ENERGY EFFICIENT CLUSTER BASED ROUTING MECHANISM FOR WIRELESS SENSOR NETWORKS

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Abstract : The Wireless sensor networks is one of the premier research are from past few decades, so the need to maintain energy efficient routing between from the nodes to base station, proper data aggregation and scalability is the important concern. In hierarchical routing LEACH is one of the energy efficient clustering protocol, but only the problem is size of the clusters are not same either they may be small or large, which causes to reduce the network lifetime. The other protocol FZ-LEACH addresses the LEACH problem by selecting some random cluster heads, but not energy efficient. In this paper, we propose a new protocol enhanced far-zone cluster-based routing protocol with optimized algorithm (FZ-CRP), form's cluster heads and zone heads based on the intra communication cost and energy. If the node's energy is the less than or equal to average minimum reach ability power then that node is said to be in far zone, far zone node transmits the data to base station via far zone, cluster heads. The performance of the proposed is better when we compare with existed scenarios.

IndexTerms - **wireless sensor network, cluster head, cluster formation, network life time and energy consumption, leach protocol.**

1. INTRODUCTION

Sensor networks have emerged as a promising tool for monitoring (and possibly actuating) the physical worlds, utilizing self-organizing networks of battery-powered wireless sensors that can sense, process and communicate [1]. In sensor networks, energy is a critical resource, while applications exhibit a limited set of characteristics. Wireless sensor network is a large network consists of several nodes called sensor nodes which transmits the data to/from a fixed wired station called base station (BS), serves as a gateway in the network. The applications of wireless sensor network include military field, structural health, environment etc., [2,3,4].

The main objective is to achieve energy efficiency with limited resource. Hence the node does not communicate with another node where the energy level at the initial state and while transmission state are equal. In order to overcome this, draw back a new protocol is designed by considering the improved version of energy factor.

The FZCRP is a hierarchical based routing protocol, which enforces the structure of a network to use energy efficiency, extend the lifetime, and scalability.in this protocol clusters are created and a head node is assigned to them, which acts as a leader for the remaining nodes in each and every cluster, it has the responsibilities like collection and aggregating the data from the respective cluster and transmitting the aggregated data to the base station[5]. This data aggregation in each and every cluster greatly reduces the energy utilization in the network where the messages are to be send to the base station. This paper presents an extension to the protocol FZCRP[6] based on different power levels for wireless sensor network. The proposed protocol FZCRP maintains the energy consumption during the transmissions in order to increase the lifetime of a sensor node.

The remaining part of the paper is arranged s follows.an overview of related work is given by section 2, section 3 describes the implementation of (FZCRP) far-zone cluster-based routing protocol. Simulation and analysis results are discussed in section 4.in section 5, the paper conclusion work and the future scope is presented.

2. RELATED WORK

Low-Energy Adaptive Clustering Hierarchy (LEACH) [7] is a clustering-based protocol to collect data from wireless network. In the network, hundreds and thousands of wireless sensors are dispersed that collects and transmit data. In the network cluster heads are elected among the sensor nodes in order to transmit the data collected to the base station.in the network the sensor node being in expensive and simple their power level is low and cannot be replaced by the another node, because of this each sensor in the cluster must take its turn as being a cluster head to make the protocol energy efficient.

Once the cluster head is selected the remaining non cluster heads decides its cluster for this round which requires minimum communication energy based on the received signal strength of the advertisement from each cluster head which is shown in the following fig. The cluster head node in leach uses TDMA schedule in order to transmit the data among the nodes which are present in cluster, it also uses CDMA schedule to transmit the data from one cluster head to another cluster head to reach the data to sink node it uses single hop routing, where it is not applicable in larger networks.

The leach protocol has some deficiencies such as,

1. The initial state and transition state of cluster head uses same energy level.
2. Some large clusters and small clusters may exist in the network at the same time.
3. In this protocol the selection of cluster head is done frequently which changes the network layer and increases the cost of energy.

In leach protocol the cluster head which is far away from the base station requires large amount of energy to transmit the data to base station. Multi hop leach protocol is used to solve this problem by simply changing the transmission mode between

cluster head and base station from single hop to multi hop, chooses the best possible path between cluster head and base station by using the other cluster heads as relay stations to send the data to base station.

In leach protocol the cluster heads are not uniformly distributed so, leach-c an improved version of leach is used .this protocol uses the centralized clustering algorithm and a steady state phase that is used by leach.In LEACH – C[8] the node sends their current location information and residual energy level to sink, which calculate the average node energy and finds which node energy is below the average.

In LEACH protocol the cluster head is responsible for receiving data from cluster members, data and then send it to the base station. If base station may be far away from cluster head, the cluster head dies then the data collected by the cluster head will never reach to the base station and therefore the cluster will become useless.

