iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 Issue: XI Month of publication: November 2017

DOI:

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue XI November 2017- Available at www.ijraset.com

A Light Weight Distributed Algorithmic Approach for Optimal Deployment of Sensor Nodes over 3D Wireless Network System

Pritam Karmakar[1], Puja Saha[2], Riya Sarkar[3], Soumi Barman[4], Susmita Sikdar[5], Srabani Kundu[6], Bidyutmala Saha[7], Sourish Mitra[8]
[1, 2, 3, 4, 5, 6, 7, 8]*Department of Computer Science and Engineering, Gurunanak Institute of Technology(MAKAUT)*

***Abstract**: In recent trends of Wireless Sensor Networks the deployment of the sensor-nodes over the region to be monitored is an important and challenging problem. However, many studies already been done on the coverage problem in 2-D environment. But, in real life scenario when the height of monitored area is not negligible along with the length and breadth, then 3-D deployment of senor nodes are highly solicited. In this paper we proposed a light weight distributed algorithm for the optimal deployment of sensor nodes over the 3-D region, maintaining full coverage of monitored volume and connectivity of the networks.*
***Keywords**: Sensor-nodes, coverage,3-D deployment, lightweight, distributed algorithm, optimal deployment, monitored volume etc.*

I. INTRODUCTION

Designing of networks in two-dimensional is a bit different where it is assumed that all nodes are place on a plane. But this basic assumption is invalid in few case where nodes are distributed in a 3D space such as ocean, atmosphere etc and applications of 3D sensor networks are increasing day by day and in future the demand will be high. For example, recently underwater acoustic ad hoc and sensor networks have generated a lot of interest among the researchers [1], [2], [3], [4].In real world placing nodes in a 3D space is much complicated. As an example we can say that to create 3D network under deep sea needs to be placed sensor nodes in different depths of water. 3D network coverage can be helpful in climate monitoring purpose also.

In this paper, we mainly focuses on the coverage and connectivity issues of 3D wireless networks, where all the nodes have the same sensing range and the same transmission range. In particular, we want to answer the following questions:

A. How can we achieve the 100% coverage with minimum number of nodes when nodes distribution is uniform?
B. How can we achieve the 100% coverage with minimum number of nodes when nodes distribution is random?

II. RELATED WORKS

In two dimensional networks the most significant thing is provide sensing coverage and maximum sensing coverage is the fundamental aspect for any application of a sensor networks e.g., monitoring, tracking and classification [5], detection [6]. In 2D plane cellular systems the cells are considered as regular hexagons, in such a way so that the maximum range of a base station is equal to each hexagon. The problem of finding exact locations in base stations on a 2D plane in such way so that the number of base stations required is minimized and get the 100% coverage has been solved for cellular networks [7]. In geographic region every point within the sensing range of at least one must be covered network. Several algorithms [8], [9], [10], [11] have been proposed to achieve the 100% sensing coverage in 2D network Using random network topology a sensor network is deployed. To get the maximize lifetime of a sensor network, energy conservation protocols [12], [13], [14], [15]. To maintain the sensing coverage dynamically has been done by keeping the nodes active at a particular time. In two-dimensional wireless sensor networks performance of greedy geographic routing has been studied in [16].There are few references on a 3D network and the works presented in [17] and [18] studied 3D cellular networks However, all these approaches covers the maximum area but in this paper, we show that how we can achieve 100% coverage on a 3D wireless network.

III.PROBLEM DEFINITION

3D Area Coverage Using Wireless Sensor Network With less Computation And less Communication.

©IJRASET (UGC Approved Journal): All Rights are Reserved

A. Assumptions

1) All nodes have same sensing range. Each sensor represented by a sphere of radius R.
2) Here Radius value (R)is very smaller than the length, the width, or the height of the three dimensional area, so that the boundary effect is negligible and hence can be ignored.
3) We are assuming a square cube inside every sphere and will place those cubes in the monitored area. If all the cubes can cover the monitored area then obviously the sensors can cover the entire area.
4) If the locations of the nodes are fixed, their location is arbitrary. If the nodes are mobile, the nodes are initially randomly deployed, and their movement is unrestricted. Thus, we ignore the physical constraints of placing the nodes, and we assume that the placement strategy is free to place a node at any location in the network.
5) *Goal:*Given any R, Find the number nodes and their coordinates in such a way so that sensors can cover the monitored area with less number of nodes.

