Comparison of Various Types of Algorithm for Target Coverage Problem in Wireless Sensor Network

Rafat Saud Pasha, Ankit Saxena , Jitender Kumar Jindal

Abstract*—*Now a days wireless sensors network is most commonly used in all the organization for using the internet and data transfer. A wireless sensors network is collection of nodes network. Every person wants to transfer a data of very high speed .There are various type of algorithms available for providing a fast speed for data transfer.

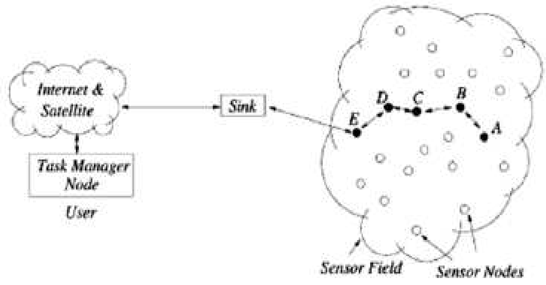
Today internet become a wide area and necessity of communication in which person transfer a small or huge amount of data from one place to another place for which they want fast speed of data transfer.

In this paper we firstly cover the concept of target coverage and define the problem for this after that we compare the algorithm and technique to solve this problem. We also give basic concept regarding the strategy to cover a specific set of targets in wireless sensor network.

Keywords*—*Target coverage problem, Routing Algorithms, strategy of target coverage, wireless sensor network

I. INTRODUCTION

This paper gives the basic information regarding the wireless sensor networks as well as the target coverage problem and the algorithm technique used to solve that problem. This paper also compares the various types of algorithm and technique to solve target coverage problem. Now days we have seen tremendous advancement in wireless sensor networks due to reduction in development costs and improvisation in hardware manufacturing. Previously in some decades have been marked with rapid use of wireless sensor networks in various fields. The wireless sensor networks are now used, other than in military surveillance, in habitat monitoring, seismic activity surveillance and are now even used in indoor applications. These wireless sensors have provided us the tool to monitor an area of interest remotely. The wireless sensor network faces various issues one of which includes coverage of the given area under limited energy. This problem of maximizing the network lifetime while following the coverage and energy parameters or constraints is known as the Target Coverage Problem in Wireless Sensor Networks As the sensor nodes are battery driven so they have limited energy too and hence the main challenge becomes maximizing the coverage area and also ensuring a prolonged network lifetime The following fig is is providing the basic layout of the wireless sensor network.



A typical Wireless Sensor Network

II. WIRELESS SENSOR NETWORKS

The Wireless sensor network consists of large number of distributed nodes which are used for monitoring or surveillance of physical area[1]. The information gathered is relayed back to a base station. Wireless sensor network has many applications and depending upon the type of its use, the quality of different service. For one application, the quality of service depends upon how information is transferred from one node to another while for others the delay in transmission has to be minimized. The quality of service parameter is that the target points in the area under surveillance are to be maximized while taking in account the limited energy supply of the sensor. Basically, it is ensured that every sensor monitors at least one target and that they operate in covers. Each cover is scheduled to work in turns while other sensors remain in the sleep mode. Thus when a particular cover runs out of energy, other cover is activated which monitors the area and hence the network lifetime is maximized.

The network lifetime is the amount of time each target is covered by at least one sensor, obtain data and transmit them back to the base station. The main concern or the bottleneck is the limited amount of battery available since there are various situations in which the sensors are deployed in hostile situation where it is very difficult to replace the battery. The main objective is to maximize the number of targets monitored before the sensors consume their energy. Second factor can be assigned to cost which might not be as great constraint as that of energy. But as the sensing range increase the number of targets monitored will also increase

Now days, wireless sensor network are emerging as a promising and interesting area for communication. Wireless Network consists of a large number of heterogeneous /homogeneous nodes (usually called as nodes) which communicates through wireless medium and works cooperatively to monitor the environment. The total number of nodes in a network can vary from hundreds to thousands. Generally the nodes senses data from environment and send these data cooperatively to the sink/gateway node.

III. TARGET COVERAGE PROBLEM

Assume that n sensors $s_1,s_2,\ldots.s_n$are deployed in territory to monitor m targets $t_1,t_2,\ldots.t_m$ [2][4] A target is said to be covered by a sensor if it lies within the sensing region of the sensor. The sensor network lifetime can be extended by finding the maximum number of disjoint sensor covers or set covers.

