Calculation on Coverage & connectivity of random deployed wireless sensor network factors using heterogeneous node

Shikha Nema*,
Branch CTA
Ganga Ganga College of Technology,
Jabalpur (M.P)

Neeraj Shukla*
Dept. of computer science
Gyan Ganga College of Technology,
Jabalpur (M.P)

ABSTRACT

A wireless sensor network (WSN) is one of the common communication networks that have been used nowadays. The main idea of this paper is to solve the coverage problem in Wireless Sensor Network (WSN) by increasing sensor nodes coverage percentages [1]. To provide proper coverage of their random deployment regions, wireless sensor networks (WSN) should employ some smart nodes. This work is focus on employing some anchor nodes in WSN which can actively move to desired locations for repairing the broken networks. This paper is proposed to redeploy the anchor nodes according to the distance information for repairing the coverage connectivity after their initial random deployment. By the simulated experiment results that we will show that the WSN can improve the sensing coverage than the stationary WSN by redeploying anchor nodes [2].

Index Terms: *Wireless sensor networks, Sensing coverage, coverage percentage, anchor nodes*

I. INTRODUCTION

WSN has been identified as one of the most important technologies for the 21st century. WSN consists of many tiny, low-power nodes, each equipped with sensing devices and wireless transceiver and often works in unknown environment. Spatially distributed self configurable sensors are employed in WSN to monitor environmental or physical conditions. WSN is normally being applied in many application areas such as military, medical, industrial and civilian application. In sensor network sensor node Cost and size constraints make some challenges for resources like such as energy, computational speed and memory. Due to these limitations of sensor nodes many problems such as routing, scheduling and coverage comes in WSN. In traditional WSN sensor nodes are stationary, the sensing area of most nodes is overlapped and the sensing coverage fraction cannot be repaired automatically. From the previous researches we know that large numbers of sensor nodes should be employed in stationary sensor network to provide proper sensing coverage according to the proportion of the sensing range of nodes to the area of the target region. To reduce the amount of redundant nodes, some research work has been done to improve the QoS in sensing coverage by employing some nodes as mobile nodes.

In wireless sensor network the sensor nodes are randomly deployed in monitored area. The deployment of sensors without enough coverage can result in unreliable outputs in wireless sensor networks. Thus sensing coverage is one of the most important qualities of service factors in WSNs. Coverage reliability of any sensor network is given by coverage rate that is the area covered by sensor nodes in a region of interest [3]. The density of sensor is very high in WSN to measure the area efficiently. In coverage calculation where we want to have knowledge about each and every point in the region so we have to cover whole area efficiently like nuclear plant for effective operations cover each and every

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point inside the monitoring site is more important than the energy consumption. So find full coverage is important in this type of scenario. In this case we use some anchor nodes to maximise the coverage. These anchor nodes can repair the connectivity based on the precise distance information of the sensing fraction which is deduced from the relative position of each node to the other nodes in WSN.

II. RELATED WORKS

In [4] sensing coverage area calculated by theoretically assuming a uniform deployment of sensors in a field. Given that the deployment of sensors in a field may not be uniform in real world [3].

To solve coverage problem in WSN numerous researches had been done. The researches focus on type of coverage strategies; voronoi and Delaunay triangulation, force based and grid based. Among all the methods, grid is the most popular approach [5, 6, and 7].

Wang [8] used voronoi diagram as the coverage strategy that helped sensors to decide whether to stay or to reposition. Combination of voronoi diagrams and PSO algorithm is explained clearly in [9]. The authors stated that PSO application in voronoi diagram approach can give better coverage result [1]. In [10] use Voronoi diagram to estimate the number of additional nodes needed to be deployed and relocated to optimal positions to maximize the coverage. A Voronoi cell of a node is the set of all points in the network field whose distance to the given node is not greater than their distance to other nodes. If a sensor covers all vertices of its Voronoi cell then there are no uncovered points within its Voronoi cells, otherwise some points are uncovered.

