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A IMP- LEACH-Based Routing Protocol For Energy Optimization In Wireless Sensor Network

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Abstract: ***Due to lack of power source, energy is the key concern area in Wireless Sensor Networks. Maximum energy is used in transmission of data. Many research works have been done to develop routing algorithms to increase the lifetime of a sensor network. Among them clustering algorithms have been widely used to reduce energy consumption. In this context, the key point in such topology is to select a cluster. One of solutions is to select a cluster alternately. However, this choice does not consider the energy as important criteria in actual papers. In order to limit energy consumption, our new method is proposed in this paper to improve Low Energy Adaptive Clustering Hierarchy (IMP-LEACH) to improve existing LEACH by selecting cluster according to the residual energy of nodes dynamically. The simulation results show that proposed algorithm achieves longer stability by comparison to original LEACH.***

Keywords: ***Base Station, Cluster, Cluster Head, Energy efficient, Hierarchical Routing Protocol, LEACH, Wireless Sensor Network.***

I. INTRODUCTION

A wireless sensor network (WSN) is a group of sensor nodes which are deployed in a field to monitor physical conditions autonomously. WSNs can measure various physical conditions like sound, temperature, pressure, humidity, load, speed etc. After sensing the data sensor nodes pass this information to a base station or sink following a particular routing pattern. The number of sensor nodes in a WSN can vary from a few to hundreds or thousands in numbers depending on the application. A sensor node consists of many components, a microprocessor or a microcontroller to control the operation of node, a radio transceiver to transmit and receive information, an ADC converter to convert analog information to digital and vice-versa and a power source. Batteries are normally used as power source in these sensors [4].

Unlike traditional wireless networks, sensor networks are characterized by power, computation, and memory constraints [5]. Since sensor nodes are generally deployed randomly in a remote location it is not feasible to provide power backup regularly. So the energy resource of sensor networks must be managed wisely to extend the lifetime of sensors. 70% of the energy is consumed in transmission of data between sensor nodes and base station. In addition, it is very important to balance the energy consumption among all sensor nodes to prolong the network lifetime.

In order to achieve high energy efficiency and increase the network scalability clustering routing protocol can be used. In this type routing mechanism sensor nodes are grouped into clusters. Sensors sense data from the environment and send it to the cluster head. Since individual node's data are correlated in a micro-sensor network, the end-user does not require all the (redundant) data; So the cluster head aggregates the data obtained from all the cluster members before forwarding it to the base station. Data aggregation helps to minimize data redundancy and reduce the communication load because much less actual data needs to be transmitted from the cluster to the base station. Clustering techniques have emerged as a popular choice for achieving energy efficiency and scalable performance in large scale sensor networks. In this paper we have proposed an algorithm based on IMP- LEACH (Low-Energy Adaptive Clustering Hierarchy) which increases the overall energy utilization of the WSN.

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II. RELATED WORK

In hierarchical routing protocols whole network is divided into multiple clusters. One node in each cluster play leading rule. Cluster-head is the only node that can communicate to Base station in clustering routing protocols. This significantly reduces the routing overhead of normal nodes because normal nodes have to transmit to cluster-head only. Description of some hierarchical routing protocols is discussed in next subsections.

W. R. Heinzelman, and H. Balakrishnan et.al[2]have proposed a distributed clustering algorithm called Low-Energy Adaptive Clustering Hierarchy (LEACH), for routing in homogeneous sensor networks. LEACH selects randomly the nodes cluster-heads and assigns this role to different nodes according to round- robin management policy to ensure fair energy dissipation between nodes In order to reduce the amount of information transmitted to the base station, the cluster-heads aggregate the data captured by the member nodes belonging to their own cluster, and then sends an aggregated packet to the base station.

Operation of LEACH is based on rounds and each round consists of two phases - setup phase and steady state phase. In setup phase CHs and clusters are created. Some nodes independently elect themselves as CHs based on some probability P and their previous record as a CH. All nodes which were not CHs in previous 1/p rounds, generate a number from 0 to 1 and if it is less than a threshold T (n)then these nodes become CHs [7][9]. Threshold value is set by the given formula:

$$T(n) = \frac{p}{1-p\left(p \bmod \frac{1}{p}\right)} \; if \; n \in G$$

T(n) = 0 : otherwise (1)

In formula (1) G is set of nodes that have not been selected as CHs in previous 1/p rounds, P is suggested percentage of CH, r is current round [10]. Elected CHs broadcast their status using CSMA/CA protocol. Non-CH nodes select their CHs by comparing the strength of received signals from multiple CHs. After creating clusters all CHs will create TDMA schedule for their associated members and broadcast it. After that a steady state phase starts which is usually longer than the setup phase. In this phase nodes transmit data to their CHs during the allocated time slots otherwise they remain in sleep mode increasing battery lifetime. After receiving data from all the members CHs will aggregate the data and transmit to the BS [14]. The advantages of this approach are that no long distance communication with the base station is required and distributed cluster formation can be done without knowing the exact location of any of the nodes in the network. In addition, no global communication is needed to set up the clusters and nothing is assumed about the current state of any other node during cluster formation. The goal is to achieve the global result of forming good clusters out of the nodes, purely via local decisions made autonomously by each node.

