

Leach Algorithm Based on Clustering for Enhancement of Wireless Sensor Network

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ABSTRACT: *Wireless sensor networks (WSN) is composed of large no. of sensor nodes which are deployed in a wide area. And it constitutes a network by self organizing. A sensor network system includes sensor nodes, sink nodes, and coordinate node. The routing protocol of WSN is to find the optimal route between the source node and destination node and its primary goal is to improve the quality of the network. For improving the quality, In this paper we propose LEACH (Low energy adaptive clustering hierarchy) protocol, which is a cluster based routing protocol for wireless sensor network. It used the clustering concept to distribute the energy among the sensor nodes in the network. It improves the energy efficiency of WSN beyond the normal clustering architecture.*

KEYWORDS: *Wireless sensor networks, Routing protocol, LEACH*

1. INTRODUCTION

Wireless sensor network (WSN) is consisting of independent sensors nodes that communicate with each other to monitor the environment. Sensor nodes are comprised of battery operated tiny nodes. which have limitation in their computation capabilities, memory and bandwidth. The most prominent applications of wireless sensor network are monitor impassable border region, monitoring strength of dams, bridges and roads and monitoring battlefield or sensitive military zones. Since these sensors are utilized in hardly accessible areas and their batteries are not rechargeable with limited energy, lifetime of the network plays an essential role in design of wireless sensor networks. Therefore some algorithm must be used which must be reduce the extra energy consumption in the sensor network. Routing protocol have a critical role in most of these activities. There are many routing protocol for wireless sensor networks, many routing protocols developed continually with the research on WSN. LEACH protocol is a hierarchical routing protocol design special for WSN. Energy efficiency is one of the major focus in designing protocols for WSNs. The energy efficient communication protocol for this

network is LEACH that works on cluster based homogeneous WSNs.

2. BASIC THEORY OF WSN

A wireless sensor network which is a collection of nodes organized into a cooperative network .Each node consists of processing capability (one or more microcontroller, CPUs chips), also contain multiple types of memories (program, data and flash memories), have a RF transceiver (with a single Omni-directional antenna), have a power source (e.g. batteries), and accommodate with various sensors. The nodes communicate wirelessly and often self-organize in the network. Systems of 1000 or even 10,000 nodes are anticipated. The application domain of WSNs are varies from environmental monitoring, to health care applications, to military application. Table 1 and Figure 1 demonstrate components and applications of wireless sensor networks, respectively.

Wireless network components	Definition
Sensor	
Sensor node	A node consisting of one or more sensors.
Network	A network composed of sensor nodes .
Base station	A node which is responsible for receiving data and establishes communication between nodes and task manager nodes.
Task manager	A node by which a person as operator or network manager communicates with the network

Table 1. Components of wireless sensor networks.

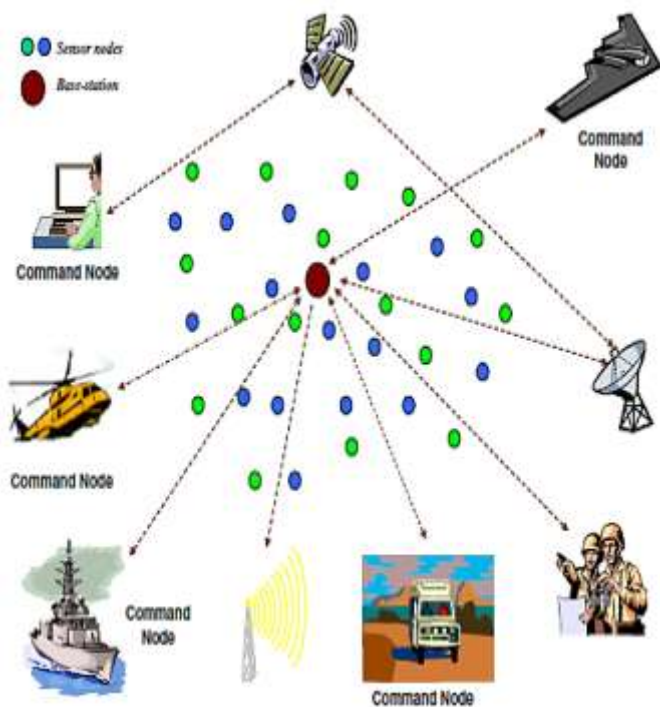


Figure1. Applications of wireless sensor networks.