III. COVERAGE & COVERAGE PROBLEMS IN WSN:

For any event, sensing the environment efficiently is the main purpose of sensor's network. Thus, one of the major concerns in WSN is coverage. In fact, it becomes a prime factor to evaluate the quality of service (QoS) in WSN. Coverage type refers to the subject to be covered by a sensor network. According to the subject to be covered, coverage in sensor networks can be classified into three types, namely, point (target) coverage, are coverage, and barrier coverage [11]. This paper discusses more on area coverage where the main idea is to maximize the coverage percentage. According to [12], coverage problem is defined as a minimization problem, which is the total area of the coverage holes in a network need to be minimized as small as possible.

There are some main reasons that cause coverage problem in WSN:

1. Random Deployment,
2. Limited Sensing Range
3. Not Enough Sensors to cover the whole region of interest.

Random deployment becomes a problem when some of the sensors are deployed too far apart while the others are too close to each other so due to this there is problem comes in coverage finding algorithms which is known as connectivity. There is also a possibility that only a few number of nodes directly connected to the sink. So in this case only some nodes are participating in the coverage.

Limited sensing range can be resolved by choosing a sensor with larger sensing range but the price of it will be more expensive and energy consuming. The limited power supply effects the sensors' operation as some of them might die out. It will result in inadequate sensors to cover the whole region and will reduce the coverage rate [1]. There is some more problematic term like hole are also present. Hole is the uncovered area in between the covered area. We also have to fill this hole

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to cover maximum area. Coverage is mainly application dependant. Therefore, to minimize these coverage problems, we need to address the problem during deployment phase.

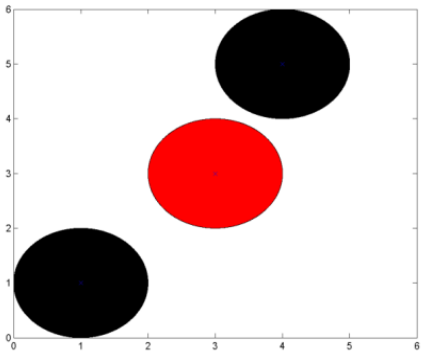

Figure I Homogeneous node

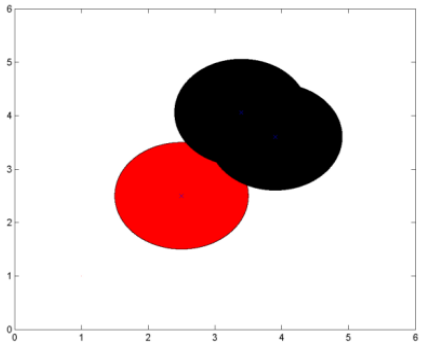

Figure II. Heterogeneous node

IV. NETWORK MODEL USED

There are number of ways to organize the communication architecture of a sensor network. One way for making sensor network architecture is a hierarchical structure which is also known as cluster based method. In this each sensor communicates with a local cluster head and finally the cluster head communicates directly with the sink node. Another way is flat communication structure, where each sensor has essentially the same role and relies on other sensors to relay its messages to the sink node via multi hop radio communication. For the sake of simplicity here in this paper we assume the flat communication architecture. We consider sensor networks in a two-dimensional field and assume that sensor nodes are randomly and independently deployed in a field and after deployment all the nodes are stationary only some redeployed anchor nodes are mobile. Random deployment strategy is much easier and cheaper [13] than manual deployment in predefine positions. We assume that a sensor node's radio transmission range is fixed and totally independent of its sensing range because of different hardware components involved [14].

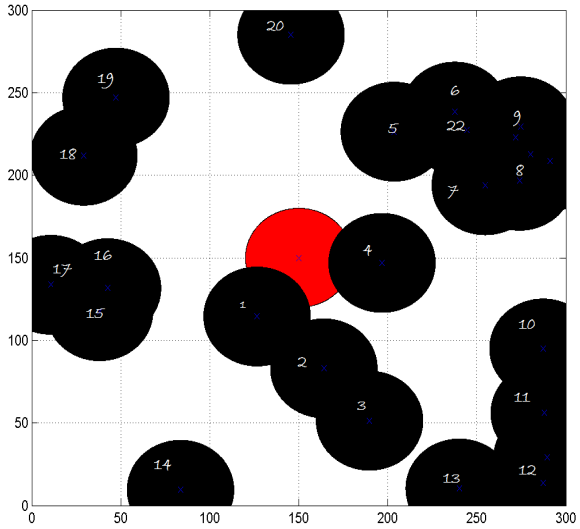

Figure III: coverage in random deployed sensor node

V. ALGORITHMS, ASSUMPTION AND SIMULATION

For finding the coverage the steps are like:

I. Random Deployment of sensor nodes.

Assure connectivity between nodes also check for the base station connectivity.

