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Analysis and Comparison of Wireless Sensor Networks Coverage Algorithms

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Abstract— **Wireless sensor networks in past few years are up grown technology in wireless field. This network has various properties such as self organization and fault tolerance. These types of networks are basically created randomly that consists sensor nodes, battery. Many algorithms have been developed to reduce the energy utilization of sensor nodes. Mainly these networks consists of advantages of being monitoring in specific area, sensing but it consists of several drawback also like battery consists of minimal lifetime. So to overcome this drawbacks the connected set coverage algorithm named three phase iteration connected set cover (TPICSC) is being introduced which is more efficient. This paper presents an analysis and comparison of this algorithm TPICSC with heuristic high energy small lifetime (HESL).**

Keywords—wireless sensor networks, three phase iteration connected set cover, high energy small lifetime

I. INTRODUCTION

Wireless sensor network (WSN) is the most prominent network of technology field. By the help of this network nowadays we can monitor over specific area and pass their data to the main centre or location. These networks are bidirectional and overall these networks are motivated by military during battle surveillance and during hospitality for health monitoring. WSN is basically collection of nodes which are connected without the use of wires that means they are wireless so that is great advantage to these networks which reduces complexity and that can be accessed through central or means they can be controlled from there as hubs are working as central controller. These nodes are connecting through sensor so they are sensor nodes. These sensor nodes contain several parts such as radio, microcontroller and battery with limited energy, analog circuit and sensor interface figure 2. Typically these sensor nodes just look like a box like structure which is rectangular in shape and that cost is also cheap. These sensor nodes contain battery which is having limited energy so our aim is mainly to get the proper use of this energy for transferring information and save as much as energy for further use. There is a scheduling process we just gave them priority order to use their battery energy if one is in active state the other one should be in sleep state only the active state will give their energy till it need than it should be in sleep state too. Wireless sensor networks main advantage is fault tolerance and self organization as there is no wired used since there should be no fault a these network work properly for the long time after its starting. And these networks are self organized after being deployed ad-hoc in a fashion. This network sends the data via wireless figure 1 in these data from data centre is sending to the sink then it is forward to the internet this process goes on and then it is sent to the user and then all information is being transferred into the main location.

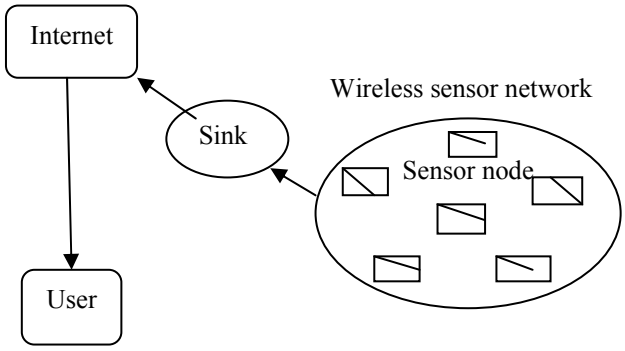

Figure 1. Wireless sensor network data processing.

These wireless sensor networks includes three of them routing, scheduling and clustering. Routing is basically used to route the paths and scheduling is used to make the sensor sets and their cover sets while clustering is the process where cluster groups are made and each group contain the cluster head which manages the whole process of transferring the information. Mainly there are several algorithms which is basically used to save the energy for the further use. Here the Q coverage [1] is also mentioned some heuristic to sort out this problem of saving the energy efficiency. Heuristic is also of two types heuristic one is the high energy first [2] and other is the high energy small lifetime (HESL). These algorithms are just solving the problem of Q coverage which motives to save the energy of the battery and use it for further transferring the information. These networks are receiving signal very strongly and via wireless it is just the sensor networks where sensor play a vital role in this field of technology. These sensor nodes just basically have some components which are playing a most important role during this data transferring. So this components are of great use with their priorities and their proper use is very necessary for or future development.

