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RAJAT BHARDWAJ BHARDWAJ

*Dept.: Computer Science and Tech. Lovely Professional University, Phagwara, Punjab, India,*  
rbhardwaj@gamil.com

HITESH SHARMA

*Dept.: Computer Science and Tech. Lovely Professional University, Phagwara, Punjab, India,*  
sharmah@gmail.com

AMAN SINGH

*Dept.: Computer Science and Tech. Lovely Professional University, Phagwara, Punjab, India,*  
amansingh@gmail.com

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# COVERAGE HOLE REMOVAL IN WSNS

RAJAT BHARDWAJ<sup>1</sup>, HITESH SHARMA<sup>2</sup>, AMAN SINGH<sup>3</sup>

<sup>1,2,3</sup>Dept.: Computer Science and Tech. Lovely Professional University, Phagwara, Punjab, India

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**Abstract-** The intention of this paper is to remove coverage holes in wireless sensor networks. Coverage holes are formed during the random deployment of sensor networks. In this paper we will discuss what are coverage holes, how they are formed, reasons for their formation and algorithm proposed for the removal of coverage holes.

**Keywords-** *Sensors, Wireless sensor networks, WSN, nodes, mobile sensor nodes.*

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## I. INTRODUCTION

As today the science and technology has enriched the world's life. Today in world everything is depend on the technology. One of such technology is Wireless Sensor Network. Sensors are used in every small thing to every big thing. Wireless sensor network is comprises of sensor nodes. Sensors are of different size from very tiny to very big. When the sensors are grouped together they form a network called sensor network. The sensors are arranged according to the topologies to form appropriate network. Wireless sensor network communicate with the radio frequency waves. The sensors have to perform two different tasks in the network. The first task is that they have to sense the data from the corresponding neighbors and send it to the other neighbor. The second one is communicate with the neighboring nodes. The communication between the different sensor nodes is done with the help of routing [1]. However the wireless sensor networks have some constraints like limited battery power, low sensing capacity. So these restrictions give rise to coverage and connectivity. In today's daily life the sensor networks are used in the electronic gates to detect the metals, in wash rooms-on water taps etc.

In this paper we will spotlight on the coverage hole formation and removal with some good technique.

## II. COVERAGE HOLE

The coverage holes are the holes when several nodes are design together and the some of the gap or the area is left without nodes then is leads to the formation of the coverage holes. The coverage holes are formed when the design of the network fails. Coverage hole are formed when the sensor nodes are arranged unsystematically in the area [2]. Coverage hole can appear into existence due to poor instalment, or nodes whose power is weak. Due to the topology failure of the network the coverage hole may occur.

## III. FORMATION OF COVERAGE HOLE

Three Main reasons for the cause of coverage problem:

1. Region of Interest (ROI) is not covered by the proper number of sensors.
2. Due to some degree of sensing range.
3. Due to random deployment.

On the other hand, the appearance of coverage holes in the target area is inescapable due to the following reasons:

### Random Deployment

Random Deployment of sensor nodes is always considered necessary; however it doesn't guarantee full coverage of the region of interest.

### Sensor Failures

Nodes are subject to failures due to depleted batteries or, more in general, due to environmental influences.

### Position Changing

A lot of ecological factors (wind or storms) may change the sensor nodes positions over time and possibly resulting in some coverage holes in the network.

### Presence of Obstruction

Some obstacles in the region of interest might damage the nodes sensing/communication functionality and thus result in some coverage holes.

## IV. SYSTEM MODEL

The frame work will describe how the coverage holes are formed and the removal of coverage hole. In the frame work the arrangement of the mobile sensor nodes in order to minimize the coverage hole. The sensor nodes are deployed in the given area and then the sensor nodes are rearranged in the manner to cover the coverage hole by overlapping the sensor nodes.

The frame work is described here:

1. Base Station consists of mobile sensor nodes, GPS and control system.
2. Base station is perpendicular to the deployment area.

3. Now the random deployment of the mobile sensor nodes from the base station.
4. Each sensor nodes have the same radius 'r'=10 and same energy or power.
5. Now mobile sensor nodes will arrange themselves in the particular order.
6. The coverage hole is formed while arranging them.
7. Now they have to again configure to arrange them in manner to convert the coverage holes into the coverage area hole.
8. Now with the help of the robot new mobile sensor nodes are deployed in the remaining area of the target field to cover the coverage area hole.

