International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Enhanced Optimal Routing Leach Protocol Using Genetic Algorithm for Wireless Sensor Networks

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Abstract: ***Leach is used for the least amount of energy consumption while the transmission from one node to another. Leach also uses a concept of cluster heads for the security purpose. This paper focuses on the enhancement of the leach protocol using genetic algorithm. This paper also focuses on the efficient use of energy and the average movements of the nodes to enhance the leach protocol.***

Keywords: LEACH, Cluster Head, Enhancement, Fitting Function, Objective Function.

1. Introduction

Wireless Sensor Network (WSN) is a class of wireless ad-hoc networks which consists of spatially distributed autonomous sensor nodes to monitor physical or environmental conditions, such as temperature, sound, pressure, etc at different locations [2]. Energy consumption is the core issue in wireless sensor networks because nodes are battery operated [2]. 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. Consequently many protocols have been proposed in order to minimize the energy consumption of these nodes [5]. By analyzing the advantages and disadvantages of conventional routing protocols, LEACH (Low- Energy Adaptive Clustering Hierarchy) Protocol was developed [2, 5], a clustering based protocol that minimizes energy dissipation in sensor networks [5]. However, LEACH outperforms classical clustering algorithms by using adaptive clusters and rotating cluster-heads, allowing the energy requirements of the system to be distributed among all the sensors [5]. Instead, when the cluster-head die, the cluster will become useless because the data gathered by cluster nodes will never reach the base station. So, there is a requirement to improve LEACH protocol to enhance the performance [2]. In this paper we propose an Improved Leach Protocol that further enhances the Power consumption, simulation results bring out that our protocol outperforms Leach protocol in terms of energy consumption and increases the total lifetime of the WSN [2].

1.1 Energy Analysis of Routing Protocols

There have been several network routing protocols proposed for wireless networks that can be examined in the context of wireless sensor networks [6]. We examine two such protocols, namely direct communication with the base station and minimum-energy multi-hop routing using our sensor network and radio models [6]. In addition, we discuss a conventional clustering approach to routing and the drawbacks of using such an approach when the nodes are al energy-constrained [8]. Using a direct communication protocol, each sensor sends its data directly to the base station. If the base station is far away from the nodes, direct communication will require a large amount of transmit power from each node (since d in Equation 1 is large). This will quickly drain the battery of the nodes and reduce the system lifetime [8]. However, the only receptions in this protocol occur at the base station, so if either the base station is close to the nodes, or the energy required to receive data is large, this may be an acceptable (and possibly optimal) method of communication [8].

1.2 Leach Protocol

Low Energy Adaptive Clustering Hierarchy (LEACH) proposed by Wendi B. Heinzelman, et al. is the first hierarchical, self-organizing, adaptive cluster-based routing protocol for wireless sensor networks which partitions the nodes into clusters, in each cluster a dedicated node with extra privileges called Cluster Head (CH) is responsible for creating and manipulating a TDMA (Time division multiple access) schedule and sending aggregated data from nodes to the BS where these data is needed using CDMA (Code division multiple access) [9]. Remaining nodes are cluster members. LEACH outperforms static clustering algorithms by requiring nodes to volunteer to be high-energy cluster-heads and adapting the corresponding clusters based on the nodes that choose to be cluster-heads at a given time [11]. At different times, each node has the burden of acquiring data from the nodes in the cluster, fusing the data to obtain an aggregate signal, and transmitting this aggregate signal to the base station [10]. LEACH is completely distributed, requiring no control information from the base station, and the nodes do not require knowledge of the global network in order for LEACH to operate [11]. Distributing the energy among the nodes in the network is effective in reducing energy dissipation from a global perspective and enhancing system lifetime [11].

1.3 Genetic Algorithm

Genetic algorithm is a search heuristic that mimics the process of natural selection [14]. This heuristic is routinlyused to generate useful solutions to optimization and search problems [14]. A genetic algorithm belongs to the larger class of evolutionary algorithms, which generate solutions to optimization problems using by natural

evolution such as inheritance, mutation, crossover and selection [14].