Let us set an upper bound p for the number of set-covers The DSC problem is formulated as follows.

Given:

set of n sensor nodes $C = \{s_1,s_2,\ldots.s_n\}$

a set of m targets $T = \{t_1,t_2,\ldots..t_m\}$

the relation between sensor and targets, that is, for each sensor which is the set of targets it covers, this is represented as each element present in C depicted as a subset of the finite set T.

Let us define

$C_k = \{i|$ sensor s_i covers target $r_k\}$

Variables:

$x_{ij,}$ boolean variable, for i = 1..n and

j = 1…p; $X_{ij} = 1$ if s_i sensor is in the set cover S_j, otherwise $X_{ij}= 0$.

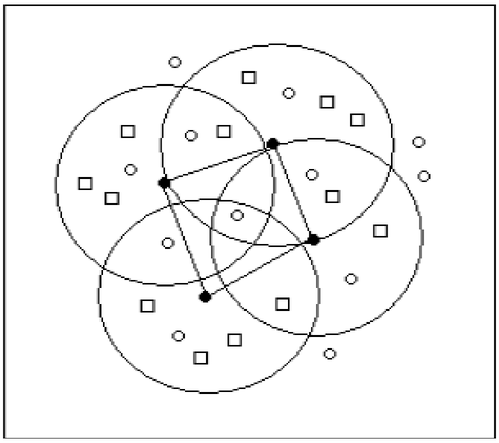
$t_j \varepsilon R$ 0 ≤ ≤ 1, for j = 1..p, represents the time allocated for the set cover S_j

The optimization problem can be written as:

Maximize: $t_1 + t_2 + \ldots.. + t_p$

subject to:

In Target Coverage Problem, the fixed number of targets are continuously observed by a number of sensor nodes with the aim of maximizing the lifetime of the network. Possibly, each target is monitored by at least one sensor node as shown in figure.

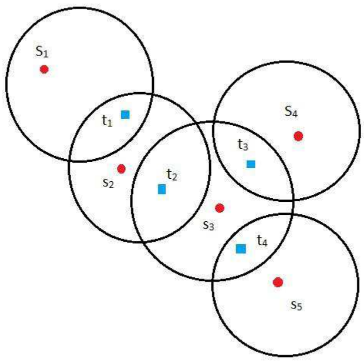


There are a specific number of targets which are to be covered by a set of sensor nodes. After getting deployed, the sensor nodes start the task of monitoring the said targets. Since sensor nodes are provided with only some limited resources and can't withstand extreme environmental conditions, they are deployed in large number much more than actual requirements. While covering the targets, several issues like maximisation of network lifetime, minimum participation of sensor nodes, minimum consumption of energy, etc must be taken into consideration in order to achieve much efficient target coverage.

IV. DISJOINT SET COVERS PROBLEM

Given a collection of S subsets of finite set T, Find the maximum numbers of disjoint target covers for T[3]. Every cover C_i is a subst of S, $C_i \subseteq$ and C_i S, uch that every element of T belongs to at least one member of C_i, and for any twoo covers C_j, $C_i \cap C_j = \varphi$.

Let T be the set of the targets, $t_1,t_2,\ldots.,t_m$, sensor s_i can be represented by a subset, denoted as S_i , of T where $t_j \in S_i$ if and only if t_j lies within the sensing region of sensors s_i.



Bipartite Graph G based on WSN Link between si and ti means ti lies within the sensing region of si.

In Figure s1, s2, s3, s4 and s5 as five sensors, and t1,t2,t3 and t4 as four targets are depicted

In this S1={t1}, S2={t1,t2},S3=(t2,t3,t4},S4={t3}, and S5={t4}.Two disjoint covers are C1={S1,S2} and C2={S2,S4,S5}.

Computing maximum disjoint set cover is NP-Complete problem. In which the aims is to find the near optimal solution to the problem. The maximum disjoint set cover approach ensures that all the targets in the given area are monitored all the time and each cover gets to monitor those targets. The covers are active for a discrete time quantum after which the next cover becomes active and the previous one goes into sleep mode. Alternating between sleep mode and active mode ensure that the energy of the sensors is used judiciously and thus the network lifetime is maximized.

V. GREEDY ALGORITHM BASED HEURISTIC

The Greedy Heuristics discussed here takes three parameters -the set of covers, -the number of targets, and -the number of sensors and returns i the number of disjoint cover sets C1,C2,….Ci formed.