IV. ALGORITHM APOROACHES

In this section, we have analysed our problem from the point of view of the shape of sensor which is a sphere [Fig 1.2] and we have implemented two approaches for placing the nodes in the 3D area. One is uniform distribution and another one is random distribution.

A. Uniform Distribution

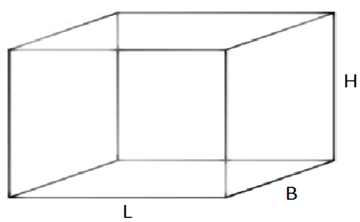
In uniform distribution we are considering the area which is needed to be covered is a cube [Fig 1.2] and sensor nodes are considered as sphere. We assumed a cube [Fig 1.3] inside every sphere. We need to place those cube in such a way so that coverage is 100%,if cube gives 100% coverage then obviously sensor will give the same, “R” is the radius of the sphere and the diameter 2R is the diagonal value.

To get the length of the sphere cube,

$$A\sqrt{2} = 2R$$

$$\Rightarrow A = 2R/\sqrt{2}$$

L ,B and H are the length , breadth are height of the cube respectively.[Fig 1.1] Now consider the axis : X = B , Y = H , Z = L



Now we will calculate that how many sensors are to cover X, Y and Z axis completely.

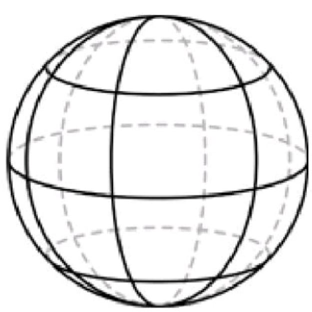


Fig:Sensor

NodeX = L/A
NodeY = B/A
NodeZ = H/A

©IJRASET (UGC Approved Journal): All Rights are Reserved

As A is the diameter of the sphere so by dividing l, h and b by a we can get the number of nodes i.e. NodeX, NodeY, NodeZ.
After getting the number of nodes, there will be a condition check. If all those axis are totally covered by NodeX, NodeY and NodeZ, then we will proceed towards next step, otherwise we will increase the number of nodes by 1.
Now node placement comes into picture. For that we need to find the possible X, Y, Z coordinates as they are placing uniformly so there will NodeX no. of X coordinates , NodeY no. of Y Coordinates and NodeZ no. of Z coordinates and store those coordinates in to memory.
Now we need to find out the possible combination of coordinates along X, Y, Z axis.

```
For i=1:nodez
    For j=1:nodey
        For k=1:nodex
Place(arrx(1,k),arry(1,j),arrz(1,i));
end
end
end
```

B. Uniform Distribution Algorithm

Step1: Find the number o f nodes along X, Y, Z axis.
Step2: Find the possible combination of coordinates along X, Y, Z respectively.
Step3: For i=1:nodez

```
        For j=1:nodey
         For k=1:nodex
Place(arrx(1,k),arry(1,j),arrz(1,i));
end
end
end
```

C. Random Distribution

In random distribution we are considering the area which is needed to be sensed is a cube and sensor nodes are considered as sphere which is the sensing range. Let's consider a cube having height, length and breadth H, L, B respectively. Now let's consider a sphere having radius R and 2R is the diagonal values of the square which resides inside the sphere.
To get the length of the sphere cube,

$$A\sqrt{2} = 2R$$

$$\Rightarrow A = 2R/\sqrt{2} \qquad (2)$$

Now we will randomly choose any point to place the sensor nodes inside the cube.

$$X = \text{random}(0, L)$$
$$Y = \text{random}(0, B)$$
$$Z = \text{random}(0, H) \qquad (3)$$

Here random () is a function to choose any point randomly and we will store those values in an array to compare with the others generated values just to avoid wastage.
For that we have to check the distance between the newly generated random point and points which are stored in the array. The distance denoted by d is-
Distance calculation between two points on a 3D plane

$$D=\sqrt{(x-xi)^2+(y-yi)^2+(z-zi)^2} \quad (4)$$

Where XI, YI, ZI are denotes points stored in the array.
Now we have to compare value of d with those points,
If D >R then the newly generated point will be placed in the cube which will be a newly placed sensor node.

D. Random Distribution Algorithm

Step 1: Generate a random X, Y, Z coordinate.

