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Enhanced LEACH Protocol for Wireless Sensor Networks

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Abstract
Wireless Sensor Networks are been used in many practical application such as health care monitoring, environmental detection, industrial supervising and data logging. However, in order to reach their potential, researchers must discover solution to some troubles which are slowing down the wide spread use of these infrastructures. The power consumption in wireless sensor network is a primary concern and it is studiedwhen designing sensor networks. To achieve balanced energy consumption and scalability, the designers use hierarchical routing protocols based on clustering. In this paper, we study the designdifficultiesin the wireless sensor networks to setup the cluster and featureemployed of Low Energy Adaptive Clustering Hierarchy protocol (LEACH). The Enhanced protocol adds the distance parameter to the threshold T(n). The multihop routing algorithm of cluster head is proposedtoo, it based on the hop count. MATLAB was used to simulate, which is concluded that the enhanced LEACH protocol can balance load of the network to extend the life cycle of network.

Introduction

A wireless sensor network (WSN) is consisted of a vast of sensor nodes that in turn are provided with a sensor to reveal any physical phenomena, such as light, heat, pressure, and so on. Accordingly, infrastructure systems will improve its accuracy and capacity by using WSNs, since they are considered as a powerful method of building the information and communication system. WSNs are also considered as the easier approach to spread and achieve better flexibility of devices, compared to the wired ones. Therefore, and as there is a quick development in technological sensors, WSNs are believed to become the main technology for the Internet of thing (IoT).

Designing protocols is a serious issue that is achieved by maintaining the right energy performance. Sensor nodes are provided with small limited power batteries which can be put or spread manually and in a random way. Hence, clusters are needed to regulate the active and scalable work of the wireless network.

The data gathering is performed by a cluster head (CH). It gathers information through its cluster's nodes and, if required, combines and compresses the data before transmitting to BS. But, as a result, the cluster heads consume a lot more energy.

LEACH is the most known clustering protocol which addresses the possibility of changing the role of the cluster head in nodes as a problem of clustering energy. This turning into a cluster head possibility has to be done in a smart way to improve the network performance. Thus, this paper aims to mark the energy problem and promote a method for add a distance factor and hop count for routing algorithm of cluster head [1].

LiteratureReview

Sensor networks were used in many applications. Military applications were the first to use them and then they began to be used in environmental monitoring, health monitoring, etc. Moreover, Power Consumption,Fault Tolerant Communication, , Data Aggregation and Delivery Models, Scalability and Node Deployment are considered as factors that motivate the design of sensor network.

One feature of LEACH as a network protocol is the use of wireless sensor hierarchically routing, in order to increase the lifetime of the network. So, all the nodes formulated as members within local clusters into the network and one of them becomes the cluster-head, whereas the data of other nodes that are non-cluster ones are transmit the collected data to the cluster-head. In turn, cluster-head node relocates data to the remote base station after performing their processing like data aggregation. Consequently, cluster-head node appears to have more power-intensive than other nodes of cluster. Accordingly, when a node of cluster-head stops working or dies the ability of all nodes to communicate with base station will be lost.

Therefore, in order to maintain the battery power in the cluster of a sensor and to equally distribute the cluster-head energy load, LEACH associates the high-energy cluster head with possible rotation in the nodes. So, a Time-division multiple access (TDMA) schedule will be made by the cluster-head who is familiar with all nodes number. In this way, nodes are informed with the exact time of relocating data. TDMA is also useful for avoiding intra-cluster collisions while data are transferred to the base station by cluster-head.

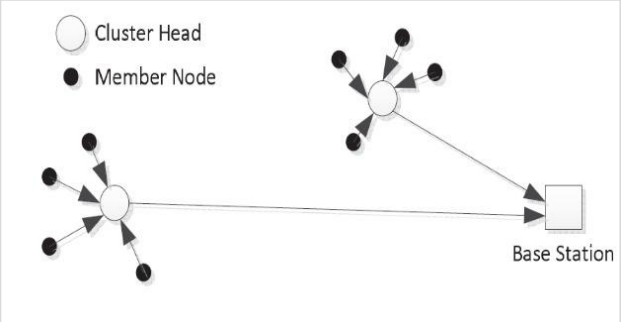
Abdellah, and Hssane (2010) Proposed Advanced Low Energy Adaptive Clustering Hierarchy A-LEACH is an extension of the LEACH, which improves the stable area of the clustering hierarchy and reduces the probability of failure nodes employing the particular parameters of heterogeneity in networks. In these networks some high energy nodes called CAG nodes become cluster head to collect the data of their cluster members and transfer it to the sink or Gateways to minimize the energy consumption of cluster head because it is employed to route information from cluster head to the sink, which permits to minimize the failure probability of clusters head and this increase the lifetime of the network [2].