II. If there is no connectivity than try to find out the connectivity between nodes and also with the base station for maximum coverage.

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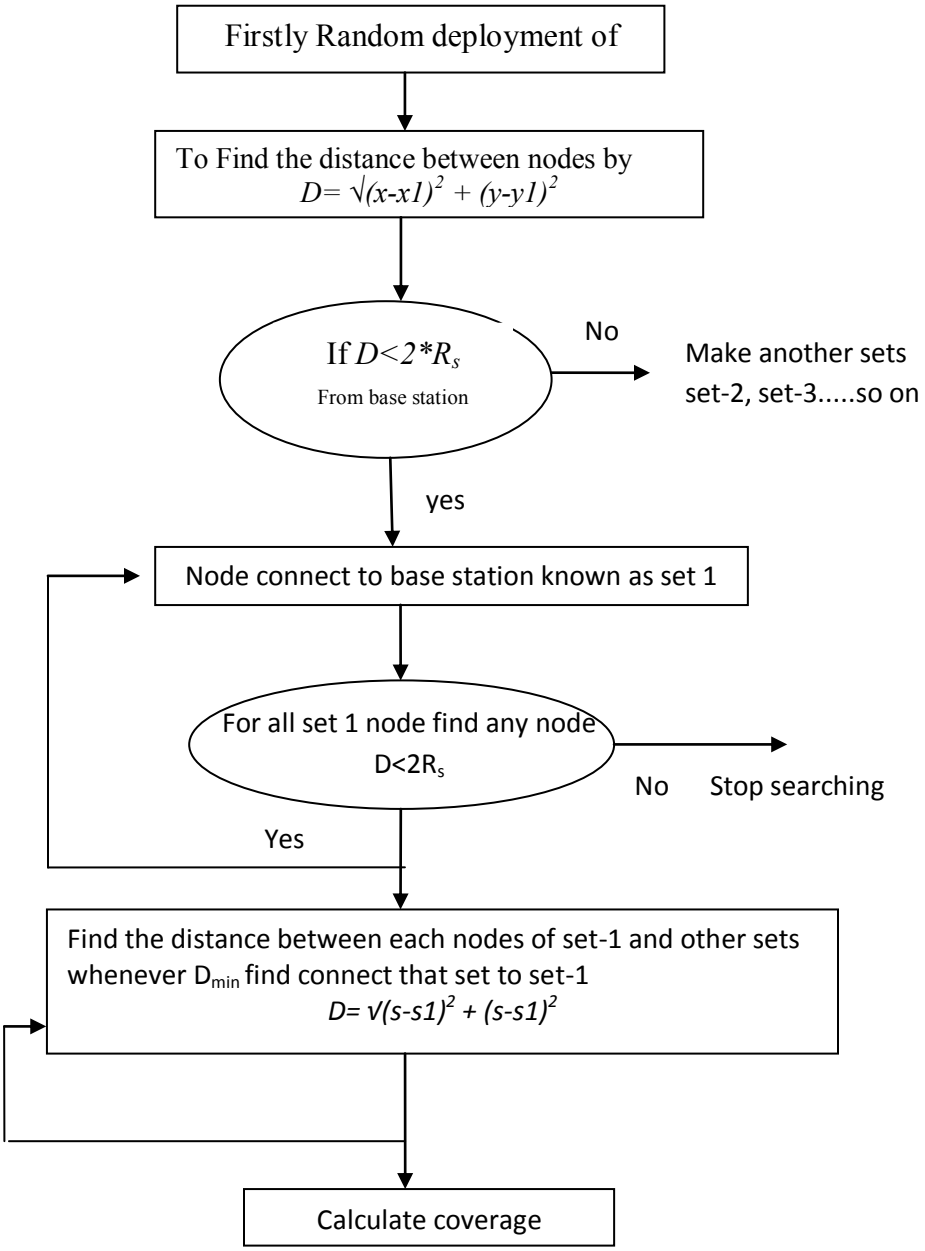
III. If there is connectivity than look for closed loop.
IV. If closed loop than check for availability of hole by above algorithm.
VI. If there is hole in between that area so put some variable range beacon node in that area to cover the hole to increases the network coverage.