However, while LEACH can increase the lifetime of the network, it has some limitations. LEACH assumes that all nodes can transmit data with great power to reach the base station and each node has a computing power enabling it to withstand various MAC layers. Therefore, LEACH is not suitable for networks deployed in large areas. In addition, LEACH randomly selects a list of cluster heads and there are no restrictions on their distribution and on their energy level.

M.Bani. Yassein, A.Al-zoubi Y. Khamayseh and W. Mardini et.al [3] have proposed. An improved version of LEACH called Multi-hop LEACH (LEACH-M) , in which members of a cluster may be more of a leap from their corresponding cluster-head and communicates with it in multi-hop fashion. Thus, they illustrate the cases in which M-LEACH outperforms LEACH. However, this proposed version requires each sensor must be able to aggregate data, which increases the overhead for all sensors.

R. V. N. Sindhwani et.al [1] to reduce the energy consumption of the nodes, new version has been proposed i.e. LEACH-V. In this, each cluster has one CH i.e. accountable for transfer information that is received from the sensor nodes to the BS, vice-CH is a node that will become a CH of the cluster when the CH dies, and the cluster nodes gather data from environment and send to the CH. There is no need to select a new CH every time the CH dies. This will expand the overall network lifetime.

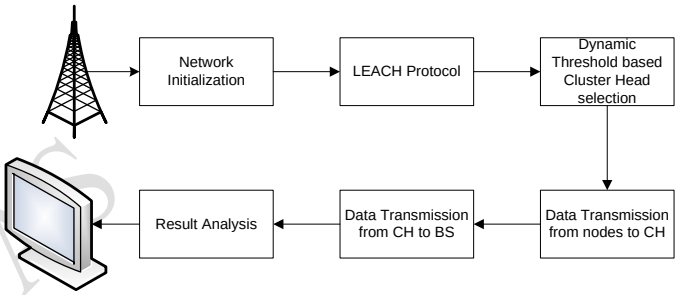

Figure 1: Block Diagram of Proposed System

III. PROPOSED WORK

Before you begin to format your paper, first write and save the content as a separate text file. Keep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads-the template will do that for you.

We have proposed an updated version of LEACH by considering the remaining energy of CH to use energy more efficiently and thereby increasing the network life time. Moreover like LEACH it is not realistic to consider that all sensor nodes in the network are homogeneous with respect to energy. Because it decreases the overall lifespan of the network as the cluster heads which directly communicate with the BS will drain out their energy earlier than the cluster member nodes.

To make the network more energy efficient we have considered heterogeneous network with nodes having two different energy levels - normal node having less energy will be treated as the cluster members and advanced node possessing more energy and if the strength of signal is above the required threshold will be elected as cluster heads. The CHs will aggregate the received data and transmit it either directly or indirectly through other CH to the BS. Whether the transmission will be direct or indirect that depends on the

distance between the CH and the BS. Since energy consumption in wireless systems is directly proportional to the square of the distance [6], so much more energy is consumed when CHs directly transmit data to the BS. To reduce the energy consumption CHs will find the minimum distance to BS and transmit data through that path unlike LEACH where data is directly transmitted to the BS by the CHs irrespective of the distance.

A. NETWORK INITIALIZATION

Network Initialization means setting up the Environment, range of the network and searching which all the nodes are ready to communicate. In homogeneous system all the available wireless sensor nodes are having equal amount of initial energy E0 = 0.5J. Here we have considered a heterogeneous network. A heterogeneous network is one in which all the nodes doesn't have equal energy. Let us assume that the total number of nodes is n & m fraction of the nodes has α time more energy than the other nodes. They are called as advanced nodes.

Number of normal nodes = *(1-m)n*
Energy per normal node = *e0*
Number of advanced nodes = *m x n*
Energy per advanced node = *e0 x (1 + α)*
Hence the total energy of the network = *((1-m) x n) x e0 + (m x n) x (e0 x (1 + α)*

B. LEACH PROTOCOL

LEACH (LOW-ENERGY ADAPTIVE CLUSTERING HIERARCHY) is a cluster-based energy efficient routing protocol, which reduce the number of transmissions towards to the BS. In other words, it reduces network traffic and the contention for the channel. LEACH has motivated the design of several other protocols which try to improve upon the CH selection process. There are number of clustering based routing protocols proposed in literature for WSNs.

In this paper we are using IMP--LEACH(E-LEACH).In E-LEACH we are using dyanamic threshold to select a cluster head.

C. DYNAMIC THRESHOLD BASED CLUSTER HEAD SELECTION

In this section we are selecting cluster head among all the sensors based on threshold value and using received signal strength Indication (RSSI) of sensor nodes. All the advanced sensor nodes generate a random number between 0 and 1 and if it is less than the threshold T(n) (equation 1) and if the strength of signal is above the required threshold will be elected as cluster head for that round.

D. DATA TRANSMISSION OF NODES TO CH

In this section Data aggregation will be done means gathering the data from all the sensor nodes and transmitted that information to the cluster head/ aggregator. The main objective of data aggregation algorithm is to gather and aggregate data in an energy efficient manner so that network lifetime is enhanced [7].