Farooq et al. (2010) Multi-hop Routing with Low Energy Adaptive Clustering Hierarchy partitions the network into different layers of clusters and in each layer there is a cluster head and then cluster head collaborates with adjacent layers to transmit sensor's data to the base station. MH-LEACH adopts an optimal path between cluster head and base station [3].

Liao, and Zhu (2013) shows that An Energy Balanced Clustering Algorithm Based on LEACH Protocol depend on the residual energy and distance factors, and these improve cluster-head election and the strategy of non-cluster head node Selecting the optimal cluster-head [4].

LEACHProtocol

LEACH was addressed by W. R. Heinzelman, and it stands for Low Energy Adaptive Clustering Hierarchy that is a sensor networks protocol that seeks for decreasing the energy dissipation in wireless sensor networks. So, the clusters are arranged based on the received signal strength. LEACH protocol aims to provide sensor networks with a set of data / data aggregation. So, the nodes are consisted of clusters (i.e. several small groups) which distribute and arrange the power consumption



inside the network. As the following formation:

Figure 1: Formation of cluster

Randomly, the cluster head is selected to rotate a possible way to spread the energy load in the cluster sensors. The node n selects a number randomly between 0-1 and if the number is less than the threshold T (n), the nodes become a

cluster head for the present round, as the following:

$$T(n) = \frac{P}{1 - p * (r \bmod (1/p))}, if n \epsilon G$$

$$T(n) = 0, Otherwise$$

In which, p is the cluster head desired percentage (e.g. 0.05), r is the present round and G is the group of nodes that have not been cluster heads in last 1/p rounds [5].

Nodes that are needed to be as cluster head that act as a router to the base station is only 5%. The cluster head (CH) nodes gets the data coming from the respective cluster nodes and compresses them, then sends a set of data to the base station. So, the aggregated data are a minimization of the volume of information that has to be relocated to the base station. Hence, data aggregation is performed local to the cluster [6].

LEACH protocol is addressed into two phases that in turn are consisted of many stages:

A. Setup phase:
   1. Advertisement stage.
   2. Cluster joining stage.
   3. Broadcast stage.
B. Steady phase:
   1. Making schedule.
   2. Data transmission.

The setup phase is divided into more three points. Firstly, in advertisement stage nodes decide independently the possibility of whether or not to become a CH for the present round, nodes sends a broadcast message if they become CH and everyone in the network hears the message. In addition, a multiple access protocol that carries sense is used to revoke any incongruity.

Secondly, in cluster joining stage the other remained nodesjoin a cluster depending on the largest received signal strength of the message in the first stage, and declare their desire to join cluster by sending a join request message. Thirdly, the broadcast stage begins when the CHs get all the join requests. In which the CHs broadcasts a message declaring that cluster member nodes can use time slot schedule for communication [7].

Moreover, the steady-state phase begins when the clusters are established, where sensor nodes and BS starts to have a real communication.

Every node knows its time slot to relocate information, messages are gathered from all their cluster members by the CHs who also aggregate the information and send the result to the BS. The steady-state phase will be compared with the setup phase as will be of a lot longer time includes multiple reporting cycles [8] [9].

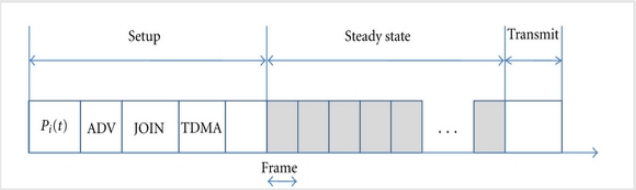


Figure 2: LEACH Time line

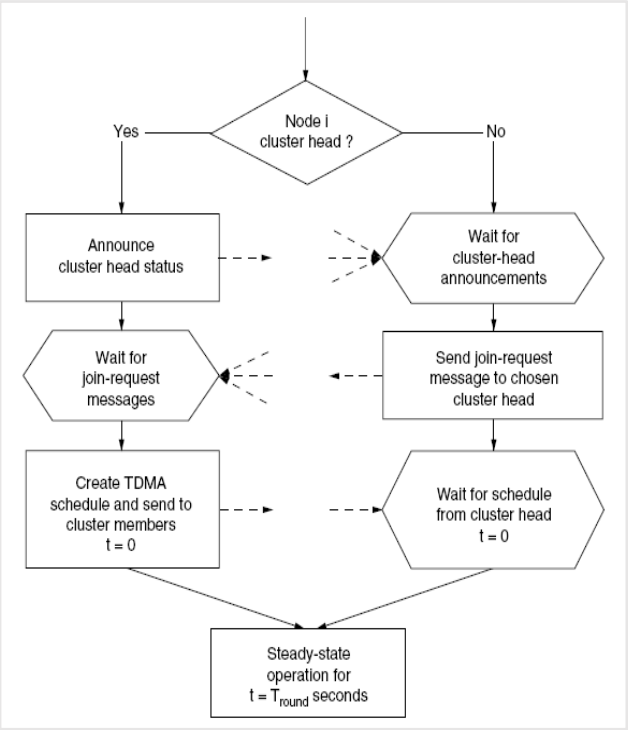


Figure 3:Set-up phase of the LEACH protocol

During the steady stage, data transmission phase deals with the mutual nodes in one cluster that send data to the cluster head by the TDMA schedule, similarly to LEACH. Every CH communicates in a direct way with BS despite how far is the distance between cluster head and BS.

