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Energy Efficient Cluster Based Leach Protocol Using WSN

Samta[1], Pankaj Gupta[2]
Research Scholar, Assistant Professor
Department of Computer Sc Glaxyn Institute of Technology and Management Kurukshetra Haryana

Abstract: Wireless sensor network systems will enable the reliable monitoring of a variety of environments for both civil and military applications. In this paper, we look at communication protocols, which can have significant impact on the overall energy dissipation of these networks. We propose LEACH (Low-Energy Adaptive Clustering Hierarchy), a clustering-based protocol that utilizes randomized rotation of local cluster base stations (cluster-heads) to evenly distribute the energy load among the sensors in the network. LEACH uses localized coordination to enable scalability and robustness for dynamic networks, and incorporates data fusion into the routing protocol to reduce the amount of information that must be transmitted to the base station.

Keywords: Wireless sensor network (WSN), LEACH protocol, clustering protocol

I. INTRODUCTION

A wireless sensor network (WSN) consists (1) of a number of sensor nodes which can communicate wirelessly. A wireless sensor node usually comprises of a microcontroller, a low power radio transceiver, sensors, and a battery power. These nodes are to monitor a given set of environmental conditions, such as temperature, sound, light, or the movement of chemicals or objects or vibrations. WSNs are often installed in very harsh environmental conditions where he human monitoring is very risky, such as in high alpine environments, forcing them to run unattended for most of the time. These nodes continuously sense the environment, communicate events to each other and route their information to a remote base station. The most important challenge in achieving this goal is the power constraint on these small, low cost sensor nodes.

It is a new (2) information acquisition and processing technology, it does not require any of the default network. A large number of randomly sensor nodes formed self-organization network by wireless communication. It has a network of self-organization, network topology reconfiguration flexibility, and many other advantages, has a very broad application prospects and high academic value. In wireless networks, inexpensive sensor nodes, but extremely limited node energy and environmental complexity of network applications, the maximum degree of reduction of communication energy consumption of sensor nodes is one of the main researches in sensor networks.

II. LOW ENERGY ADAPTIVE CLUSTERING HIERARCHY (LEACH)

LEACH is the first (3) and most popular energy-efficient hierarchical clustering algorithm for WSNs that was proposed for reducing power consumption. In LEACH, the clustering task is rotated among the nodes, based on duration. Direct communication is used by each cluster head (CH) to forward the data to the base station (BS). It uses clusters to prolong the life of the wireless sensor network. LEACH is based on an aggregation (or fusion) technique that combines or aggregates the original data into a smaller size of data that carry only meaningful information to all individual sensors. LEACH divides the a network into several cluster of sensors, which are constructed by using localized coordination and control not only to reduce the amount of data that are transmitted to the sink, but also to make routing and data dissemination more scalable and robust. LEACH uses a randomize rotation of high-energy CH position rather than selecting in static manner, to give a chance to all sensors to act as CHs and avoid the battery depletion of an individual sensor and dying quickly. The operation of LEACH is divided into rounds having two phases each namely (i) a setup phase to organize the network into clusters, CH advertisement, and transmission schedule creation and (ii) a steady-state phase for data aggregation, compression, and transmission to the sink. LEACH is completely distributed and requires no global knowledge of network. It reduces energy consumption by (a) minimizing the communication cost between sensors and their cluster heads and (b) turning off non-head nodes as much as possible. LEACH uses single-hop routing where each node can transmit directly to the cluster-head and the sink. Therefore, it is not applicable to networks deployed in large regions. Furthermore, the idea of dynamic clustering brings extra overhead, e.g. head changes, advertisements etc., which may diminish the gain in energy consumption. While LEACH helps the sensors within their cluster dissipate their energy slowly, the CHs consume a larger amount