V-LEACH[9] protocol solves this problem by introducing the vice-cluster head acts as a cluster head while the real cluster head dies and start working as cluster head and the cluster head data will reach to the base station. There is no need to elect the new cluster head, so it will save the energy and enhance the network life time.

3. FZ-LEACH PROTOCOL

In this section we present an improvement in pre-existing, well known clustering protocol LEACH, proposed by Heilzemen *et al.* [5]. One major drawback of this protocol is that size of the cluster is not limited; clusters in LEACH may be very small or very large in size. In large clusters sensor nodes deplete energy faster because of the transmission distance. Here we propose a solution to this problem by introducing the concept of Far-Zone. The working of algorithm can be divided into two phases.

3.1. Cluster-head Selection and Cluster Formation Algorithm

In the proposed algorithm, cluster head selection and cluster formation is done in same manner as LEACH. The operation of FZ-LEACH is generally divided into two phases, the set-up phase and the steady-state phase. In the set-up phase, cluster heads are selected and clusters are organized. In the steady-state phase, the actual data is transmitted to the sink station. In the proposed FZ-LEACH algorithm, few nodes are randomly selected as CHs. This role is rotated to all nodes to balance the energy dissipation of the sensor nodes in the networks. Cluster head formation and creation for the algorithm is shown in the figure 1.

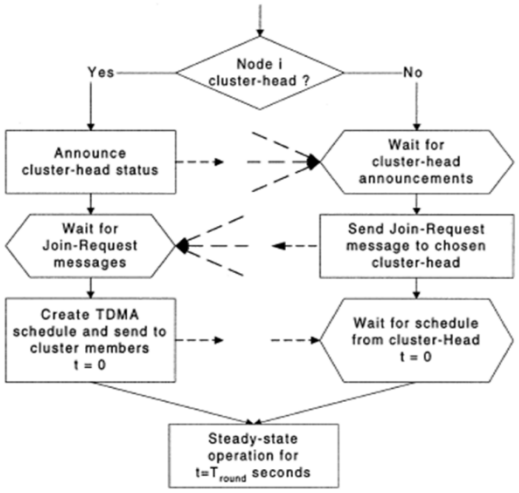


Fig.1. Cluster head selection and formation in proposed FZ-CRP

During the set-up phase, when clusters are being created, each node decides whether or not to become a cluster head for the current round. This decision is based on a predetermined fraction of nodes and the threshold T(s) given by following equation.

$$T(n) = \frac{P}{1 - P \times (r \bmod P^{-1})} \quad \forall n \in G$$

$$T(n) = 0 \quad \forall n \notin G$$

Where n is a random number between 0 and 1
P is the cluster-head probability and
G is the set of nodes that weren't cluster-heads the previous rounds

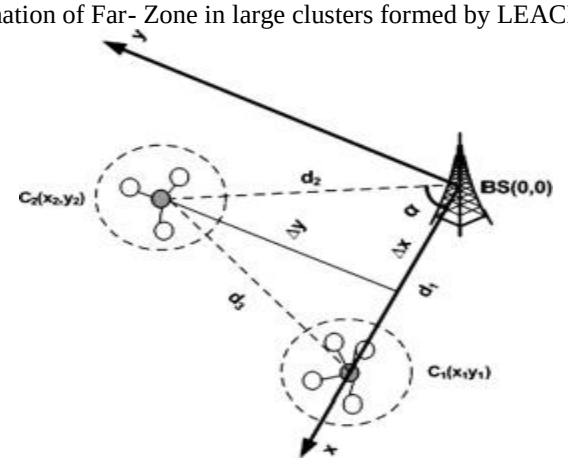
where *popt* is the predetermined percentage of cluster heads (e.g., *popt* = 0.05), r is the current round, and G is the set of nodes that have not been cluster heads in the last 1/ *popt* rounds. Using this threshold, each node will be a cluster head at some round within 1/ *popt* rounds. After 1/ *popt* rounds, all nodes are once again eligible to become cluster heads. In FZLEACH, the optimal number of cluster heads is estimated to be about 5% of the total number of nodes.

Each node that has elected itself cluster head for the current round broadcasts an advertisement message to the rest of the nodes in the network. All the non-cluster head nodes, after receiving this advertisement message, decide on the cluster to which they will belong for this round. This decision is based on the received signal strength of the advertisement messages. In this way cluster formation is done in FZLEACH

After cluster head receives all the messages from the nodes that would like to be included in the cluster and based on the number of nodes in the cluster, the cluster head creates a TDMA schedule and assigns each node a time slot when it can transmit.

