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Research Article

Clustering Protocol for Wireless Sensor Networks

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Abstract

Wireless sensor network (WSN) require various power management protocols to reduce the energy consumption. But the lifetime of sensor network greatly depend on their battery. Radio irregularity and fading in multihop WSN also affect lifetime of a sensor. Various cluster-based schemes are discussed as a solution for this problem. The proposed schemes centering on the clustering of network for conserve the energy of a network. The performance of the proposed system is evaluated in terms of energy efficiency and reliability.

Keywords: *Wireless Sensor Network (WSN), Cluster Head (CH), Stable Election Protocol (SEP), LEACH, (Energy Efficient Hierarchical Clustering) EEHC.*

1. Introduction

Wireless sensor networks are one of most hot topics in computer science. Wireless sensor networks are networks in which thousands of small and battery powered nodes communicate with each other through their sensing capabilities. Power management is a major design constraint in sensor networks. Due to this constraint, the sensing capability of sensor nodes reduces and their bandwidth limit. These networks can contain hundreds or thousands of sensing nodes. It is desirable to make these nodes as cheap and energy-efficient as possible and rely on their large numbers to obtain high quality results. So protocols must be designed to achieve fault tolerance in the presence of individual node failure while minimizing energy consumption. In addition, since the limited wireless channel bandwidth must be shared among all the sensors in the network.

In order to manage energy, it is common for sensor nodes to self-organize into clusters periodically, in which one sensor is selected as cluster head. The cluster head is responsible for the organization of the cluster, data collection and aggregation within the fet acluster, as well as transmission of the aggregated data to the sink. PEGASIS protocol presented in form a chain including all nodes in the network using greedy algorithm so that each node transformed to and received from a neighbour. In each round, randomly selected node takes turns to transmit the aggregated information to the base station. Nodes in TEEN and APTEEN are designed to respond to sudden changes in the sensed attribute when node exceeds a user defined threshold. They assume that position of the base station is fixed and every node in the network directly communicates to base station. OEDSR is a demand protocol for WSN's that minimizes a different link cost factor which is defined using available energy, end to end delay, and distance from to a base station.

The main idea of LEACH protocol is that all nodes are chosen to be the cluster heads periodically, and each period contains two stages with construction of clusters as the first stage and data communication as the second stage. MIMO systems can dramatically reduce the transmission energy consumption in wireless fading channels.

2. Related Work

Heinzelman *et al* proposed Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol. LEACH is a self organizing, distributed, adaptive clustering protocol that forms clusters on the basis of received signal strength and uses cluster heads as the routers to the base station. Since data transmission to base station consumes more energy, so rotation of cluster head is done to balance the energy consumption of all the nodes. This decision is made by the on the basis of a threshold equation.

Heinzelman *et al* has also presented LEACH-C in which uses a centralized clustering algorithm and the same steady state protocol as LEACH. Several protocols based on LEACH described in literature [8,9,10,11,12,13,14,]. All of these have assumed the homogenous sensor network configuration.

Mhatre *et al* made a comparative study on homogenous and heterogeneous network for single hop communication. For homogenous networks, LEACH is used as the representative and for

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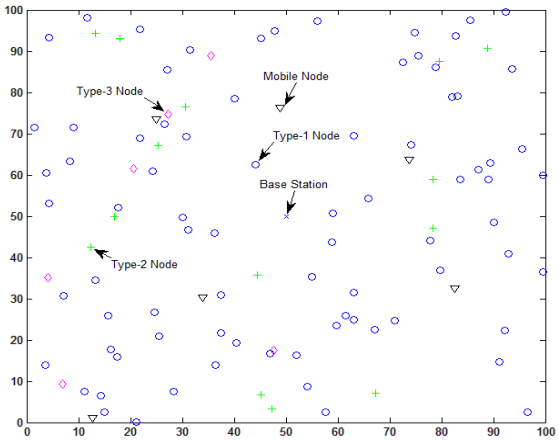
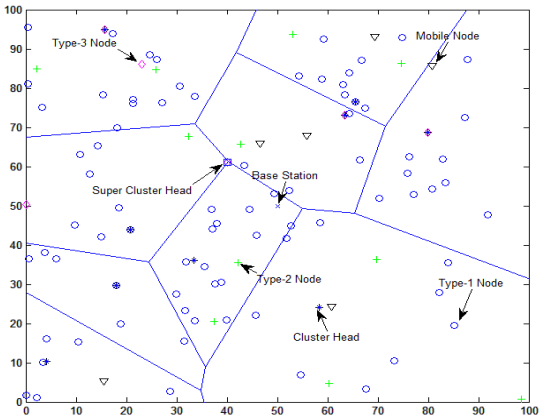
heterogeneous networks, a network with two types of nodes is used. A method to estimate the optimal distribution among different type of sensor nodes is proposed. The case of multi-hop routing is also studied within each cluster.

Smaragdakis *et al* proposed SEP protocol for heterogeneous wireless sensor networks, which is made up of two types of nodes with different initial energy, advance nodes and normal nodes. This technique prolongs the stability period, which is defined as the time until the first node failure.



(a)



(b)

Fig.1 (a) Test Network Model (b) Cluster Formation

Smaragdakis *et al* presented a distributed clustering scheme called DEEC for heterogeneous WSNs. Cluster heads are elected using a probability based on the ratios of residual energy of each node and the total energy of network. The nodes with high residual energy will have more chances to be elected as cluster heads than the nodes with low energy. Another protocol for heterogeneous WSNs is proposed in this. EEHC extends the network lifetime by introducing three degrees of heterogeneity: normal, advanced and super nodes. For each type of nodes, optimal percentage to become CH is defined. Principle is same as SEP with addition of one more node type.