©IJRASET (UGC Approved Journal): All Rights are Reserved

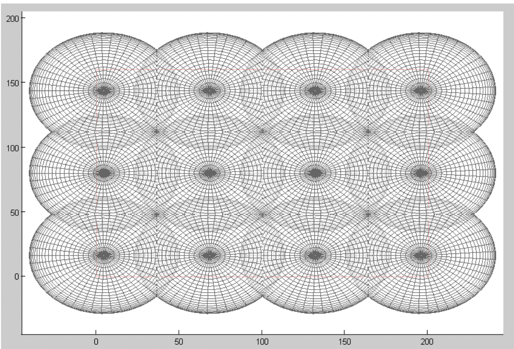
Step 2: Check whether it is lies within the sensing range of other sensors.
Step 3: if lies then go to Step 1 else Step 4.
Step 4: Add the point into array.
Step 5: End

V. SIMULATIONS

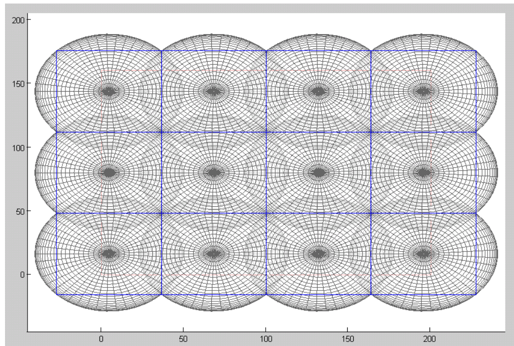
We wrote our simulation in MATLAB implemented the strategies provided in subsection Uniform Distribution & Random Distribution. The graphical output shows that placing nodes according to equations (1), (2), (3), and (4) indeed covers the whole space.

A. *Uniform distribution simulation*

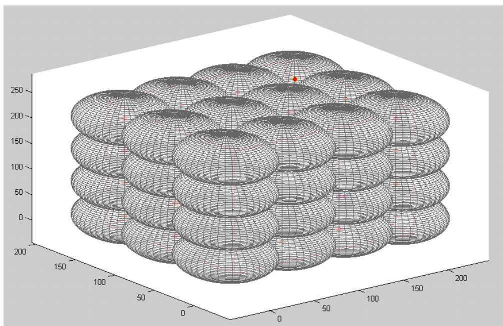
In uniform distribution simulation ,we have considered an area having (length X breadth X height) as (200 X 160 X 240) units. Radius of the sensor was 45 units.



[Fig.1] 2D view of the covered area



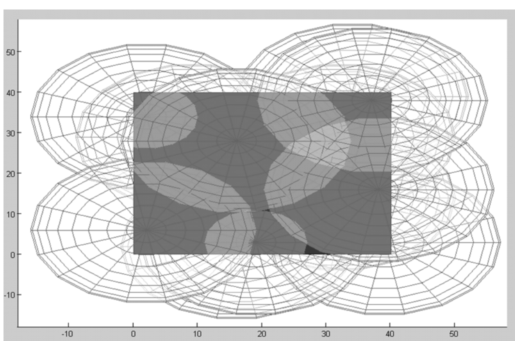
[Fig2] Assuming Cube inside every Sphere



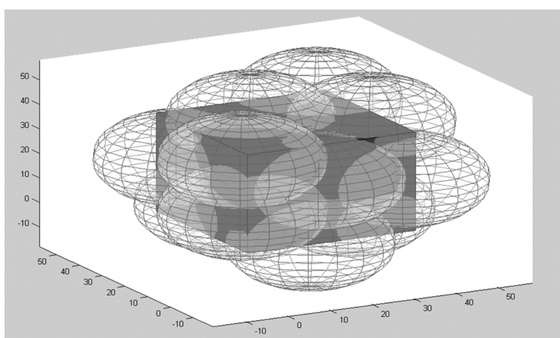
[Fig 3] Simulation if uniform distribution

B. *Random Distribution Simulation:*

In random distribution simulation [Fig 5], we have considered an area having length 40 units. Radius of the sensor was 18 units.