2. Proposed Work

Step-1 Implement the WSN network. The network, that consists of many small sensor nodes with sensing, control, data processing, communications, and networking capabilities.

Step-2 Failed nodes may decrease the quality of service (Qos) of the entire WSN. The node status in WSNs can be divided into two types: normal and faulty. Faulty in turn can be "permanent" or "static". The so-called "permanent" means failed nodes will remain faulty until they are replaced, and the so-called "static" means new faults will not generated during fault detection. In , node faults of WSNs can be divided into two categories: hard and soft. The so-called "hard fault" is when a sensor node cannot communicate with other nodes because of the failure of a certain module (e.g., communication failure due to the failure of the communication module, energy depletion of node, being out of the communication range of entire mobile network because of the nodes' moving and so on). The so-called "soft fault" means the failed nodes can continue to work and communicate with other nodes (hardware and software of communication module are normal), but the data sensed or transmitted is not correct.

Step-3 Apply LEACH protocol, to find the node failure. In LEACH, the cluster-heads compress data arriving from nodes that belong to the respective cluster, and send an aggregated packet to the BS in order to reduce the amount of information that must be transmitted to the BS. So it came to know about node failure, as soon as node failure occurs, optimization is done using GA algorithm.

Step-4 Apply GA for optimization process. GA will work as follows:

- Initialize GA parameters i.e, population size, selection, mutation and crossover.
- Create fitness function.

$f = (1 - e) \cdot (m - F_s / F_t)$ (changed fitness function)

Where Fs= feature, Ft=total number of festure, e= classification error rate(optimization paramter).

- Call GA function with the fitness function.
- If the output is 1 then the feature is selected else neglected.
- Write the reduced features to excel file.

3. Results

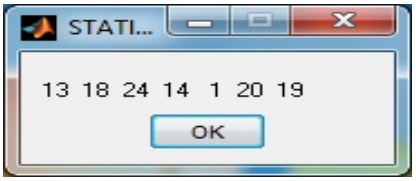


Figure 1-1: Static Path

The above diagrams shows that in the WSN network we have number of nodes , but the actual path that we consider for routing is from node 3-18-24-1-20-19. To check out the network optimization as well the detection of attacks.

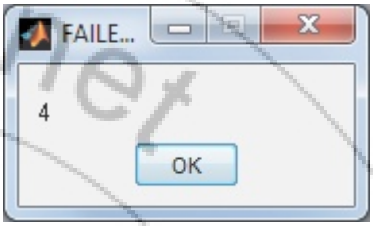


Figure 1-2 : Failed Node

The above Figure shows in the chosen node set , the node number .4 gets failed, there are many reasons due to which node failure takes place like fabrication process problems, environmental factors, enemy attacks and so on; battery power depletion .So detection and prevention of failed node is must.

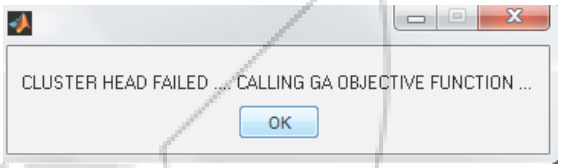


Figure 1-3: Calling GA function

when node failure occurs and that node gets failed which is the cluster head, we have to call GA (Genetic Algorithm Objective Function) .

