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N-target Coverage in Wireless Sensor Network using DFS and Genetic Algorithms

Anudeep, Subhash Chander

JCDM College of Engineering and Technology, India

Abstract: ***One of the current trends of the sensor network communication is to track multiple targets. In this problem target nodes are defined as the destination nodes and to monitor the effective communication over these nodes, we have defined cover nodes in terms of distance coverage and the number of target specification. To select cover nodes we included a factor called failure probability analysis. We will use a hybrid approach of Depth first Search along with Genetic Algorithm to extend lifetime of network. The first layer will be performed by DFS so that the minimum connectivity coverage will be identified respective to each target. Now the genetics will be implemented so that the optimized solution can be derived.***

Keywords: Wireless Sensor Network, Target Coverage, Genetic algorithm, Optimisation, Depth First Search.

1. Introduction

A sensor network is one of the major emerging technologies that require the data transmission at high rate with higher reliability ratio. These kind of network needs the equal concern for the architectural definitions as well as the algorithmic enhancements. WSN needs the regular monitoring of network because of continuous change is possible as the sensors are having floating movement and relatively need to analyze the energy definitions, requirement, consumption etc. Target Coverage problem is concerned with the random deployment of sensor nodes for monitoring the specific targets for maximum duration. While defining these kind of network, the concern is required while selecting the sensors based on the type of surface, the type of link, control centre ,control parameters etc. Providing efficient resource management and reliability and Qos are two of the most important requirements in sensor networks. The coverage problem is heavily dependent on the coverage model of individual sensor and the locations of the deployed sensor nodes. Sensor coverage model can be considered as a measure of the quality of service of sensor's sensing function and is subject to a wide range of interpretations due to a large variety of sensors and applications. Network sensing coverage on the other hand can be considered as a collective measure of the quality of service provided by sensor nodes at different geographical locations Wireless sensors can be either deterministic placed or randomly deployed in a sensor field. Deterministic sensor placement can be applied to a small to medium sensor network in a friendly environment. When the network size is large or the sensor field is remote and hostile, random sensor deployment might be the only choice, e.g. scattered from an aircraft. In this article, our focus is to healing coverage hole using genetic algorithm with minimize total movement of mobile sensor. GA was introduced as a computational analogy of adaptive systems collective measure of the quality of service provided by sensor nodes at different geographical locations Wireless sensors can be either deterministic placed or randomly deployed in a sensor field. Deterministic sensor placement can be applied to a small to medium sensor network in a friendly environment. When the network size is large or the sensor field is remote and hostile, random sensor deployment might be the only choice, e.g. scattered from an aircraft. In this article, our focus is to healing coverage whole using genetic algorithm with minimized total movement of mobile sensor. GA was introduced as a computational analogy of adaptive systems.

2. Methodology

In this work a hybrid approach using the DFS and the genetics algorithm is suggested to define the cover nodes with minimum connectivity energy. The approach is improved here so that each cover must monitor more than one target nodes so that no target will be lost. The reliability of the network will be estimation by using the failure probability parameter. The DFS based routing algorithm performs DFS search in a given graph in distributed way. The property that enables its use in routing is the fact that DFS creates a path in the graph without making any jumps from a node to another that is not is in its neighbor. In DFS algorithm nodes are colored as white or grey, initially all nodes are white. The process of routing nodes coincides with sending messages between nodes. There is always one copy of message in the graph, and thus a path is created. The sender node S begins routing and colors itself as a grey node. Grey nodes are nodes that are visited (that is, they received message at least once). Each message that is sent from a node B to anode A has one bit that indicates whether the message is forwarded or returned. Node A on receiving the message then acts according to that bit. White node A, upon receiving forwarded message for the first time, changes its color grey, and order sits neighbors according to distance from destination (the neighbors which are closer to destination are preferred). The only exception is that node B, which sends message to 'A' is ignored. Thus node A should memorize, together with the message id, also neighbor B that forwarded that message. The message is then forwarded to the first choice C among neighbors. If there is no choice, message is returned to B. Grey node A, upon receiving forwarded message from any node B, will reject the message immediately. That is, the message will be immediately returned to B. If node A sends message to node B, and node B rejects the message, it is counted as two hops in the simulation (A to B and B back to A). Grey node A, upon receiving a returned message from node C, will forward the message to the next choice E in its sorted list of neighbors, if such a neighbor exists. If A has no more neighbors in its list, message will be returned to the neighbor B which sent the message to A. A depth-first search starting at A, assuming that the left edges in the shown graph are chosen before right edges, and assuming the search remembers previously-visited nodes and will not repeat them (since this is a small graph), will visit the nodes in the following order: A, B, D, F, E, C, G. Performing the same search without remembering previously visited nodes results in visiting nodes in the order A, B, D, F, E, A, B, D, F, E, etc. forever, caught in the A, B, D, F, E cycle and never reaching C or G .