This paper indicates that there are two types of the transmission between CH and BS: onehop transmission asstandard LEACH and multihop. Its purpose is to decrease the loss of the transmission. When there is a remained energy of the live near cluster, cluster heads sendsthe aggregated data to this near cluster head and it is the far place they can reach. Then, this near cluster heads select the nearest cluster head to get the aggregated data and it goes like this until data are relocated to BS. Nevertheless, this paper uses the strategy of ideal path accepts multihop between cluster head and BS. Thus, the cluster head that chooses the next-hop node rather than transmitting data directly to BS must have two certain conditions: (1) there is a far distance to the BS and there are other cluster heads in a way to the BS and these cluster heads have enough energy that is remained to transmit the aggregated data. (2) Cluster heads node will die and stop working if they transmit the data that has been received.

Simulation Analysis

The developed protocol has been simulated and compared with the standared LEACH protocol.

A. Simulation parameters setting:

- There are two types of nodes in the network: and general nodes (allnodes with energy limitation) and one as BS nodes (without energy limitation)
- Power consumption in each round of the ideal channels between the nodes is 0.05J, but sending power consumption is the same receiving it, and the initial power of the node in the network is 10J.
- Randomly, nodes are spread in an area within 120 x 120m.
- 0.04 is the possibility of becoming cluster head in the network.
- The variety in network structure leads to different capacities of the same number of nodes in the network. In this paper, the simulation of the network topology is constructed in a random way each time and it results the average for ten various network topologies.

B. Simulation results:

The capacity of the residual energy of LEACH protocol and the enhanced method are shown in figure 4. As a result, the new enhanced algorithm maintains the energy more than LEACH. Hence, it has better performance than LEACH protocol.

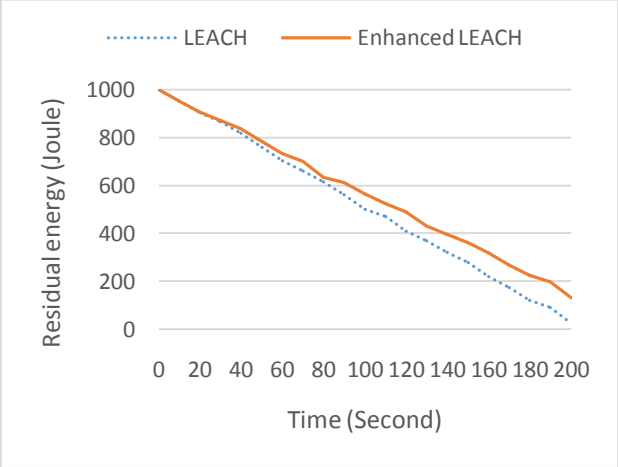


Figure 4: Residual energy of 100 nodes

The capacity of the death time of network among various numbers of nodes is shown in figure 5. The new enhanced algorithm lasts longer than LEACH protocol, and in comparison with LEACH, the new algorithm method extends the network lifetime.

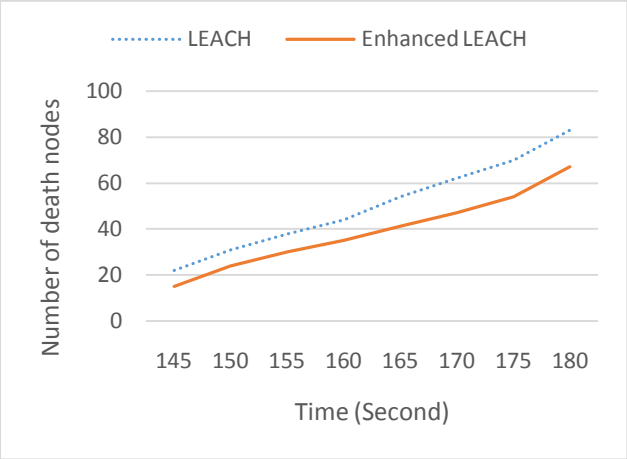


Figure 5: Time of network death in different number of nodes

Conclusion

The enhanced algorithm adopts multi-hop communication between cluster and BS presented in this paper, shows that this new strategy has better performance than LEACH protocol according to the simulation results.

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