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A DFS Improved Genetic Approach to Optimize Target Coverage Problem in Underwater Wireless Sensor Network

Manisha Yadav
PDM College of Engineering for Women
Bahadurgarh Haryana, India

Prof.(Dr.)Yusuf Mulge
Principal PDM College of Engineering for Women
Bahadurgarh Haryana, India

Abstract—An underwater sensor network is one of the major emerging technology .These kind of network needs the equal concern for the architectural definitions as well as the algorithmic enhancements. The fundamental challenges of wireless sensor networks are first it is the problem of the limited energy source equipped with every sensor that is from the battery source. Second it is the problem of covering a non-uniform target area in most of the situations. Then cost minimization becomes a serious issue. The challenge to optimizing the network lifetime while monitoring the target nodes is known as the Target Coverage Problem. This is use as the foundation of this work. An existing heuristic is used to serve as a baseline against our proposed algorithm which seeks to maximize the network lifetime A conventional heuristic algorithm used for scheduling the sensors is used for simulation. In this paper we proposed the hybrid approach use of Depth first Search along with Genetic Algorithm to solve the target coverage problem.

Keywords:- Wireless Sensor Network, Target Coverage Problem , Genetic Algorithm ,Connectivity, Lifetime, Depth First Algorithm

I. INTRODUCTION

One of the current trends of the wireless communication is the underwater communication. The problems in underwater sensor networks are coverage problem and connectivity issues. The coverage problem shows how a sensor network is monitored by sensors. While defining these kind of network, the concern is required while selecting the sensors based on the kind of surface, the kind of link, control center, control parameters etc. These networks 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.

A. Target Coverage Problem

Target Coverage problem is concerned with the random deployment of sensor nodes for monitoring the specific targets for maximum duration. In Target Coverage, each Target is monitored by at least one sensor node. Coverage Problem is one of the active issues of the WSNs that determine how efficiently the sensor network is being covered by a set of sensor nodes [8]. This problem deals with the Quality of Service (QoS) of the network ensuring that the particular sensor network is monitored or observed by at least one sensor node. It may be broadly classified as Area coverage, Target coverage and coverage dealing with the determination of maximum support/breach path. While covering the targets, several issues must be taken into consideration in order to achieve much efficient target coverage.[8] The target coverage problem is useful for the kinds of applications such as surveillance or environmental data collection where fixed points or locations are required to be monitored. [12]

B. Network lifetime

Network lifetime is one of the most important and challenging issues in WSNs which defines how long the deployed WSN can function well. Since a sensor network is usually expected to last several months without recharging, prolonging network lifetime is one of the most important issues in wireless sensor networks [9]. There are multiple definitions for the network lifetime based on different assumptions. The network lifetime is defined as the period from the time when the network was set up to the time when the first sensor node dies due to energy dissipation Therefore, in our proposed work, we define the network lifetime as the time interval from the activation of the network until the first time at which the coverage hole appears. Our research work is based on maximizing the network lifetime while optimizing the coverage performance.

II. ALGORITHMS

The DFS is an algorithm for searching or traversing the nodes in the graph or tree. The searching is start with the root node and explore all the node along each branch before backtracking.[9] In DFS based algorithm, nodes are Initially all nodes are white then select the root node i.e. A that color itself gray then explore its adjacent nodes of A the adjacent nodes of A is S,B the select the one node let select the node B and color itself gray then explore the adjacent nodes of B and B has no adjacent node then go to the unvisited node S color itself gray and the adjacent node of S are G,C then select node C that color itself gray and the adjacent unvisited nodes of C are D,E,F and select the node D that color itself gray and explore the adjacent nodes of D that D have no adjacent node then go back and the next unvisited node of C are E,F the select the node E that color itself gray and explore its unvisited adjacent nodes, the node is E. The nodes E color itself gray and the unvisited adjacent node of E is H. The node H color itself gray and explore the adjacent nodes of H.