Sensor nodes incorporated with mobile nodes are more useful as they have more capabilities like self deployment, network repair and event tracking. The architecture of mobile sensor network is proposed in this paper and simulation results show that hierarchical mobile sensor networks can effectively reduce the energy consumption of sensor nodes.

Manik Gupta *et al* presented a framework for fault revoking and homogenous distribution of randomly deployed sensor nodes is proposed, so that the cluster head within various clusters consume equal amount of energy.

3. Results and Discussions

In this section, a comparison is drawn between the performance of HEEMCP with LEACH, Heterogeneous LEACH, SEP and EEHC protocol in terms of energy consumption and network lifetime. Comparison result for network lifetime of HEEMCP with that of LEACH, Hetero-LEACH, SEP and EEHC protocol is shown in figure 2 and its comparison in terms of number of rounds is shown in figure 3:

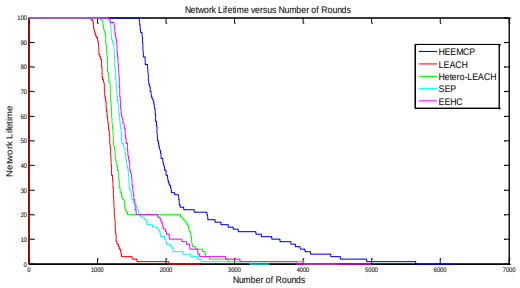


Fig.2 Network Lifetime Comparison of HEEMCP with LEACH, Hetero-LEACH, SEP and EEHC

We have used heterogeneous sensor network in terms of energy heterogeneity, that is, we have increased the total energy of the network as compared to homogeneous network used in LEACH. We have also introduced mobile nodes as back -up nodes for cluster head and super cluster head, which in turn again increase the total energy of the network. Hence network lifetime of HEEMCP is compared with other protocols in terms of the ratio of percentage increase in network lifetime to the percentage increase in total network energy. Let this ratio be denoted by £ and is given by:

$$£ = \frac{Improvement\ in\ Network\ Lifetime}{Increase\ in\ Total\ Network\ Energy}$$

In case of comparison between HEEMCP and EEHC, there is 26% increase in total energy of network in HEEMCP than EEHC. This improves the network life time of HEEMCP by 44.64%. Hence £ is given by:

$$£ = \frac{0.446}{0.26} = 1.72$$

Hence, for HEEMCP and EEHC, improvement in network lifetime of HEEMCP is 1.72 times of increase in total energy of the network.

Similarly, in comparison between SEP and HEEMCP, there is 20% increase in total energy of the network in HEEMCP. This has improved the network lifetime by approximately 75%.

Hence £ is given by:

$$£ = \frac{75}{20} = 3.75$$

This shows that for HEEMCP and SEP, improvement in network lifetime of HEEMCP is 3.75 times of increase in total network energy.

In case of comparison between HEEMCP and Heterogeneous LEACH, network energy is increased by 20% and lifetime increases by 46.6%.

Hence £ is given by:

$$£ = \frac{46.6}{20} = 2.03$$

Therefore, improvement in network lifetime in case of HEEMCP and Heterogeneous-LEACH is 2.03 times of increase in network energy. There is less improvement in case of heterogeneous LEACH due to larger unstable period.

In case of LEACH and HEEMCP, there is a significant increase in total network energy because LEACH used homogeneous network settings, while in HEEMCP, we have used heterogeneous network settings. In this case, there is 35% increase in total network energy which gives an improvement of 176% in network lifetime. Hence £ is given by:

$$£ = \frac{176}{35} = 5.02$$

This shows that improvement in network lifetime is almost 5 times of increase in total network energy in this case:

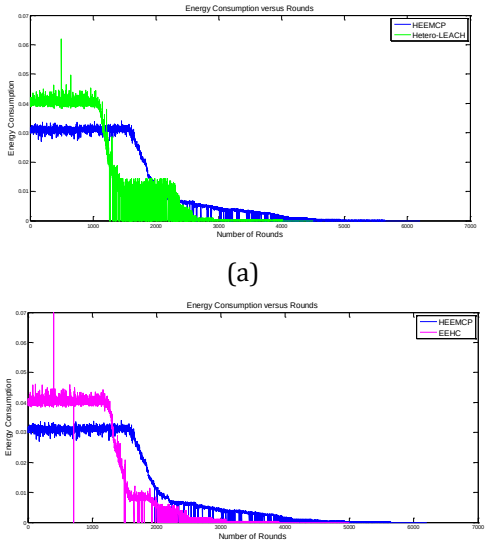


Fig.3 Comparison of Energy Consumption per Round of HEEMCP with Hetero-LEACH and EEHC Protocol

Conclusions

In this paper, the various power management protocols illustrated by many researchers as explained above have been suggested to improve the performance of battery for sensor nodes. They presented various characteristics of wireless sensor networks to improve the performance which makes them reliable and stable. The parameters which are basically included energy, sensing. These protocols are used in many applications of wireless sensors networks.

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Jyoti Garg, she is a student of M.Tech in Electronics and Communication in Panchkula Engineering College, Barwala, Haryana. She has completed her B.Tech in Electronics and Communication in 2013 from PTU, Jalandhar. Her area of interest is Clustering Protocols for wireless sensor networks.

Manish Kansal has done his B.Tech in Electronics & Communication Engineering. He is having 4+ years of teaching experience and his area of interest is wireless communication.

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