Algorithm

Greedy-MSC Heuristic (C, T, S)

1: set lifetime of each sensor to 1

2: SENSORS = C

3: i = 0

4: while each target is covered by at least one sensor in SENSORS do

5: /∗ a new set cover Ci will be formed ∗/

6: i = i + 1

7: Ci = ∅

8: TARGETS = T

9: while TARGETS = ∅ do

10: /∗ more targets have to be covered ∗/

11: find a critical target tcrit TARGETS

12: select a sensor su SENSORS with greatest contribution, that covers tcrit

13: Ci = Ci∪ su

14: for all targets tk TARGETS do

15: if tk is covered by su then

16: TARGETS = TARGETS − rk

17: end if

18: end for

19: end while

20: for all sensors sj Ci do

21: SENSORS = SENSORS - sj

22: end if

23: end for

24 : end while

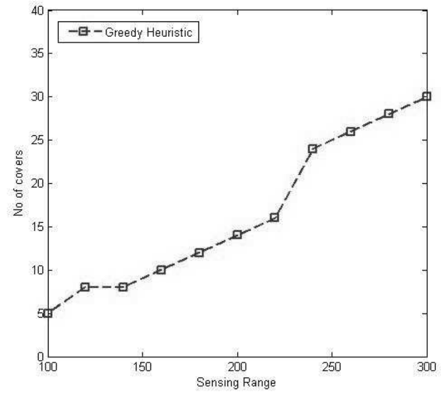
25: return i-number of set covers and the set covers C1, C2, ..., Ci

Simulation:

Sationary network spanning an area of 500m by 500m with a fixed number of targets and sensors randomly deployed around the targets is simulated. The main objective is to study increase in number of cover sets as sensing radius and number of sensors increase. More the no of cover sets found, more is network lifetime.

Simulation 1: Adjusting the Sensing Radius

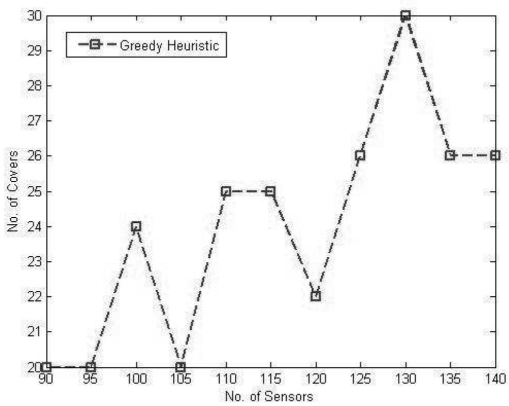
In the first simulation, 90 sensors and 10 targets are deployed and the sensing radius of each sensor is increased from 100 to 300 by 10 for observing performance of given algorithms.



No. of Covers with Sensing Range

Simulation 2: Controlling the number of Sensors.

In the second simulation, the sensing radius is fixed at 220 and sensors are randomly deployed from 90 to 140 increasing by 5 to cover 10 targets.



Greedy Algorithm based heuristic, [3] approach finds the cover sets to maximize the network lifetime of a WSN in polynomial time, its performance is very sensitive to how close an initial candidate is to an optimal solution. Thus, the approach can lead to a local maximum solution due to its heuristic search. In the next Simulation, a Genetic Algorithm based approach to solve MDSC problem is discussed to find the optimal solution by evolutionary global search. In this work, the Greedy Algorithm based approach is used as a baseline for comparison.

VI. CONCLUSION

In this paper we define the target coverage problem and the algorithm or technique used to solve the problem.in this we define the genetic algorithm concept and greedy algorithm.

REFERENCES

[1] J. Yick, B. Mukherjee, D. Ghoshal "Wireless sensor *network survey*", Elsevier press, 2008

[2] M. Cardei, My T. Thai, Y. Li, W. Wu "Energy-Efficient Target Coverage in Wireless Sensor Networks", INFOCOM'05, IEEE press, 2005

[3] R. L. Haupt, S. E. Haupt, "Practical genetic Algorithm", 2nd edn., Wiley Press

[4] Chinmoy Bharadwaj , Dr. Santosh Kumar Swain , Amlan Jyoti Baruah "An approach for solving target coverage problem in wireless sensor network", IJCSET, Vol. 4 No. 04 Apr 2013