The adjacent unvisited node of H is G. the node G color itself gray and explore adjacent unvisited node of G, the unvisited adjacent node of G is F, the node F color itself gray and explore its unvisited adjacent node so there is no unvisited node is left in the graph the output of graph is :A,B,S,C,D,E,H,G,F[4]

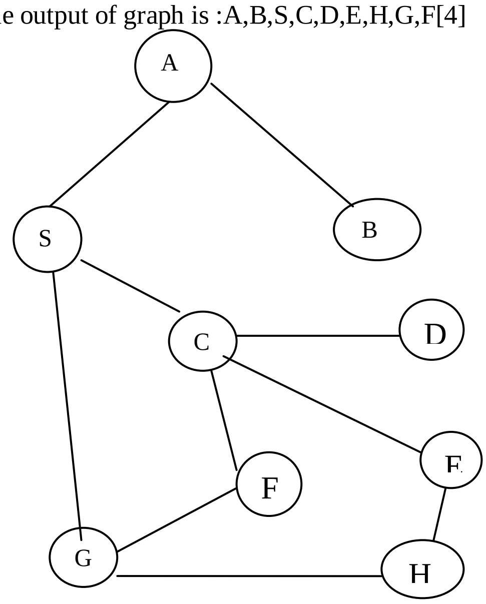

Fig 1: DFS Graph

The DFS algorithm provides the path Wireless sensors nodes randomly deployed in a sensor field.

B.Genetic Algorithm

Genetic algorithm is the search technique to find the optimal solution of a problem. The genetic algorithm optimize the path.[4] The four operator of genetic algorithm:-

1. Representation
2. Fitness Function
3. Crossover
4. Mutation

1. Representation

The representation means defining the individuals. The chromosome represents the states of the sensors nodes. Chromosome can be bit string, real numbers, lists of rules etc Here the chromosomes are represent in the bit string either "0" or "1" if it is one its means the sensor node is in wake up state and if it is zero it means the sensor node is in sleep state.

0	**1**	**0**	**1**	**0**	**1**	**1**	**0**	**0**	**1**	**1**	**0**	**1**	**1**	**1**	**0**

Fig 2:- Chromosomes representation

2. Fitness Function

The fitness of a chromosome is evaluated using a defined function to solve a problem. A chromosome with a higher value has the better chance of survival. Each chromosome has a chance of selection that is directly proportional to its fitness. T

3. Parent Selection Mechanism

The role of parent selection is to distinguish among individuals based on their quality to allow the better individuals to become parents of the next generation. The high quality individuals get a higher chance to become parents than those with low quality.

4. Survivor Selection Mechanism

The role of survivor selection is also individuals based on their quality. In GA, the population size is (almost) constant, thus a choice has to be made on which individuals will be allowed in the next generation. This selection is based on their fitness values, choose those with higher quality.

5. Variation Operators

The variation operators is to create new individuals from old ones. Processes selected solutions to generate new candidate solutions that share similarities with selected solutions but are novel in some way.

6. Mutation Operator

Mutation operator change one or more gene values in a chromosome in its next generation. Mutation operator allows each bit to flip (i.e. from 0 to 1 and 1 to 0) with the mutation probability. This can result in entirely new gene values being added to the search space. The main objective of mutation is to provide the optimal solution

7. Crossover Operator

Crossover operates on individuals. The crossover operator is used to create new solutions from the existing solutions available in the search space after applying the selection operator. The crossover point is randomly selected [3] All data beyond that point in either organism string is exchanged between the two parent strings. The resulting strings are the children strings [4]

III. METHODOLOGY

The presented work is divided in two main phases. In first phase, we have defined eligibility criteria for the node to be the member of cover set. A node can be the member of cover set and will cover the target node if it satisfy the following criteria

(i) Sensing Range
(ii) Energy Vector
(iii) Load

In this present work, the second decision criteria are about to decide which cover set will be activated. To perform this decision the following criteria's are defined.

(i) Cover set Energy : A Cover set will be activated, if the overall energy of the nodes is higher than the defined threshold value. Let for any ith cover set we have m number of sensor nodes then the energy required by the cover is

$$\sum_{j=1} S(i,j).Energy > EnergyThreshold$$

(ii) Sensor Cover Failure Probability

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. {
    c. If(S(i).Energy>Threshold and S(i).Load <ThresholdLoad)
    d. {
    e. EligibleNode= EligibleNode U S(i)
    f. }
    g. }
(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 NumberofRounds
(viii) {
(ix) [Identify the effective cost coverset using genetics]
(x) For i=1 to MAXITERATIONS
(xi) Perform the selection of coversets called coverset I and J
(xii) Apply the fitness function to perform the cost analysis
(xiii) Implement Crossover K=Crossover(I,J)
(xiv) Implement K=Mutation(K)
(xv) }
(xvi) If(Energey(Coverset(K))>threshold and failureprobability(Coverset(K))<Threshold)
(xvii) {
(xviii) Select coverset as the current, coverset for round r
(xix) S(I,:).Energy=S(I,:).Energy-CommEnergy
(xx) If(S(I,:).Energy<=0)
(xxi) {
(xxii) Dead=Dead+1
(xxiii) }
(xxiv) }
(xxv) }
(xxvi) }
(xxvii) }

IV. OUR WORK

A. Network Establishment

A Wireless sensor network is simulated in the MATLAB tool. A stationary network with a fixed number of targets and sensors randomly deployed around the targets is simulated. A 500×500m area is considered for deploying the sensors and targets randomly.