[Fig 4] 2D view of the covered area



[Fig 5] Simulation if random distribution

©IJRASET (UGC Approved Journal): All Rights are Reserved

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue XI November 2017- Available at www.ijraset.com

Further we have studied in our simulation project that, we consider an area having length (40).
sensor node is a sphere which radius (R) is-In simulation (4:1) is no, of nodes vs. coverage. Here the radius of the graph is fixed. If we increase the no. of nodes then the area of that particular value gives 100% coverage. In our graph if the no. of nodes is 6 then it will give 85% (approx) coverage. Then we increase the no. of nodes to 8, 10, 12 then it will give 95 %(approx), 98 %(approx), 99 %(approx) converge respectively. And finally if we take 14 nodes it will give 100% coverage. So, there we can see if radius is fixed coverage percentage is increasing with the no. of nodes.
Our second graph is radius vs. coverage where no of nodes is fixed. For a certain no of nodes of it does not give 100% coverage, then we increase the radius of nodes. So than it can give100% coverage. And as increasing the radius of nodes the coverage will also increase. And at 21 unit of radius the area of that a particular value is give 100% coverage. So in here with increasing of radius of nodes it will give 100%coverage.

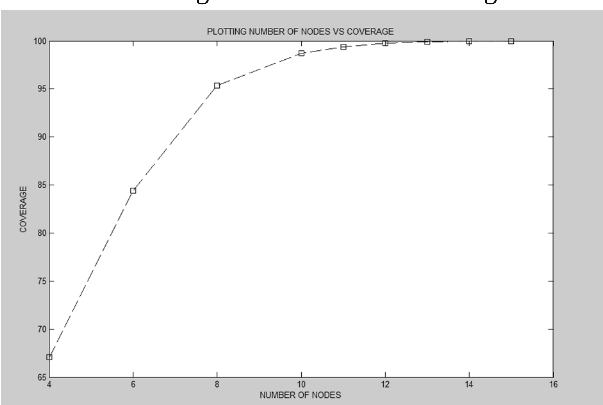


Fig [6] Nodes vs. Coverage Graph

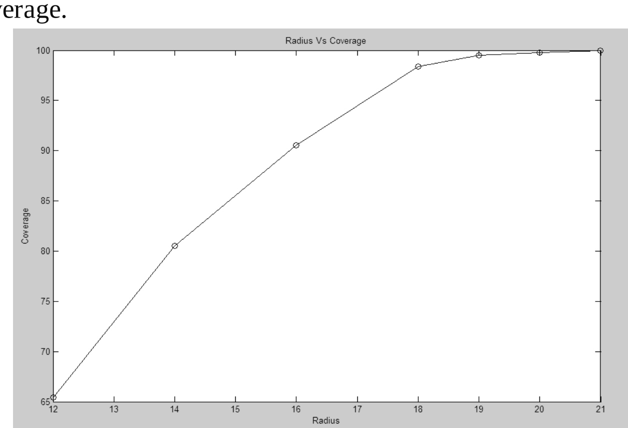


Fig [7] Radius vs. Coverage graph

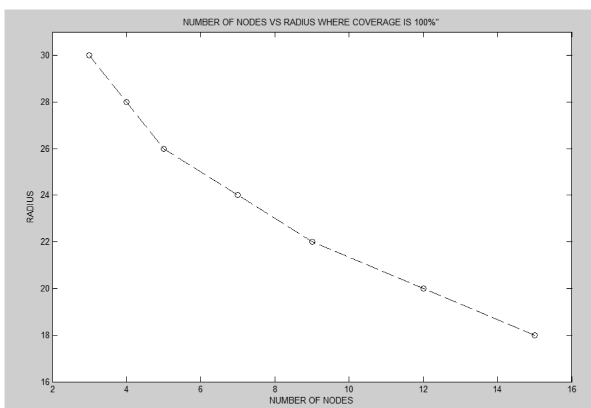


Fig [8] Number O Nodes Vs Radius Where Coverage Is 100%

VI. CONCLUSION

We have proposed a solution to the three-dimensional coverage problem for wireless sensor networks. We have shown that using the random distribution we can get 100% coverage with minimum number of nodes. This problem in a 3D space can be done at polynomial time. The result may be used in deploying sensors in 3D space and in reducing on-duty time of wireless sensors.

