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Efficient Genetic Algorithm Based Cluster Head Selection Strategy With Mutihop Routing In Networks

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Abstract

In this paper, a genetic algorithm based method (GABEEC) is proposed to increase the lifetime of wireless sensor networks. The proposed method is similar to LEACH. By means of round method the Genetic algorithm can increase the lifetime of wireless sensor networks. There are 2 phases in this method which are Set-up phase and Steady-state phase. In the set-up phase, the clusters are formed and are not changed throughout the network. The clusters are not recreated for any of the round. In each round, there are static clusters with dynamically changing cluster heads. A simulator is developed in MS Visual C# 2010 development environment to validate the proposed method. In the simulation, 14 nodes are randomly distributed in 50x50 square meters area. The outcome of the proposed method is found to be more efficient than the LEACH algorithm.

Keyword: Genetic Algorithm.

Introduction

Wireless Sensor Network (WSN) is used in many application environments. Well known applications are data logging, area and health care monitoring, environmental or earth sensing. A WSN contains sensor nodes that are tiny, battery constrained and cost efficient. One of the major problems for a WSN is energy consumption during communication between sensor nodes. The longer the distance between sensor nodes, the energy consumption will be more. Therefore to extend the lifetime of the WSN, there are several researches based on communication distance of the sensor nodes. Cluster-based approaches are useful for environment monitoring. The use of clusters for sensor networks reduces communication distance for most sensor nodes, demanding only few nodes to transmit long distances, e.g., Base Station (BS). A cluster-based protocol divides the network into a number of clusters. Each cluster has a cluster-head (CH) that collects data from all member nodes in its cluster. These CHs then aggregates the received data and sends it to the BS. This approach intensely

reduces the communication cost of the sensor nodes so that the lifetime of the network can be increased. In this work, static clustering with dynamic CH selection is used. At the end of each round, a member node called associate, becomes CH based on the residual energy of the current CH and the average energy amount of the member nodes in the cluster. And we use genetic algorithm (GA) to minimize the communication distance in the network and maximize the lifetime of the network.

Related Work

Wireless sensor nodes has certain constraints associated with them particularly minimizing energy consumption is the basic and key requirement in formulating the sensor network protocols. Since the nodes are small, it is not approachable, batteries may die, so it is necessary that the network should be energy efficient inorder to maximize the lifetime of the networks[1,2]. It expects fault tolerance scalability, production costs and reliability[1]. By using Direct Diffusion(DD), a command based technique for routing the packet and by aggregating, caching and reinforcement the suitable link is dynamically selected for transmission. In LEACH protocol the selection of cluster head is elected dynamically in rotation. Data fusion is adopted to reduce the amount of data send over the link in the network[3]. In continuation the time is partitioned into fixed intervals with equal length and CH's are selected here[4,5]. Sensors sense and gathers the datas of its sensing and through the data forwarding transmission technique the datas are transmitted[5,6]. Some stochastic mode of technique is adopted for cluster head selection. In HCR method clusters are managed with a set of associates and the lifetime of the cluster increases[7]. In S-MAC concept, some random nodes are put to sleep mode for a particular time till then the traffic is controlled by storing the packet in the neighbouring nodes. When the node is ON it starts retrieving the packets from its neighbouring nodes. This mode selection is made in random so that the consumption of energy by the network is maintained low[8]. In some papers it is discussed that the cluster head is selected based on the number of times the node has been a cluster head so far or by choosing the random number and if its below the optimized threshold that particular nodes is given a chance as a cluster head in the network[9]. Some cases by deducting the hierarchical clustering strategy it has been found that the energy savings increases with the number of levels in the hierarchy[10]. As a conclusion, CHs are elected based on the various techniques seen above and these strategies supports the concept of reducing the residual energy in the network. Even the concept of iteration plays a major role in selecting the heads as term basis and performs the task. The received datas are send out to the destination immediately after sensing the current status of it.

The Proposed Algorithm

Genetic algorithm based cluster head selection. Here a fittest individual is a candidate for cluster head selection. A genetic Algorithm based method to optimize the lifetime of WSN. The method is cluster-based approach like LEACH. There are two phases in the proposed method which are set-up phase and steady-state phase. In the proposed

method, the clusters that are created in the set-up phase are not changed throughout the network. The selection of the new CH is based on the residual energy of the current CH and its member nodes. The clusters are not recreated for each round. So in each round, there are static clusters with dynamically changed CHs. GA with Multi-hop method in the communication between the cluster heads. The cluster-head is in charge of transmitting sensing data from its own local cluster, as well as collecting and compressing multiple data before sending them to a sink node. They consume more energy than other sensor nodes as a result of these additional tasks. Genetic Algorithm executes fitness tests on new structures to choose the cluster head selection. Fitness regulates the quality of the individual on the base of the defined principles. In nature, an individual's fitness is its capability to pass on its genetic material. Anything that backs this capability contributes to the organism's total fitness. This capability contains characters that permit it to survive and additionally reproduce. In a GA, fitness is estimated by the function significant to the problem. The fate of an individual chromosome rest on the fitness value; the superior the fitness value more are the chances of survival.