Table 1: Simulation parameters for the network establishment

Parameters	**Specification**
Area	500× 500
Sensors	30
Target	5
Base Station	(450,400)
Energy of each sensor	0.5 J
Sensing Model	Binary
Sensing Range	150 m

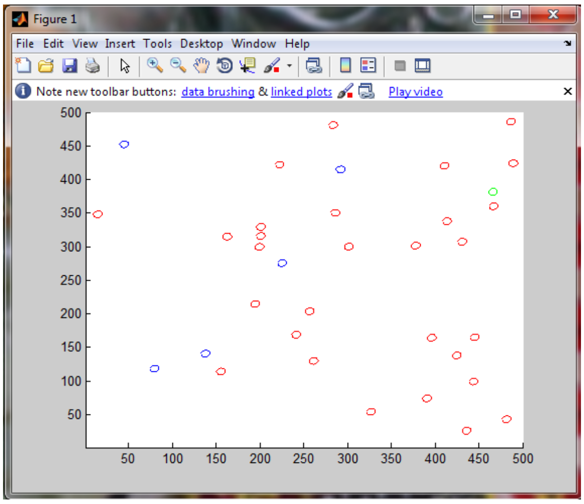

Fig. 3: Sensor Network Establishment

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.

B. Generate the sensor covers

The heuristic will generate the cover by selecting the sensors with certain energy and that will cover at least one uncovered targets. The sensor covers are generated till all the targets are covered. For the generation of sensor cover we first find the Euclidean distance of each target from the sensor. Figure 4 shows the matrix containing the Euclidean distance of sensors from targets.

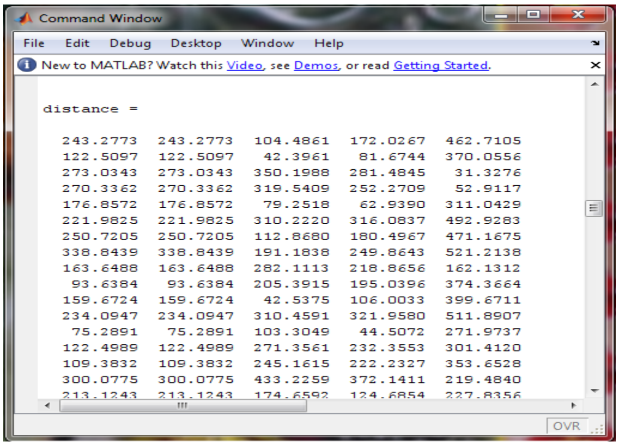

Fig 4 : Euclidean Distance Matrix

C. Assign lifetime

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.

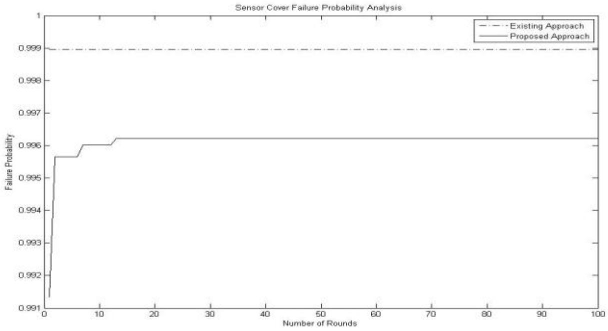

Fig 5: Number of iterations vs. Failure Probability

Figure 5 shows that the presented work has reduces the failure probability of the network. Here x axes represents the rounds y axis represents the failure probability

V. CONCLUSION

The DFS algorithm use to achieve connectivity and consume less energy. Sensor nodes executing this algorithm exchange messages with their one-hop neighbors to decide the nodes in the active cover set, In underwater wireless sensor network the nodes are in floating nature so that DFS and Genetic algorithm both used to monitor the targets as well the connectivity dynamically.The algorithm reduced the failure probability of sensor nodes lifetime.

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