy of sensor nodes cannot be recharged and cannot be replaced. The node radio will consume the following E_tx (k, d) amount of energy to transmit a k-bits packet over distance d [13]

$$E\_tx(k, d) = \begin{cases} E_{ele} * k + E_{fs} * d^2 * k & for\ d < d_o \\ E_{ele} * k + E_{mp} * d^2 * k & for\ d > d_o \end{cases}$$

And E_rx amount of energy to receive this k-bits packet: $E\_rx(k) = E_{ele} * k$

Where,

- E_tx (k,d) : energy dissipated per bit at transmitter;
- E_rx (k) : energy dissipated per bit at receiver;
- Efs , Emp : amplifier parameters of transmission respectively in free space (with d^2 power loss) and multi-path fading (with d^4 power loss) channel models;
- E_{ele} : Energy dissipation to run the radio;
- k : number of transmitted data bits;
- d : distance from a sender node to a receiver node or BS.
- d_0 : is the threshold distance between multi-path fading model and the free-space model.

The value of d_0 can be calculated by using the following equation: $d_0 = \sqrt{\frac{E_{fs}}{E_{anp}}}$

The simulation parameters are as follows:

No. of sensor nodes are 100; The network area is M X M =100 X 100; Initial energy of deployed nodes is 0.5J; The energy required for running the electronic circuit E_{ele} is 50nJ/bit; The transmit amplifier energy dissipation of free space model is 100pJ/bit/m^2; The transmit amplifier energy dissipation for two model is 0.0013pJ/bit/m^2; The data aggregation energy per bit is 5Nj; No. of bits in a packet k is 4000 bytes; The crossover distance is assumed to be 87 m.

V. RESULTS AND ANALYSIS

Here we are comparing LEACH, MG-LEACH with enhanced multipath LEACH protocol. This comparison is based on the like energy consumption and lifetime of network. The Enhanced multipath LEACH has more residual energy than basic LEACH and MG-LEACH. The below given table shows node die with respect to each round:

INITIAL ENERGY	PROTOCOL	FND	HND	LND
0.5 J	LEACH	32	47	60
	MULTIGROUP-LEACH	602	1067	1332
	MULTIPATH-LEACH	1122	1789	2353

FND: First Node Die **HND**: Half Node Die **LND**: Last Node Die

The simulation results from Fig. 1 to Fig. 3, demonstrate relative behavior of LEACH, multigroup-LEACH and discussed algorithms with parameters values n =100, p= 0.1, Eo = 0.5 J.

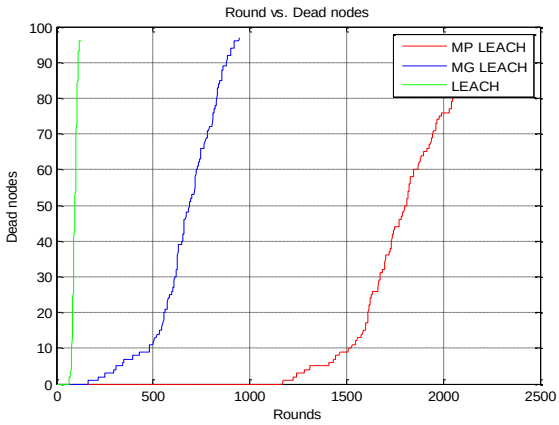

Fig. 1 Round vs Dead Nodes

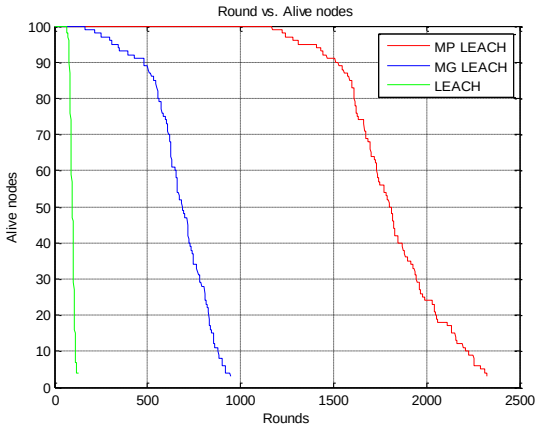

Fig. 2 Round vs Alive Nodes

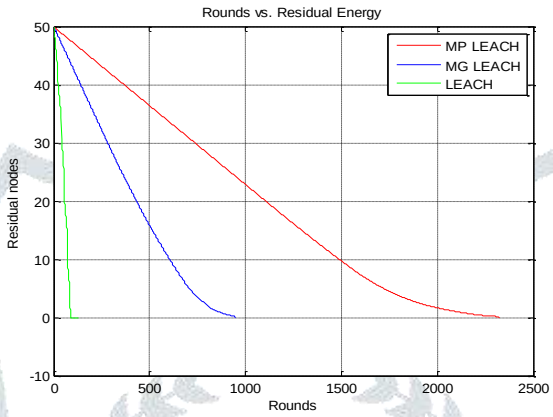

Fig. 1 Round vs Residual Energy

VI. CONCLUSION

From the proposed algorithm, communication between cluster head and node data routed by using shortest and multiple paths. Therefore energy consumption by each cluster is minimized. This increases the lifetime of network.

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