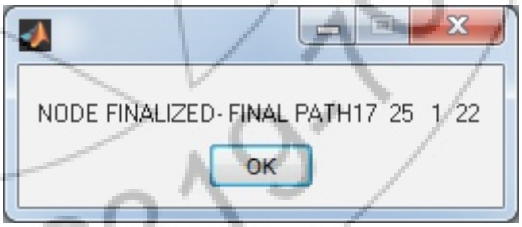
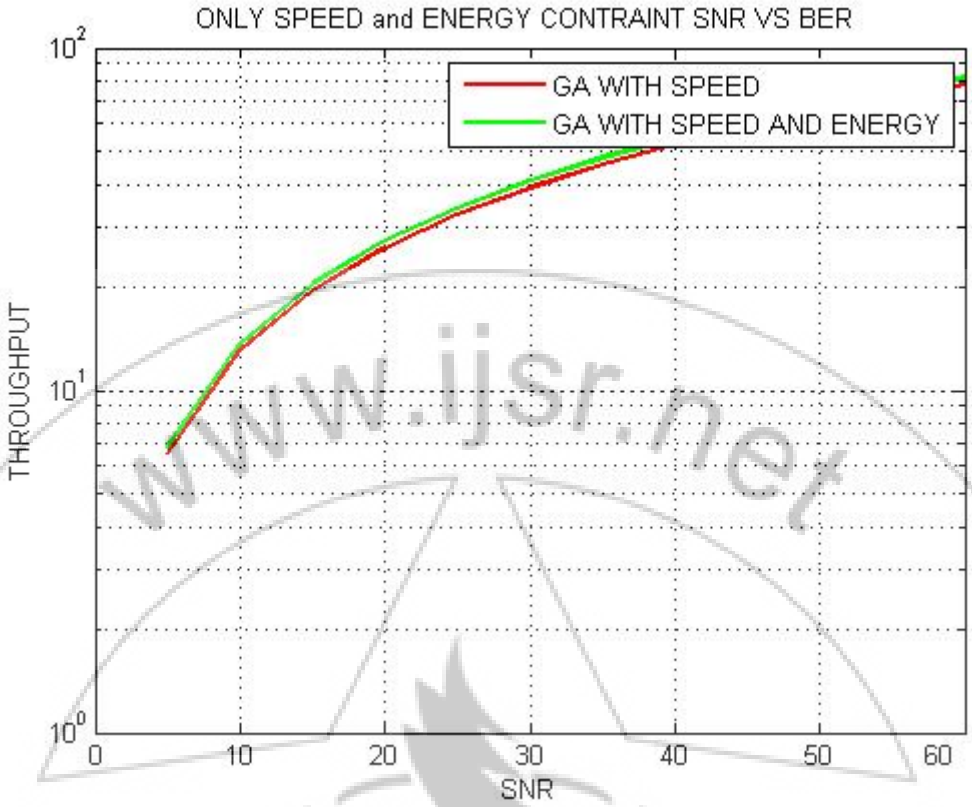


Figure 1-4: Finalized path

As the objective function is called,it will return the fitness function which contains the list of best energy efficient cluster heads, Then leach uses them to route the data. so above Figure describes that now the chosen path has to be changed and now the finalised path is from node-25-1-22. Here intial node is 25 and final node is 22.

4. Graph



The above graph shows the comparative analysis of the results of the protocol where the constrains have been put against speed, speed and energy , speed and energy and frequency and speed and frequency .

Table 4.1: Result

Parameters	WSN	WSN with GA
Throughput	85%	97- 98%
Error rate	1.9934	1.4223
Total Energy	4.2234	2.2208

5. Conclusion

Learning algorithms including the genetic algorithm are used by many researchers to study network attributes such as clustering, energy consumption, determining of sensor nodes status and clustering with appropriate cluster heads, as well as for hierarchical cluster-based routing. We adapt genetic algorithm parameters based on software services to determine the throughput and therefore extend the lifetime of the network. There is a trade-off between throughput and distance parameters because making large numbers of clusters shortens the distance between the sensor member nodes and also corresponding CH. Further more in this thesis we considered a well known protocol for wireless sensor networks called LEACH protocol which is the primary and the most imperative protocol in wireless sensor network which uses cluster based propagation technique. Followed by an overview of LEACH protocol implementations, this work proposes a fusion of LEACH protocol involving Genetic algorithm (GA). From the simulation results, we found that throughput is enhanced using GA by 95-96%. As, the number of CHs is obtained from the described genetic algorithm process.

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