3. PROBLEMS OF NETWORK DISCONNECTIVITY DUE TO CLUSTER HEAD FAILURE

When WSNs operate, its cluster head node starts to die as they have consumed their limited battery power and no longer be connected to the system, which will disconnect some important nodes from the access point. In such a situation the probability of network partitioning or nodes separation is high. Also Radio transmission is dependent on the battery power and low battery power causes less transmission range that ultimately causes bad connectivity. The problems that can occur due to sensor node failure in the network are causes loss in connectivity and delay due to the loss in connection. Therefore, to overcome sensor node failure and to guarantee the system reliability, faulty nodes should be detected in the minimum possible time and take appropriate acts to recover connectivity between nodes must be taken to accommodate for the faulty node. A solution to maintain or to re-establish network connectivity is to remove the failed or compromised nodes which are creating connection problems and deploy the more nodes in the sensor field to eliminate the connectivity problem, but there are situations, for example battlefield, where nodes redeployment is impossible, therefore WSNs' fault management schemes must be efficient enough to overcome connectivity problems

without human intervention. Whenever cluster head at any of the levels fails accidentally.

4. CLUSTERING CONCEPT IN WIRELESS

In LEACH (Low energy adaptive clustering hierarchy) protocol, during the establishment of network connection the whole area is divided into permanent and static clusters. The shape of clusters can be square or rectangular according to the design requirement and area available. Each cluster contains a separate LEACH protocol running parallel to its neighboring clusters. The main aim of separating the whole area into small static fields is to reduce complexity and power dissipation. Small portions of clusters are easy to manage rather than one large field of operation. In this way, the nodes also reduce the power level of their broadcast messages, because they only have to cover a small portion of area from the main region. And also helps to increase the network lifetime and minimizes energy consumption.

■ CLUSTERING ALGORITHMS FOR WSNS

Clustering algorithms here are classified on the basis of methodology of clusters i.e. centralized, distributed and hybrid clustering.

- I. **distributed clustering algorithms:** In this algorithm cluster head keeps on moving from node to node are called distributed clustering algorithms.
- II. **Equal clustering based algorithms:** In large scale WSN energy efficiency and network life time are main issues. Clustering of network made data aggregation and communication between node and BS more efficient, thus saving node energy and increasing network lifetime.

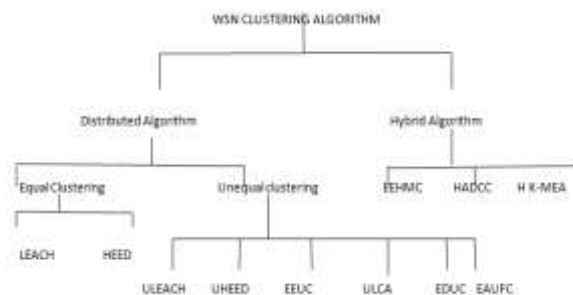


Figure2 clustering algorithm for WSNs

5. LEACH PROTOCOL:

LEACH stands for Low-Energy Adaptive Clustering Hierarchy. It is the first hierarchical routing protocol in Wireless Sensor network. In this protocol nodes are divided into only two types of categories; normal sensor nodes and cluster heads (CH). At first the normal sensor nodes are grouped together and form clusters and among all the sensor nodes in a cluster one node are selected as a CH node. The CH selection procedure is a random selection procedure where every node is assign a random value and this is compared with a threshold value.