Volume 5 Issue I, January 2017
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of energy when they are located farther away from the sink. Also, LEACH clustering terminates in a finite number of iterations, but does not guarantee good CH distribution and assumes uniform energy consumption for CHs.It is one (4) of the earliest clustering routing protocols for WSNs to increase the lifespan of network. LEACH is a self-organizing protocol that distributes energy load equally among all the sensors of the network. In LEACH, nodes form clusters and a CH is elected from each cluster. LEACH chooses high energy sensor node CH and rotates this role among all nodes of the network.. LEACH also performs data fusion to compress the amount of data being sent from cluster to base station. Thus LEACH reduces energy dissipation and increases network lifetime. For each round, sensors elect themselves as CH with certain probability. The status of these CHs is broadcasted within the network. Each sensor node selects its CH by choosing the one which requires minimum communication energy to send data to. After the formation of a cluster, CH creates a schedule for the nodes to transmit data. In this way, nodes transmit data to the CH in their allocated time and are in sleep condition for the rest of the time. So, the energy dissipation of individual sensor node is minimized in this manner. When the cluster-head receives all the data from nodes within a cluster, it aggregates that data and sends compressed data to the base station. In this way, energy dissipation of the whole network is reduced. Similarly, being a CH, the energy of that node drains fast. LEACH has no fixed number of CH and a CH is self-elected in every round. For a node to become CH, depends on energy of that node. So, node with higher remaining energy acts as CH for that round.

A. Peration of leach

The operation of (4) LEACH is broken into rounds. Each round consists of two phases, a set-up phase and a steady-state phase. In set-up phase, the clusters are organized and in steady-state phase data is transmitted to the base station. Generally steady-state phase is longer than set-up phase to minimize overhead.

B. Advertisement phase

At the (5) beginning, when clusters are formed, each node decides whether it should become a CH for the current round or not. This decision is taken by determining the suggested percentage of CH and number of times a node has been a CH. A node n makes a decision by taking a number between 0 and 1 randomly. If the number is less than a certain threshold T(n), the node becomes CH for the current round. The threshold is determined as:

$$T(n) = \begin{cases} \dfrac{P}{(1 - P * [r \bmod (1/P)])} & \text{if } n \in G \\ 0 & \text{otherwise} \end{cases}$$

Where 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. By using this threshold, each node has the chance of becoming a CH at some stage within 1/P rounds. During initial round zero (r=0), each node has the probability P of becoming a CH. Similarly, if a node becomes CH in round zero, it cannot become a CH for the next 1/P rounds. The node that has elected itself as CH for the current round, broadcasts an advertisement message to all nodes within the network. The non-CH nodes have to keep their receivers on. This advertisement is received by non-CH nodes. After receiving this message, each sensor node decides to join a certain cluster for the current round. This decision is taken according to the strength of received signal. So, the non-CH will join a CH whose received signal strength is larger. In this way, the energy required for communication between non-CH nodes and CHs nodes is less. In certain cases where received signal strength is same for more than one CH, a random CH is selected.

C. Cluster set-up phase

When a node (5) decides to join a cluster, it must inform the cluster-head that it wants to be a member of that cluster. During this phase, the CHs have to keep their receivers on.

D. Schedule creation

After receiving (5) message from all nodes that would like to join that cluster, the CH creates a TDMA schedule based on number of nodes and informs the nodes when to transmit data.

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E. Data transmission

Once the clusters (6) are created and the TDMA schedule is fixed, data transmission can begin. Assuming nodes always have data to send, they send it during their allocated transmission time to the cluster head. This transmission uses a minimal amount of energy (chosen based on the received strength of the cluster-head advertisement). The radio of each non-cluster-head node can be turned off until the node's allocated transmission time, thus minimizing energy dissipation in these nodes. The cluster-head node must keep its receiver on to receive all the data from the nodes in the cluster. When all the data has been received, the cluster head node performs signal processing functions to compress the data into a single signal. For example, if the data are audio or seismic signals, the cluster-head node can beam form the individual signals to generate a composite signal. This composite signal is sent to the base station. Since the base station is far away, this is a high-energy transmission.

F. Advantages Of Leach

LEACH is (5) completely distributed, requiring no control information from the base station and the nodes do not require knowledge of the global network in order for the LEACH to operate.

Node serves as CH once in a round to distribute the load equally.

TDMA prevents CHs from unnecessary collisions. 4. Excessive energy dissipation is prevented by communicating only in the allocated time.

G. Disadvantages Of Leach

It performs (5) single hop communication which is not applicable to large networks because of excessive energy dissipation.