VI. FLOW CHART FOR ALGORITHM



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VII. SIMULATION

In monitored area if we deployed the node randomly than there is possibility most of the sensors are not connected to the base station directly.

Here we are proposing a method in which we will find out the connectivity between base station connected sensors and unconnected sensors nodes to calculate the maximum possible coverage.

In this we first find out the sensors which are directly connected to the base station because they directly contribute in the coverage then denoted it by set-1. Than we find the nearest sets which is not connected to the base station set and denoted by set-2, set-3, set-4 and so on. Calculates its distance between all the nodes of set-1 to all the other sets nodes and whenever we find the minimum distance than we try to add that unconnected set with set-1.

For making connection we put anchor node with the radios of half of the distance between the set-1 and that unconnected set.

To obtain the distance information we must done a great deal of work to we compute the relative distance of each node to its neighbours. In this paper we propose minimum distance coverage algorithm (MDCA) by making connectivity between each set of sensor nodes to enhance the coverage in the target region by redeploying the anchor nodes. If the distance between two node is less than the twice of their sensing range than the definitely that two nodes are overlapping with each other. With the increase in connectivity

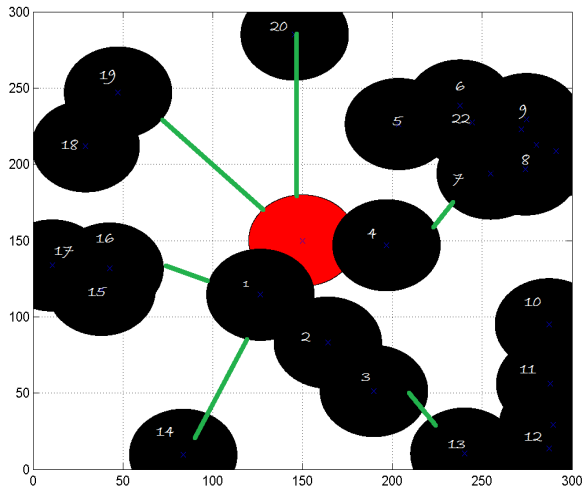

Figure V: Distance calculation from base station

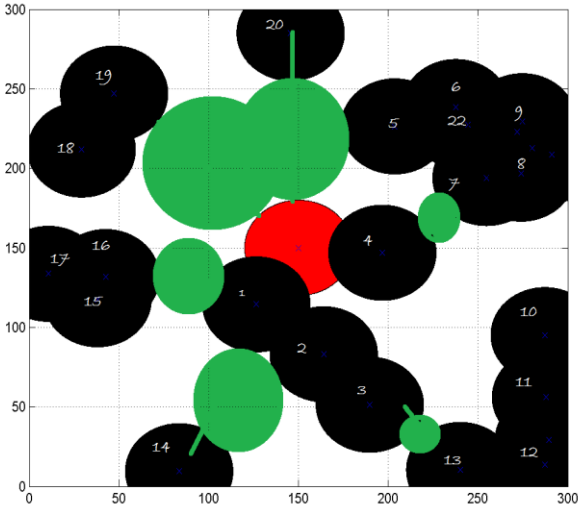

Figure VI: Coverage and connectivity in nodes using heterogeneous nodes

the area of uncovered region will decreased. So we can redeploy the anchor nodes to improve the sensing coverage by MDCA according to the connectivity, and also find the coverage hole and cover it at the same time to increases the coverage [2].