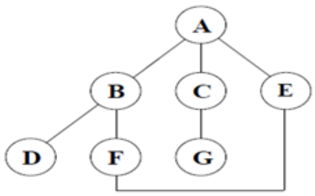

Figure 1: Gives an example of a DFS routing path for the following

2.1 Genetic Algorithm

Genetic algorithm was introduced as a computational analogy of adaptive system. The Four Operators of Genetic algorithm:

- Selection
- Fitness Function
- Crossover
- Mutation

2.2 Selection

A chromosome represents sleep or wake up sate of sensors, the gene index determines number of sensors and the gene's value identifies the state if it is one its means the relative sensor is active and if it is zero it means the relative sensor is not active. It is shown at Fig.2.

Figure 2: Representation of Chromosomes

2.3 Fitness Function

A fitness function value quantifies the optimality of a solution. The value is used to rank a particular solution against all the other solutions. It is calculated on distance parameter. D must lie between sensing or communication range.

2.4 Parent Selection and survivor selection Mechanism

The role parent selection is to distinguish among individuals based on their quality. An individual is a parent if it has been selected to undergo variation in order to create offspring. High quality individuals get a higher chance to become parents than those with low quality.

2.5 Variation Operator

The role of variation operators is to create new individuals from old ones. Its role is to create new optimized solution that has similarities with parent solution.

2.6 Two-point crossover

The crossover operator is used to create new solutions from the existing solutions available in the mating pool after applying selection operator. Crossover selects any two solutions strings randomly from the mating pool and some portions of the strings are exchanged between the strings.

2.7 Mutation

Mutation is the occasional introduction of new features in to the solution strings of the population pool to maintain diversity in the population. Though crossover has the main responsibility to search for the optimal solution, mutation is also used for this purpose. Mutation operator changes a 1 to 0 or vice versa, with a mutation probability of .The mutation probability is generally kept low for steady convergence. A high value of mutation probability would search here and there like a random search technique.

2.8 Cost Network Function

The other objective that we want to optimize is the transmission cost. As already mentioned, in sensor networks, the transmission cost is divided into two parts: the cost to communicate between sensor nodes and cluster-heads and the cost to transmit from the cluster-heads to the sink. Cost network function is going to be minimized.

3. Our Work

We suppose a WSN in which a massive number of small battery-driven sensor nodes are deployed in target field. Sensor nodes periodically sense environmental information such as temperature, humidity or sunlight. We proposed an algorithm to keep a small number of active sensors regardless of the relationship between transmission and sensing range. Our WSN is simulated in Matlab Tool.
Various Simulation parameters are:

Table 1: Simulation parameters

Area	50×50
No. of sensors	30
Variable No. of target nodes	3,4,5,6,7
No. of generations	1000
Sensing range	10m
Sensing model	Binary
Base Station	-450,450
Communication range	10m

The work is about the localization of nodes and the identification of cluster head in an effective way that will improve the network life and will give the efficiency as well as the reliability of the network. Our work is divided into

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two main parts. First is node will be member of cover set if it satisfies main criteria;

- Sensing range
- Energy
- Load on sensor

Second is to decide which cover node is to get activated to decide this criterion:

i. Cover set energy: Cover set will be activated if its energy is greater than defined threshold value.
ii. Sensor covers failure probability.

3.1 Algorithm

(i)Define a sensor network with N number of nodes called (S1,S2…Sn) and m number of Targets (t1,t2…tm)
(ii) Define each node with energy specification, range, failure probability and load vector.
(iii) Implement the DFS to perform the distance analysis over the network and to identify the eligibility Criteria.
(iv) Generate a list of eligible nodes based on DFS cost analysis

a. For i=1 to n
b. If(S(i).Energy>Threshold and S(i).Load <Threshold Load)
c. Eligible Node= Eligible Node U S(i)