Let radius of circle is 'r'  
 In triangle ABC, by Pythagoras theorem  
 $(AC)^2 = (AB)^2 + (BC)^2$   
 $= (2r)^2 + (2r)^2$   
 $= 8r^2$   
 $AC = 2\sqrt{2} r$

Now calculate distance XY  
 $XY = AC - 2r$   
 $= 2\sqrt{2} r - 2r$   
 $= 2r (\sqrt{2} - 1)$  , r=10  
 $= 8.28$

To calculate the distance of shift of circle or sensor nodes =  $8.28/1.414 = 5.85$

For the calculation of the distance move to cover the coverage hole horizontally and vertically:

For Horizontal: 5.85  
 For Vertical: 5.85

Random Deployment of the Mobile sensor nodes from the Base Station

In the coverage hole removal algorithm we describe the following conditions:

First we know the area of the deployment area and then we assume the mobile sensor nodes of the same radius in that area.

With the help of the base station we will deploy the mobile sensor nodes in the required area.

Then we will rearrange them to cover the coverage hole so as to sense more and more area and in the manner that there should be less overlapping and the power consumption should be there.

In the grid based we have seen that the circular grid has less overlapping and hence better for the sensing. So we have taken the circular sensor nodes of the same radius and same energy [3]. Now we deploy them in the given area randomly and then we will arrange them in the proper manner to sense the data. During the arrangement of the sensor nodes the coverage hole are formed between two nodes and the area is not sensed by the nodes. So we will rearrange them with the help of grid based method. We will overlap the sensor nodes to minimize the coverage hole. Then after that all the sensor nodes are rearranged. Now some of the area is left without the sensor nodes. There we will deploy new sensor nodes with the help of the robot with same condition of the overlapping. Finally the coverage hole is removed. For the calculation of the distance between the circles (sensor nodes) i.e. coverage hole

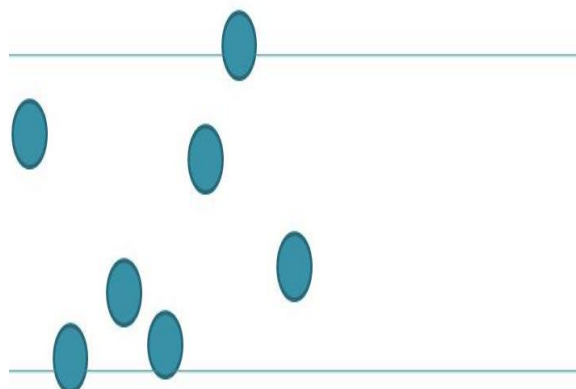


Figure 2: Random Deployment of Sensor Nodes

In this figure 2, the mobile sensor nodes are deployed randomly from the base station in the required area. The sensor nodes are scattered here and there in the required area and then they are arranged in the proper manner through GPS.

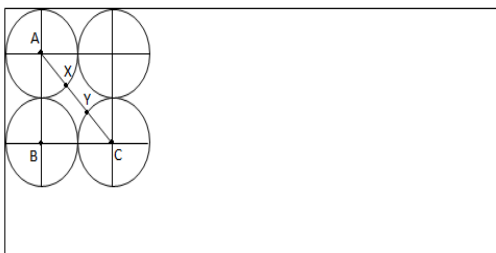


Figure 1: Concept of finding coverage hole

Coverage Hole Formed (Black Color indicates):

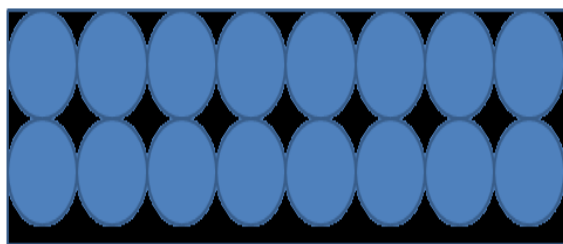


Figure 3: Coverage Hole Formed

In figure 3, the black part represents the holes in the area and the blue color is the sensor nodes. During the deployment of the sensor nodes the holes are formed and are known as coverage hole.

## V. RESULTS

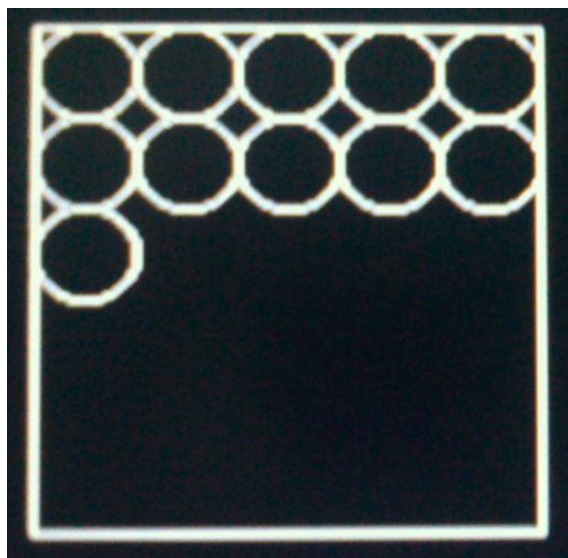


Figure 4: Scenario 1

In this scenario 1, the sensor nodes are deployed in the given area. The area left between the sensor nodes is known as the coverage hole.