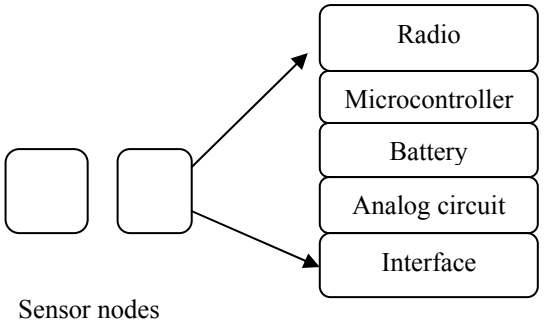

Figure 2. Components of sensor nodes

II. ANALYSIS OF EXISTING ALGORITHMS

For energy efficiency there are so many coverage algorithms are being described their point of view to save and utilize the energy in a correct form. In this portion here is the discussion about those coverage algorithms will be done and presented. Greedy-CSC and Ip-CSC [3] are the two algorithms mainly used for CSC (connected set covers) as heuristic. There are some of the algorithms which are mainly used to improve the lifetime of system. HESL is also one of the heuristic which is used to solve the problem of coverage and maximizing the energy efficiency of the required system. There is several more algorithms are there which are described according to the coverage and target area problem.

High energy small lifetime (HESL) :-

High energy small lifetime (HESL) is one of the heuristic which is developing to solve the Q coverage problem. And this Q coverage problem is NP complete [1].Mainly three steps are used in this heuristic.

(1)First the heuristic basically generates Q cover(Set of sensors that covers all the targets) by using sensors with the highest battery life .Means according to the priority it just generates the Q cover for every sensor till it cover all the targets according to coverage vector Q.

(2) Once the entire target is covered then there will be no mover generating Q cover. Then it is checked if it is minimal or not by removing one sensor at a time and check whether it is Q cover or not. Instead of assigning maximum lifetime, small constant of lifetime is assigned.

(3)In order to avoid the repetition of same Q cover in the iteration, the priority of sensor is reduced when once it is used.

Pseudo-codes [1] of algorithm:-

INPUT M, Q, w
We assume initial value of bi is 1, for each sensor i.
repeat while for each target $\Sigma i\ Mij\ bi \geq qj$
1. Generate a Q- cover

$S = \emptyset$
for all targets t
uncover_label(t) = qi

do while uncover_label(t) $\neq 0$ for some t
select a sensor s with highest bi>0 that covers at least
one target with uncover_label(t) > 0.
$S \leftarrow S \cup \{s\}$
for all targets t covered by s,
uncover_label(t) = uncover_label(t)-1

end do
minimalize S

2. assigning lifetime to Q- cover S

compute max_lifetime(S)

$w' = Min\ (w, max\_lifetime(S))$

$lifetime(S) \leftarrow lifetime(S) + w'$

3. update priorities

for each $s \in S$
$bs \leftarrow bs - w'$

so this is the pseudo-code for high energy small lifetime basically these code indicates how the whole process of this algorithm actually works out and what it means so this is the algorithm whose pseudo-code synchronize the every step such that there will be no problems in signal as they were same in both side receiver side as well as senders side. The above pseudo-code exactly describes the high energy small lifetime (HESL) algorithm clearly step by step.

Three phase iteration connected set covers (TPICSC):-

Three phase iteration connected set cover (TPICSC) is one of the heuristic which is developed to solve the problem of CSC. The steps of this algorithm are given below with three phases.

(1) Coverage phase:- This algorithm is basically having iterations and during these iterations algorithms find a CSC from every available set of sensors. So this algorithm is much more efficient as the greedy-CSC and IP-CSC because this gives optimal solution as well as takes the polynomial time too by covering the entire target by sensors in cover set.

(2) Connectivity phase: - In this algorithm after coverage there should be proper connectivity. so this is the phase which is playing a main role in this heuristic of CSC. So for the proper connectivity there should be shortest path for this network which should be properly connected. We introduce the BS (Base Station) connectivity.