3.2. Far-Zone Formation Algorithm

Most of the percentage of nodes energy is consumed in long distance transmissions. One of the solutions to efficiently utilize the energy in LEACH protocol is formation of Far- Zone in large clusters formed by LEACH protocol.



Once the cluster head formation is complete, proposed algorithm searches for eligible clusters to form Far-Zone. For formation of Far-Zone each node of the cluster sends its power level to CH.

4. SIMULATION AND ANALYSIS

This section compares the performance of proposed algorithm with LEACH protocol. The performance evaluation includes two parts: network lifetime and energy consumption. The sensors are simulated to deploy over a square sized area of l00m x l00m with variable communication range.

Simulation is performed using ns-2 [10], a discrete event network simulator. We have compared the performance of FZLEACH with LEACH. The basic parameters used are listed inTable-I.

TABLE I. SIMULATION PARAMETERS

Parameter	**Value**
Number of nodes	100
Network grid	100 100 m
Base station position	50 X 175 m
fs ε	10 pJ/bit/m2
mp ε	0.0013 pJ/bit/m4
elect E	50 nJ/bit
Size of data packet	500 bits
Initial energy of normal nodes	1 J

Figure 5 illustrates the performance comparison of LEACH, FZLEACH and FZCRP in terms of energy dissipation. As shown in Figure 5when compared to LEACH and FZLEACH, the energy consumption is less in FZCRP protocol in all cases thus it is energy-efficient and has optimum performance. The reason is clear that the sensor nodes within the Far-Zone have not to transmit for long distances that save a significant amount of energy.

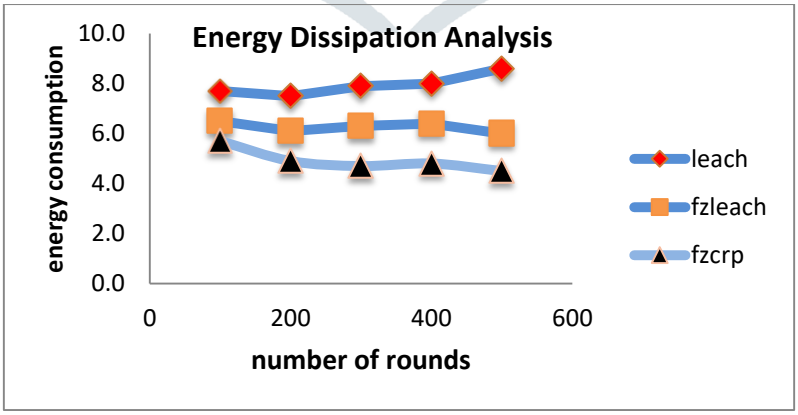


Figure 5. Energy dissipation analysis.

Figure 6 illustrates the performance of our algorithm comparing to LEACH, FZLEACH, and FZCRP algorithm in terms of network lifetime. As it is clear from Figure 6 that sensor network performs longer with FZCRP in comparison to, LEACH, FZLEACH. This is due to energy saving in transmission by the sensor nodes in Far- Zone.

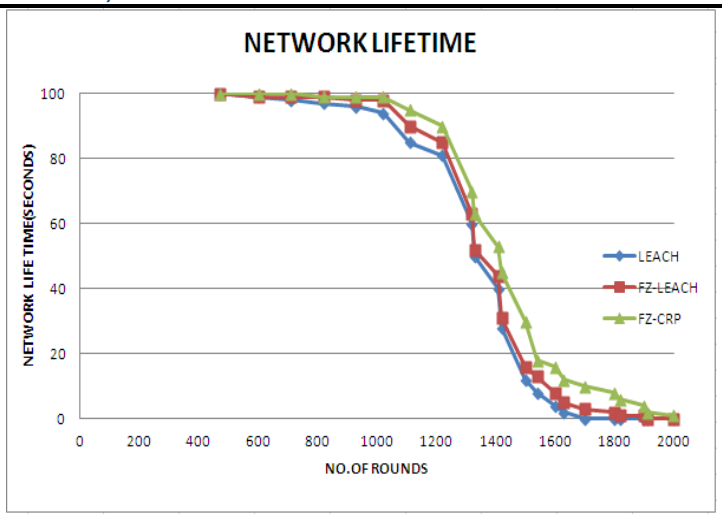


Figure 6. Network lifetime analysis.

5. CONCLUSION

In this paper we have proposed an improvement in LEACH protocol to overcome the shortcoming in this well-known and widely used protocol for clustering in wireless sensor networks. We have proposed FZ-LEACH algorithm, which is based on the original protocol and considers a Far-Zone inside a large cluster. Simulation results prove the improvement in the performance in the original LEACH protocol in terms of energy dissipation rate and network lifetime. It is found that FZ-LEACH protocol saves around 30% energy of sensor network in comparison to LEACH.

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