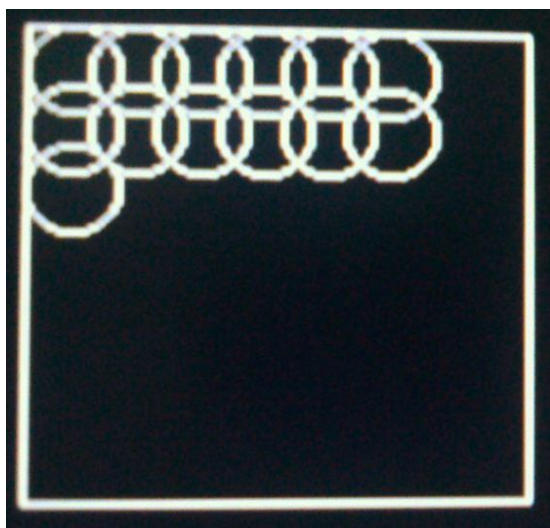


Figure 5: Scenario 2

In this scenario 2, the coverage hole has been removed by using the algorithm and sensor nodes are arranged in the manner to minimize the coverage hole.

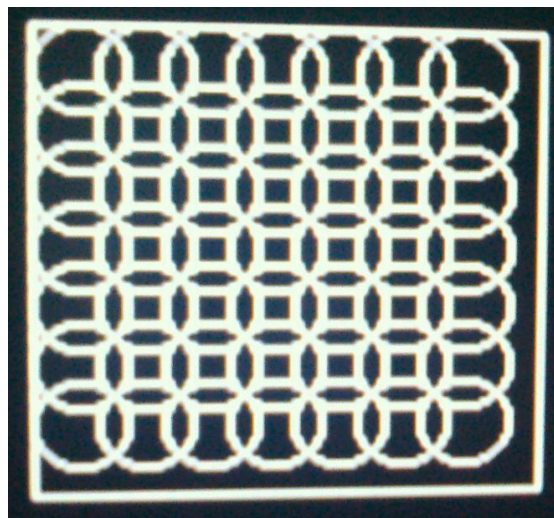


Figure 6: Scenario 3

In this scenario 3, the all the coverage holes have been removed and the area is free from the coverage hole. Now the sensor nodes can sense the area properly.

## VI. CONCLUSION

Today the wireless sensor network technology is used in every area. This has reduced the work load of the people. In the upcoming years this will be used in vast areas. It is very easy to install and maintain and at a low cost. Now for detection of the holes in the networks the following algorithm has been proposed. Wireless sensor networks when deployed need to make use of resources in a better way so that life of network can be increased. Even in an environment where there are no environmental hazards a wireless network will become non functional over time because of drained battery power of sensor nodes in network, until unless we use solar powered sensor nodes. But this will lead to significant increase in the cost of entire network. Wireless sensor networks are deployed in the areas where we cannot reach easily. They are deployed by the help of plains etc... During the deployment of the nodes some of the nodes get destroyed and some are placed here and there. So they lead to the formation of the different types of holes. One such hole we have discussed that is coverage hole in wsn. Coverage holes are formed by the sensor failure, random deployment and many more. We have proposed algorithm for the removal of the coverage hole in wireless sensor networks. This algorithm is based on the concept of the mathematical formulation and efficient to remove the coverage hole. Its functioning is based on the movement of the sensor nodes to minimize the coverage hole while

deployment. In the last we conclude the work with the removal of the coverage hole in the required area.

## REFERENCES

- [1] F.L. Lewis, "Wireless sensor Network", Smart Environments: Technologies, protocols and applications Ed., New York, 2004.
- [2] I. Khan, Dr. H. Mokhtar, Prof. M.Merabti "An Overview of Holes in Wireless Sensor Network "School of Computing and Mathematical Science Liverpool Joh Moores University, 2010.
- [3] Shahram Babaie1 and Seyed Sajad Pirahesh "Hole Detection for Increasing Coverage in Wireless Sensor Network Using Triangular Structure" IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 1, No 2, January 2012