Modules

1. Creation of Network topology

A novel clustering concept to limit the number of member nodes for each cluster head by using a threshold value. The proposed clustering approach selects a cluster head based on a new cost function which considers the residual battery level, transmission range, energy consumption and distance to the other cluster node. Specifically, CHs located near the BS trajectory are grouped in small sized clusters while SNs located farther away are grouped in clusters of larger size. The cluster distance is the sum of the distances from the member nodes to the CH and the distance from the CH to the BS

2. Genetic Algorithm Based Energy Efficient Clusters

A Genetic Algorithm based method to optimize the lifetime of WSN. The method is cluster-based approach like LEACH. Grouping sensor nodes into clusters has been widely pursued by the research community in order to achieve the network scalability and to maximize the network lifetime. A GA to the problem of finding optimum number of CHs based on minimizing the communication consumption energy of all sensor nodes to efficiently maximize the network lifetime and to improve the stability period. The operation of the GAEEP protocol is broken up into rounds, where each round begins with a set-up phase, when the BS finds the locations of CHs and assigns members nodes of each CH, followed by a steady-state phase, when the sensed data are transferred to CHs and collect in frames

3. GA Set-up Phase and Steady-state Phase

The set-up phase and it is performed only one time. In the set-up phase, pre-defined numbers of sensor nodes are chosen as cluster heads. The number of CHs also

indicates the number of clusters in the network. Non-CH nodes are assigned to the clusters based on their distances to the CHs. These non-CH nodes join into the clusters. All nodes start to communicate with their CHs. Each node uses a Time Division Multiple Access (TDMA) schedule to communicate with CH. TDMA is a technology that allows multiple access to share same radio channel and divides each channel into time slots to enable data transmissions. After the CH receives from all member nodes, it fuses the data packets into one packet and sends it to the base station (BS). When all CHs send their data to BS, *a round* is completed. At the end of each round the BS checks the energies of CHs and the member nodes. If the energy of a CH is under the average energy of the member nodes of its cluster, an associate CH is selected from the member nodes of the cluster. The selection of the new CH is based on the residual energy of the current CH and its member nodes. The clusters are not recreated for each round. So in each round, there are static clusters with dynamically changed CHs.

4. GA with Multi-hop communication between Cluster heads

The initial population pool (parents) and off springs chromosomes that generated in previous step are sorted in ascending order based on the objective function values. Then the first ps CHs chromosomes with minimum objective function values are selected to form the population pool for next generation. The CH node must keep its receiver on to receive all the data from the nodes in the cluster. When all the data have been received, the CH node performs signal processing functions to aggregate the data into a single signal. This aggregated signal is sent to the BS. After a certain time, which is determined a priori, the network again goes back into the setup phase and new CHs are determined using GA. GA with Multi-hop method in the communication between the cluster heads. The cluster-head is in charge of transmitting sensing data from its own local cluster, as well as collecting and compressing multiple data before sending them to a sink node. They consume more energy than other sensor nodes as a result of these additional tasks. Therefore, it is desirable that all sensor nodes should take on the role of a cluster-head, equally and randomly. Based on the number of cluster-heads, the size of a local cluster may change. It is important to construct adaptive clusters because the number of cluster-heads has an effect on the energy consumption of the cluster-head and the sending of member nodes' data. As more cluster-heads become available and the smaller the size of a local cluster, the smaller the amount of packets required to be sent will be. With additional cluster-heads, however, there is an increase in the number of packets needed for cluster-heads to communicate to a sink or base station, therefore increasing the energy consumption as a result of clustering.

Algorithm

Begin

1. Specify the probability (*pset*), area of nodes considered.
2. Xinit(u)=X0, u=1,2, …, n;

(1) Preparation Phase

1. **if** (Xinit(u) < 0 & rmod(1/pset)≠0) **then** //pset can set>1
2. r□random(CH,node) and compute G(u); //given by (1)
3. **if** (r > G(u)) **then**
4. CCH{u}=FALSE; //node u not be a candidate CH
5. **else**
6. CCH{u}=TRUE; //node u be a candidate CH
7. **end if**
8. **end if**
9. Communication between CH(IDu, (xu,yu), CCH(u)) All nodes sends data to corresponding cluster head.
10. GAinCH(*popt*) Optimal probability is determined;
11. BC (*popt*) □ CH transmits messages to BS.