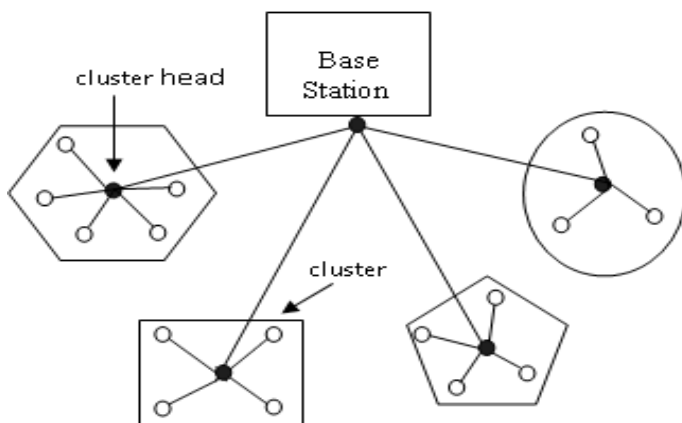


Figure 3 . Clustering In LEACH

LEACH is the most popular hierarchical cluster-based routing protocol for a wireless sensor network. In LEACH, the nodes in the deployed area are organized into local clusters and the communication process is divided into rounds with each round including the following phases:

A. Setup Phase

In the cluster setup phase, a predetermined fraction of nodes, p , elect themselves as CHs as follows. A sensor node chooses a random number, r , between 0 and 1. If this random number is less than a threshold value, $T(n)$, the node becomes a cluster-head for the current round. The threshold $T(n)$ is calculated as:

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

Where P is the desired percentage of nodes which are CHs, r is the current round, and G is the set of nodes that has not been CHs in the past $1/P$ rounds. The node whose number is larger than the threshold will select itself as a cluster head and then broadcasts the message to its surround sensor nodes. Otherwise the node whose number is smaller than threshold will only

send request message containing its ID to the cluster which has the strongest signal strength for saving energy spent on the transmitting distance. Once the cluster head receives request message coming from one node, it records the node's ID and proclaims it as its member node. Based on the message it records, the CH creates a TDMA schedule table and broadcasts it to the cluster members. Therefore, all the member nodes get their idle slots for data transmission, and then the steady-state phase starts.

B. Steady-State phase

During the steady state phase, the data collected by the individual sensors will be given to the CHs during TDMA schedule. And then CH performs the data aggregation/ fusion by local computation to the base-station (BS). The BS receives only aggregated data from cluster-heads, leading to energy conservation. After a certain period, the network returns into the setup phase again and enters another round for selecting new CH. Each cluster communicates using different CDMA codes to reduce interference from nodes belonging to other clusters. However, heavy tasks executing on CH can lead too much energy consumption. In order to avoid making the CHs die early and cause the cascade effect in the network, a new round begins and new clusters will be rebuilt in the whole network.

6. ADVANTAGES AND DISADVANTAGES OF LEACH

The various advantages of LEACH protocol are:

1. The Cluster Heads aggregates the whole data which lead to reduce the traffic in the entire network.
2. As there is a single hop routing from nodes to cluster head it results in saving energy.
3. It increases the lifetime of the sensor network.
4. In this, location information of the nodes to create the cluster head is not required.
5. LEACH is completely distributed as it does not need any control information from the base station as well as no global knowledge of the network is required.

Besides the advantages of LEACH it also has some Demerits which are as follows:

1. LEACH does not give any idea about the number of cluster heads in the network.

2. One of the biggest disadvantage of LEACH is that when due to any reason Cluster head dies, the cluster will become useless because the data gathered by the cluster nodes would never reach its destination i.e. Base Station.
3. Clusters are divided randomly, which results in uneven distribution of Clusters. For e.g. some clusters have more nodes and some have lesser nodes. Some cluster heads at the center of the cluster and some cluster heads may be in the edge of the cluster, this phenomenon can cause an increase in energy consumption and have great impact on the performance of the entire network.

7. CONCLUSION AND FUTURE SCOPE

Wireless sensor network is composed of many wireless sensing devices called sensor nodes, sink nodes and coordinate nodes. These nodes are small in size, limited in resources and randomly deployed in harsh environment. In this paper, we have explained about the cluster formation and then problem of network disconnectivity due to cluster head failures in wireless sensor networks. So we have tried to find a solution for network disconnectivity . We have proposed LEACH(Low-Energy Adaptive Clustering Hierarchy) protocol for wireless sensor network to diagnose faults and perform appropriate measures to recover sensor network from failures. It maintains the connectivity of the network and the reliability of data transfer even when a node in the network runs out of energy. And help to increase the network lifetime.

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