Leach does not ensure real load balancing for nodes having different initial energy because CH is selected by probability and not seeing its initial energy.

The idea of dynamic clustering brings extra overhead.

III. PURPOSED WORK

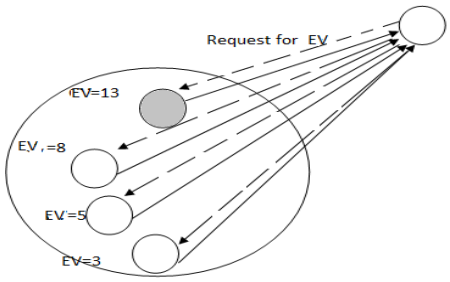
A. Srreer Algorithm Details

The operation of SRREER is broken upon in to some steps, where initial step is cluster building stage, after building of clusters second step is election of cluster head based on cost value calculations which is calculated by some random node chosen as supervisor node outside the cluster followed by third step which is data transmission phase in which data is transmitted from that supervisor node to the base station and alteration of cluster is done based on packet loss ratio calculated by supervisor node itself. In order to minimize overhead, the data transmission and cluster size alteration phase is long compared to the cluster building phase.

Routing protocols (4) for wireless sensor networks can be characterized into two classes, proactive and reactive protocols. LEACH protocol is considered as proactive protocol since it refers reports to the BS periodically. In reactive protocols, when an event of attentiveness occurs, it is reported to the BS. Reactive protocols are mostly used for time critical applications where speedy response to fluctuations in the sensed parameters is mandatory.

B. Cluster head selection

Let us take an example of cluster depicted in the figure 3.1. We have a cluster in which four sensor nodes are deployed. And randomly a SN is elected which is closest to cluster. SN broadcast a request message to nodes for their cost value. Cost value is given in reply by the nodes 1, 2, 3 and 4. Their cost value is checked out and the node having highest cost value is elected as cluster head. Cost value of node 1 has highest cost value of 13 and therefore it is declared as CH of the cluster. SN sends this information to other clusters.



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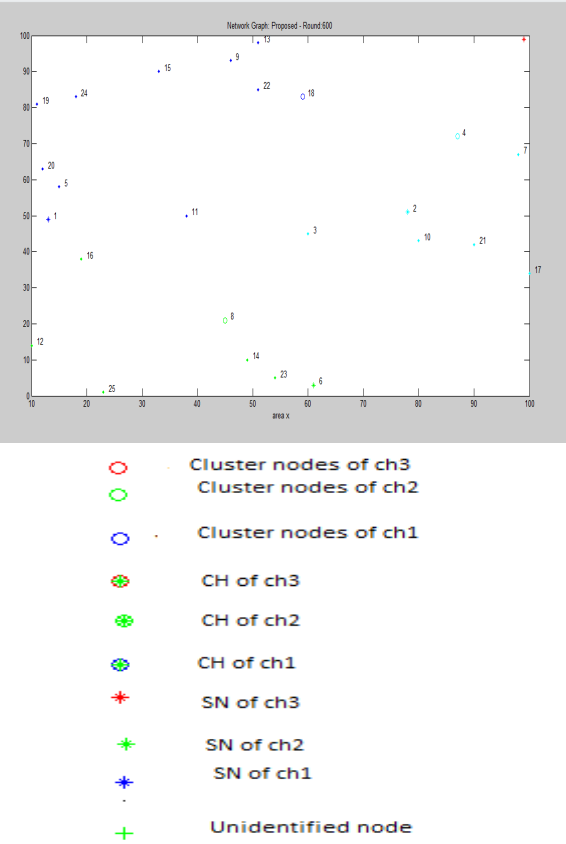
C. Initialization of network