(2) Set-Up Phase

1. **do** { //repeat after 10 happenings
2. r□ random(CH,node);
3. **if** (Xinit(s)>0 & rmod(1/popt)≠0) **then**
4. compute G(u); //given by (1)
5. **if** (r > G(u)) **then**
6. CH{u}=FALSE; //node s be a CH
7. **else**
8. CH{u}=TRUE; //node u not be a CH
9. **end if**
10. **end if**
11. **if** (CH{u}=TRUE) **then**
12. transmit data between cluster heads.
13. **end if**

(3) Steady-State Phase

1. **If** (CH(u)=TRUE) **then**
2. Receive(IDi, DataPCK) //receive data from members;
3. Aggregate(IDi, DataPCK) //aggregate received data;
4. TransToBS(IDi, DataPCK); //transmit received data;
5. **else**
6. **If** (No. Of Happenings=TRUE) **then**
7. TansToCH(IDi, DataPCK); //transmit sensed data;
8. **else**
9. SleepMode(i)=TRUE; //node i at a sleep state
10. **end if**
11. **end if**
12. } // one round is completed

END

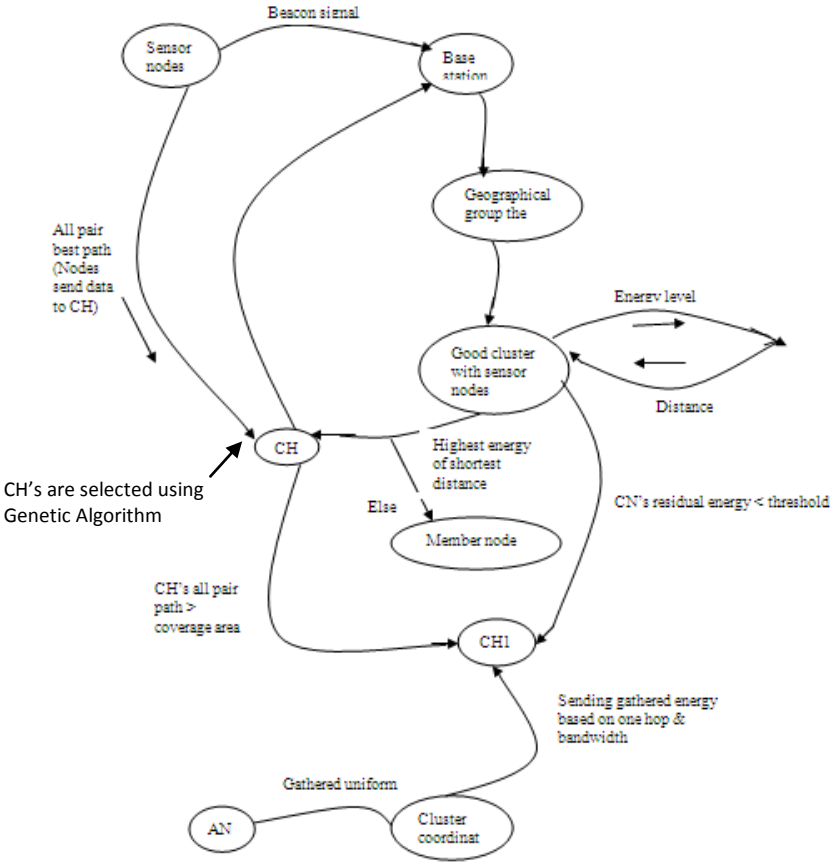
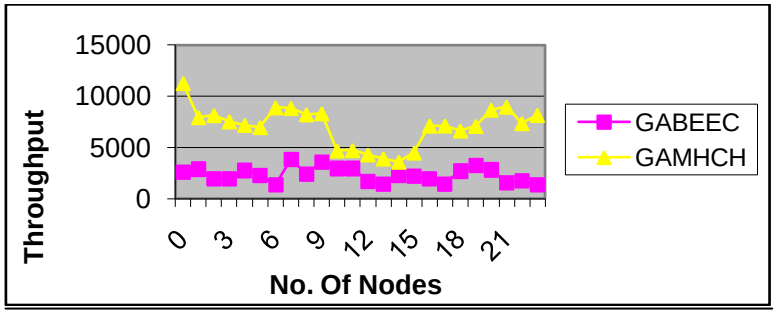