E. DATA TRANSMISSION OF CH TO BS

In this section data is transmit from cluster head to base station. In the wireless sensor network, all the nodes can't communicate directly to base station. One of the sensor nodes also called "data aggregator" or "cluster head" gather the information from its neighboring nodes and aggregates them and then sends the aggregated information to the Base Station[8].

IV. RESULTS

The simulated results depicted in Figure 1 shows Network Initialization and formation of Sink node and in Figure 2 depicts the selection of cluster head and associate cluster header in the figure all the red color clusters are cluster headers and blue color are associate cluster header and remaining are common clusters.

Figure3 compares Energy consumption of PEGASIS, LEACH and IMP-LEACH vs. number of nodes. The LEACH protocol loses their energy in cluster formation. Because clusters are formed after every round so that it consume more energy. But in case of IMP-LEACH cluster formation is using threshold value and signal strength so it consumes less energy compare to LEACH. Figure4 shows the comparison of dead nodes between the proposed optimized IMP-LEACH protocol and the existing protocols. The IMP-LEACH protocol gives the better results than the other protocols.

In the Figure. 5, the IMP-LEACH protocol gives the better results than LEACH and PEGASIS. In optimized IMP-LEACH packets that are sending to base Station and packets sent to cluster head are more than the other protocols and it improve the network lifetime and also reduce the energy consumption.

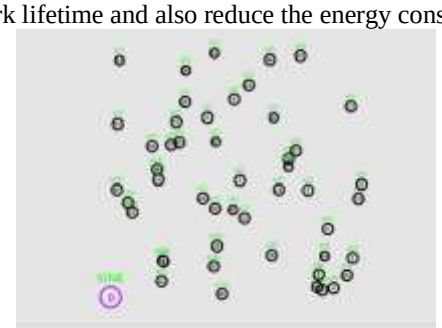

Figure1: Network Initialization and formation of sink node

Figure2: formation of Cluster Head and Associate Cluster Head

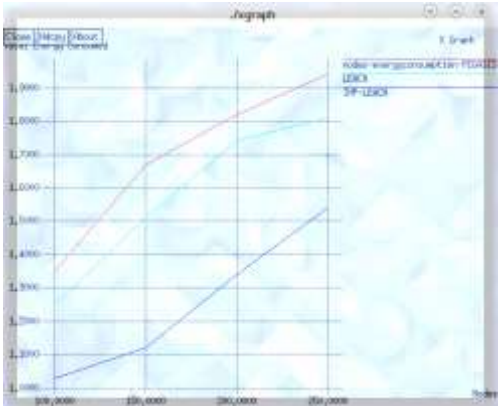

Figure 3: Comparision of Energy Consumption PEGASIS, LEACH and IMP-LEACH vs nodes

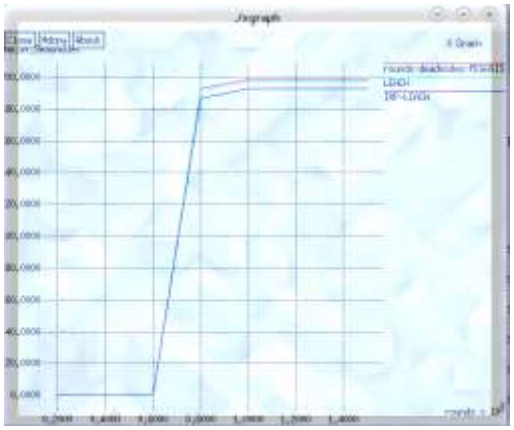

Figure 4: Dead nodes in PEGASIS, LEACH and IMP-LEACHprotocol

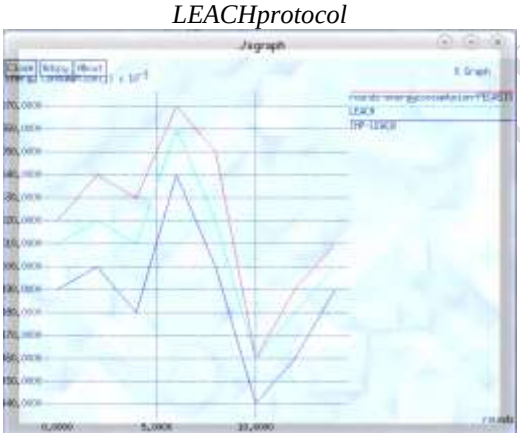

Figure5: Comparison of Energy Consumption PEGASIS, LEACH and IMP-LEACH vs rounds

V. CONCLUSION

The paper presents an energy efficient clustering algorithm based on LEACH for wireless sensor network. We have simulated the proposed algorithm on MATLAB and compare the performance of LEACH and the proposed protocol. Simulation shows that the lifetime and throughput of our proposed method are more than that of LEACH. This improvement is achieved by the heterogeneity of nodes and using the threshold values and RSSI in the selection of cluster head. The cluster heads communicate with the base station directly or indirectly using multi-hop hierarchical routing through other CHs which makes our algorithm suitable for large-scale wireless sensor networks.

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