We have consider a network of 25 nodes where nodes dimensions for node 1 to 25 are
Node=[10,30;25,25;20,20;30,40;40,25;30,10;30,5;50,25;50,5;60,20;70,10;70,45;95,40;80,25;72,15;80,15;90,20;15,70;40,80;50,70;40,60;55,55;60,75;65,60;70,80];
These nodes are considered in the network area of
xm=100;
Ym=100;
Where the dimensions of sink is
xd=99;
And yd=99.
Out of this network area; three non-overlapping regions for cluster is determined where sensor nodes are fitted. Three clusters are ch1, ch2 and ch3. These clusters have their members fitted in their own region.
Cluster member of first cluster is
ch1= 3, 4, 5, 6
Respectively for ch2 and ch3 are
ch2= 14, 15, 16, 17 and ch3=20, 21, 22, 23, 24
Their respective supervisor nodes are
sn =[7, 10, 19]
and non-cluster members are
nch=[1,2,8,9,11,12,13,18,25];



C. Performance evaluation in terms of rate vs packet delivery ratio

In figure 3.2 it can be evaluated that the packet delivery Ratio of our new proposed protocol is greater than the existing LEACH protocol. It is presented that with the increased rate there is increase in packet drop which will lead to reduction in delivery of packet. EERDAT is beneficial here when compared to LEACH because the new protocol calculates the data fatal ratio at the

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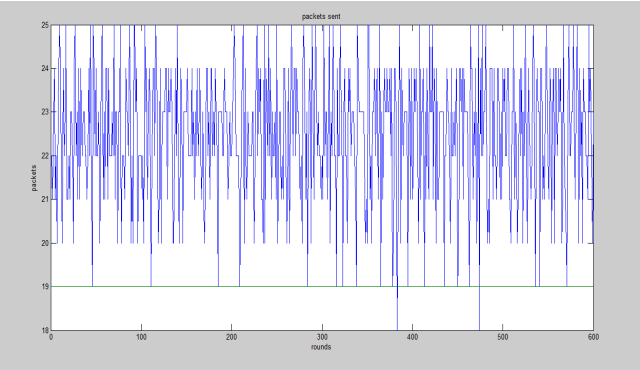
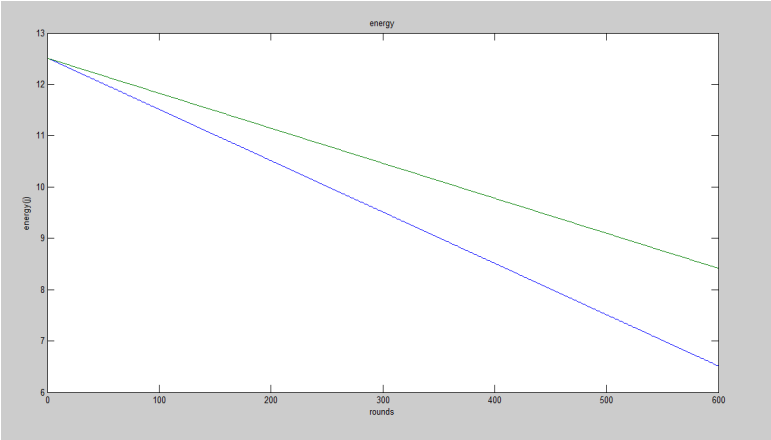
supervisor node and accordingly adjusts the cluster size based upon modification in their respective size.



D. Performance evaluation in terms of energy consumption

In the figure 3.3 we can see that with the increased rate in node, it consumes more amount of energy which increasing the network congestion and also increase in traffic which causing packet drop and resending of the packet which is causing wastage of energy. Proposed protocol is more efficient in terms of energy consumption because in this protocol we are selecting CHs based upon levels of energy where LEACH consumes more amount of energy compared to our proposed protocol.



IV. CONCLUSION

In this paper, we described LEACH, a clustering-based routing protocol that minimizes global energy usage by distributing the load to all the nodes at different points in time. LEACH outperforms static clustering algorithms by requiring nodes to volunteer to be high-energy cluster-heads and adapting the corresponding clusters based on the nodes that choose to be cluster-heads at a given time. At different times, each node has the burden of acquiring data from the nodes in the cluster, fusing the data to obtain an aggregate signal, and transmitting this aggregate signal to the base station. LEACH is completely distributed, requiring no control information from the base station, and the nodes do not require knowledge of the global network in order for LEACH to operate.
Distributing the energy among the nodes in the network is effective in reducing energy dissipation from a global perspective and enhancing system lifetime.

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