(3) Redundancy reduction phase:- this phase of the heuristic deals with the reduction of the redundant sensors to form a minimal connected set cover

Pseudo-codes [3] of algorithm:-
1. find_active_set (Av , M)
2. begin
3. Set A = 0;
4. /* Coverage phase */
5. ….
6. /* Connectivity Phase * /
7. ….
8. /* Remove Redundancy Phase */
9. ….
10. Return B;
11 end

12. Main O
13. begin
14. Set the residual energy of each sensor i to Ei <--E
15. Av<--{(51' E1). (52' E2), ... (5N, E;')};
16. TARGETS <--{Tl. T2 .... ,TM};
17. h<--0;
18. while the sensors in Av are connected and cover all targets do
19. Ai <--Fined_active_set (Av' M);
20. i <--i+l;
21. for all sensors sj E Ai
22. if sj is a relay node then
23. Ei <--Ei - E2;
24. else if sj is a sensing node then
25. Ei <--Ei -(El + E2) ;
26. else if Ei < E2 then
27. Av<--Av- sj ;
28. end if
29. end for
30. end while
31. end main

So this is the pseudo-code for the required TPI-CSC algorithm which is basically showing the synchronization of this algorithm in these steps. This is the algorithm which is more efficient as this algorithm gives an optimal solution in polynomial time.

III. COMPARISON OF EXISTING ALGORITHMS

In this paper we analyzed the two algorithms which target is to coverage the whole area so that it can easily transfer the information via wireless. These algorithms are basically used for to increase the lifetime of system means to save the energy and use it further. This algorithm high energy and small lifetime and three phase iteration connected set cover is being compared here according to their communication range lifetime of the system. These algorithms basically compared with each other as both the algorithms are mainly designed to remove the drawback of limited battery lifetime. So these algorithms are compares and study of this is being described here. The TPI-CSC algorithm is mainly tested practically with different sensors for cover problem compared with different algorithms like high energy small lifetime (HESL). For TPI-CSC each case tested so many times independently without any further issues. These sensors are deployed in a large area and their location of sensors is generated randomly. These way the TPI-CSC algorithm is presented and its parameter are population size s=3, the interval is 100, the mutation rate μ=.5 and parameters p1= p2 = 5

Experiments on Point Coverage Issue:-

In this paper the issue of point coverage is being experiment to get the both algorithms compared. The TPI-CSC is being compared with high energy small lifetime algorithm so that we can pretend that which algorithm is quite suitable for point coverage which is basically through this experiment analysis and practical we are able to say. As\ we know that both algorithms have different roles of saving the lifetime of system so these algorithms mainly differ from each other. TPI-CSC algorithm mainly gives an optimal result as compared with mean, average and time to HESL so these algorithms comparison is necessary being presented here in this paper to get the best result out so that we can use the best algorithm for further use in our life. Here N is no sensor tested and T is the upper limit of cover sets.

Table 1. Figure out the point coverage issue

Cases			TPI-CSC			HESL		
NO	N	T	MEAN	AVG	TIME	MEAN	AVG	TIME
1	80	30	30	590	17	28.63	1982	965
2	90	22	22	241	5	21.83	1193	568
3	100	26	26	152	4	26	6142	303
4	110	34	34	422	15	34	1989	1248
5	120	42	42	1856	84	42	1027	741
6	130	45	45	3245	172	44	2010	1550
7	140	41	41	532	25	40	1923	1517

The above table shows the difference between both algorithms as in point coverage it shows the mean and average and this is the comparison and study about this algorithms.

IV. CONCLUSION

Wireless Sensor Networks is one of the leading networks for the researchers and their development purpose. Covering is the most critical issue for this networks as it needs to cover the whole sensor and target all the required to get the information up to the main location. As we know that the system has limited lifetime of network so energy is quite important in wireless sensor network so in this paper we just analysis and compared the algorithms to maximize the lifetime of system. In this paper the two algorithms TPI-CSC and HESL compared and TPI-CSC is most prominent for the energy efficiency.

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