(v) Perform the distance analysis over the network to identify the target nodes respective to the coverage range
(vi) Based on the coverage range analysis, the cover sets are generated. Each cover set is defined with k number of nodes so that all targets get covered.
(vii) For r=1 to Number of Rounds
(viii)[Identify the effective cost cover set using genetics]
(ix) For i=1 to MAXITERATIONS
(x) Perform the selection of cover sets called cover set I and J
(xi) Apply the fitness function to perform the cost analysis
(xii) Implement Crossover K=Crossover(I,J)
(xiii)Implement K=Mutation(K)
(xiv)If(Energy (Coverset (K))>threshold and failure probability(Cover set(K))<Threshold)
(xv) Select cover set as the current, cover set for round r
(xvi)S(I,:).Energy=S(I,:).Energy Comm Energy
(xvii) If(S(I,:).Energy<=0)
(xviii) Dead=Dead+1

4. Results

Sensors and targets are generated at random positions in terms of their coordinates assuming that no two sensors are at the same position. The location of base station is fixed and predetermined. We assumed that sensors are homogenous and initially have the same energy and have similar sensing range. It is assumed that if the Euclidean distance of the target from the sensor is equal to or less than the sensing range of the sensor then that sensor covers the target.

4.1 Generate Cover Nodes

Cover nodes are generated following DFS algorithms.

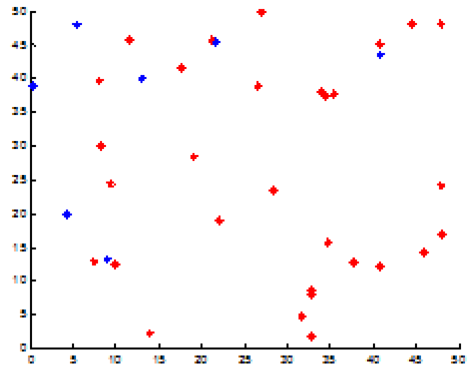

Figure 3: Sensor network establishment

4.2 Network Life Time

Each generated cover is assigned a lifetime. And the cover will be active only until its lifetime expires. The total network lifetime is the product of number of sensor covers and their respective lifetime associated with each cover. Energy Consumption of cover nodes is calculated at best fitness function value for different number of target nodes.

Table 2: Energy consumption for various target networks

No of target nodes	*Energy Consumption(pj)*
3	50
4	50
5	73.75
6	85.7
7	131.5

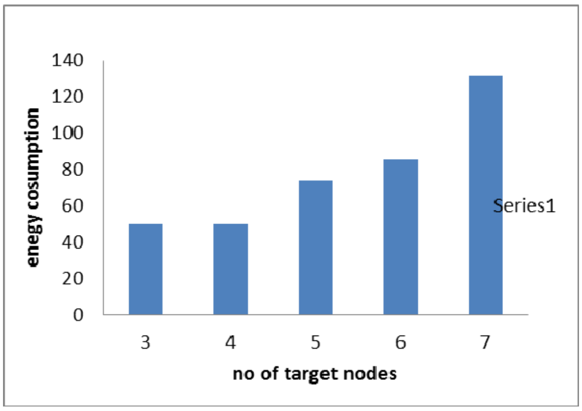

Figure 4: Graph Showing Energy Consumption.

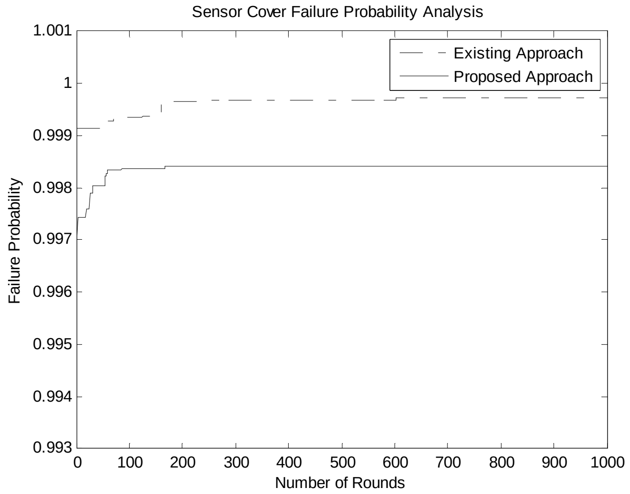

Figure 5: Failure probability versus number of rounds.

This graph shows reduction of failure probability using DFS and genetic algorithms. This increases lifetime of network.

5. Conclusion

We proposed DFS based genetic algorithm to cover different target nodes with minimum cover sets generation. We simulate proposed work using Matlab tool. We improved life of network by reducing failure probability of various cover nodes. Number of cover nodes to cover n targets are fewer so prolong the network lifetime we show energy consumption of best cover node to cover different target nodes.

6. Future Scope

We will work on connectivity issues on mobile sensor nodes and mobile base station.

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