In the case when many numbers of sensors sensing range are overlapping with each other

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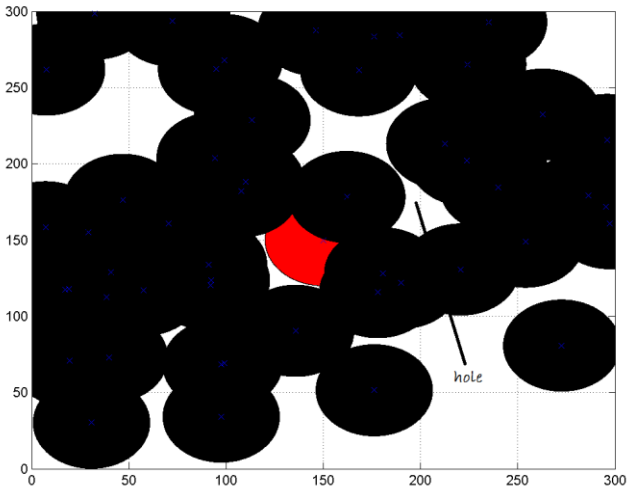
so there is a possibility to be a hole in between there sensing region. The hole is uncovered



area between the covered areas. If we find out the location of that hole, than we will apply some algorithms to cover that hole.

Figure VII: coverage and connectivity in anchor nodes

In that case if we know the location of the each sensor node than we are able to find out the location of hole. But when we not have any idea about the location of sensor nodes than first we have to find out the location of these sensor nodes. For this we use some location finding algorithms. To save energy the time when beacon node not using we put them in to the sleeping mode so we use scheduling for that.

Table1 - Simulation Parameters used

Parameters	Assume values
Area size	$300^m * 300^m$
Base station	150^m , 150^m
Sensing range	15^m
Transmission range	30^m
Anchor node transmission range	variable
Minimum energy (initial)	1 Joule

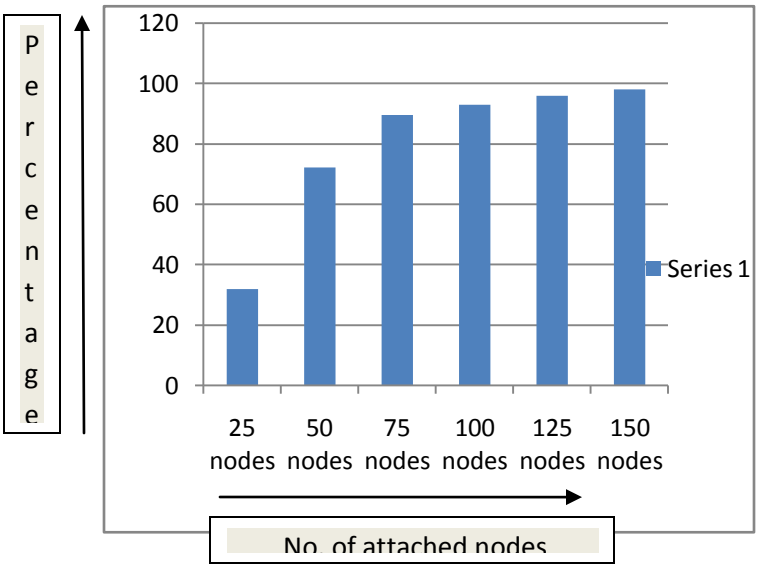
VIII. RESULT & DISCUSSIONS:

Table II – Total no. Of nodes used

NO. Of Heterogeneous Node added	Total no. Of Nodes Attached	Total no. Of Nodes (heterogeneous + attached node)
0	**5**	**0+5= 5**
1	**11**	**1+11=12**
2	**15**	**2+15=17**
3	**18**	**3+18=21**
4	**20**	**4+20=24**
5	**21**	**5+21=26**

The above table II clearly depicted that when we increase the Heterogeneous nodes in the given network the number of connecting node sets will increases accordingly, hence the effective coverage area increase so that efficient network will save the energy in the routing of given network. In above case the optimum numbers of heterogeneous nodes are three it clearly shown in above table.

ISSN: 2278 – 1323



The graph1 shows the relationship between numbers of nodes vs. Percentage of area covered in the fix network size. The number of nodes will increase hence the coverage area increases. Also the coverage area is depending upon the number of heterogeneous nodes.

IX. CONCIUSION

This paper viewed the design considerations for coverage problems in WSN or small area, and it presented the solutions. This researches focus on the following consideration: evaluating and improving coverage performance of area and point. While maintaining, connectivity and maximizing the network lifetime. Although many schemes have been proposed and progress has been made in coverage problems of WSN, there are still many open research issues. More authentic model of sensor nodes can provide the coverage and connectivity for large area.

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