Figure 1: Transistion Diagram for Proposed Algorithm

Performance Evaluation

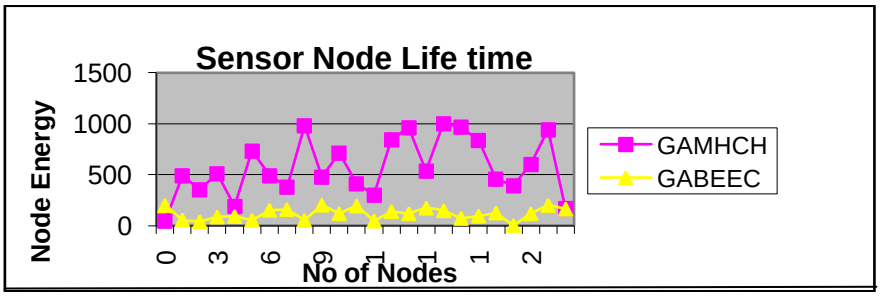
The performance evaluation on energy consumption, Throughput, delay, Network lifetime and Time taken for cluster formation was executed and compared with the existing techniques.

A. Throughput



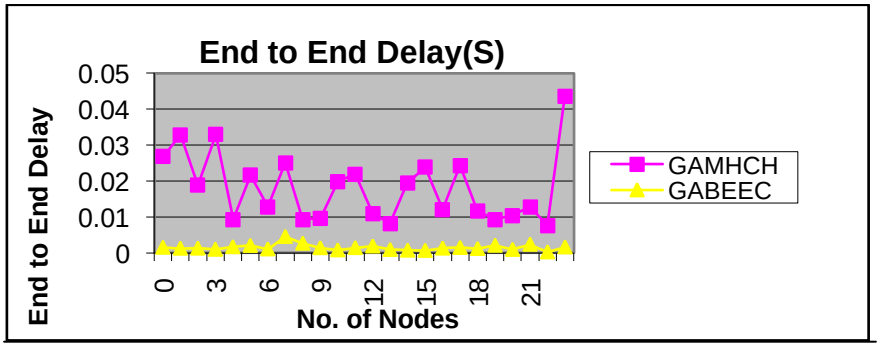
Because of the reduced energy consumption and the time taken to reachout the destination, the throughput of the network is comparatively higher than the other protocols because of the fast computation of shortest paths.

B. Node Life Time



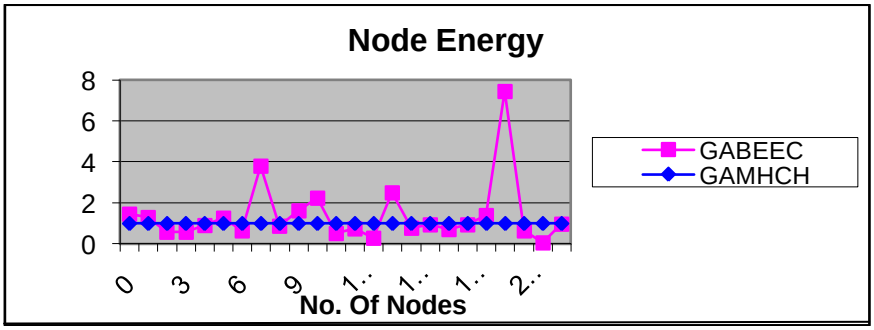
With the previous statistics the energy consumption of GAMHCH is very low so the withstanding power of the sensors battery is more. Though the nodes are unattendable, because of its efficiency in consumption/energy saving, the entire network's lifetime have been increased.

C. Delay



Delay in the proposed system is reduced partially but then calculating the all pair best path from time to time in a dynamic mode makes the delay to be little high.

D. Energy



The above graph proves that the energy consumption of the cluster based network interms of GAMHCH is less compared to the other protocols. It reduces to about 12% of energy consumption.

Simulation Results

In this section, the performance of our proposed algorithm is compared using the simulated results Hence the throughput of the entire network is partially good. Because of high overheads due to large computation the delay is marginally increased. Selection of cluster heads in quick response is the efficient way to have better communication. Techniques are developed for fast recovery from single-link failures to provide more than one forwarding edge to route a packet to a destination.

Conclusion and Future Work

GAMHCH-Genetic algorithm based mutihope communication between the cluster head shows a better out performance in the field of energy, computation and increasing the lifetime of the network and the time taken by the packet to reach the destination. And it has been overviewed that this scheme is very suitable for wireless networks as for as energy efficiency is concerned. As a future work the research takes the direction on relying the strategy of hierarchy, mode based selection, sleep and awake mode selection especially for the dynamic topology. In future the above completed task can be modified by some other new techniques and algorithms which will reduce the delay time and traffic even more and helps to transmit the packets with high speed to reach the destination.

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