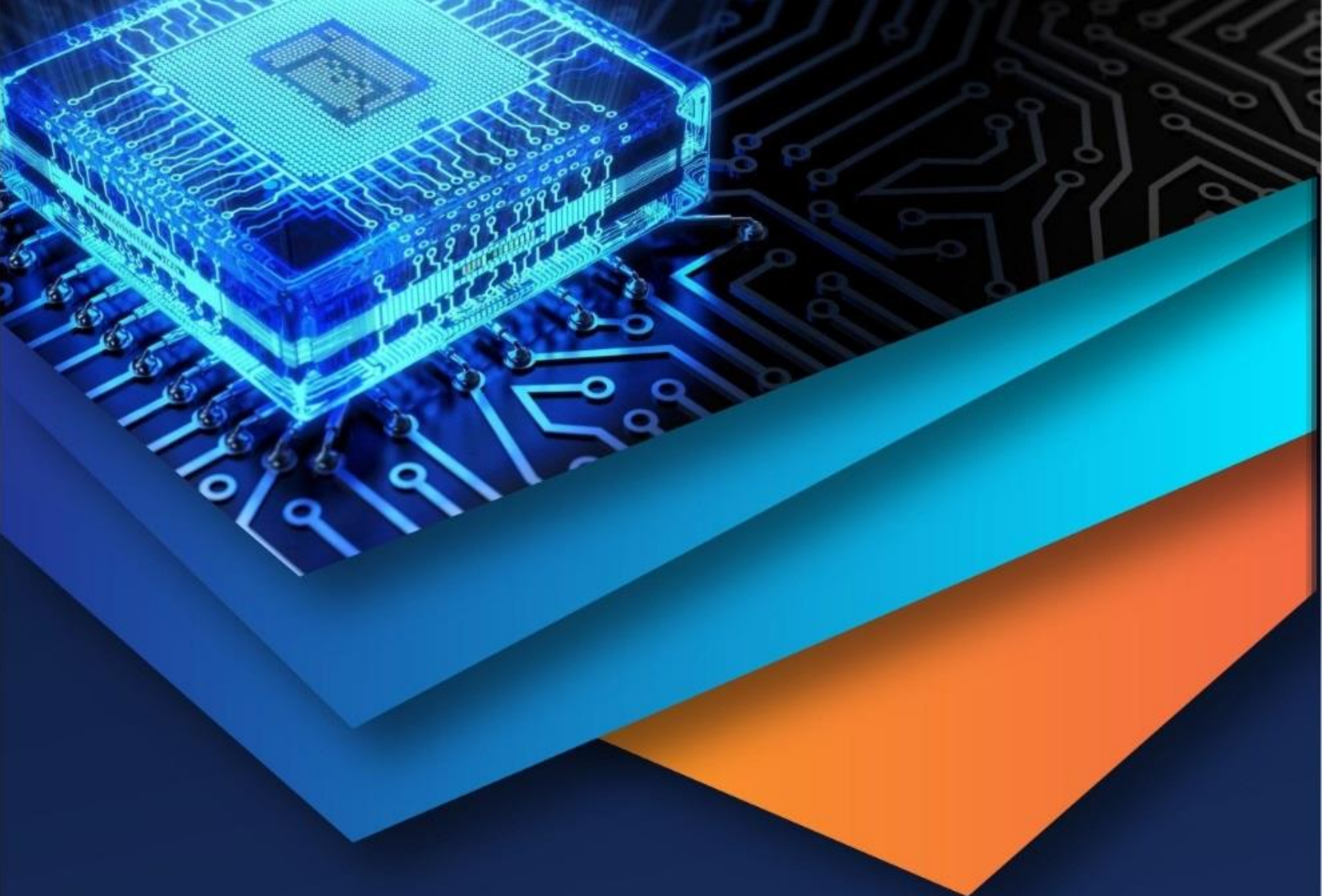
REFERENCES

[1] Akyildiz, I.F., Pompili, D., Melodia, T., Underwater Acoustic Sensor Networks: Research Challenges, Ad Hoc Networks Journal, (Elsevier), March 2005.
[2] John Heidemann, Wei Ye, Jack Wills, Affan Syed, and Yuan Li. Research Challenges and Applications for Underwater Sensor Networking, IEEE Wireless Communications and Networking Conference, p. to appear. Las Vegas, Nevada, USA, IEEE. April, 2006.
[3] Jiejun Kong, Jun-hong Cui, Dapeng Wu, Mario Gerla, Building Underwater Ad-hoc Networks and Sensor Networks for Large Scale Real-time Aquatic Applications, IEEE Military Communications Conference (MILCOM'05), October 17-20, 2005. Atlantic City, New Jersey, USA.
[4] I. Vasilescu, K. Kotay, D. Rus, M. Dunbabin and P. Corke, Data Collection, Storage, and Retrieval with an Underwater Sensor Network, SenSys'05,

©IJRASET (UGC Approved Journal): All Rights are Reserved

November 2–4, 2005, San Diego, California, USA.
[5] D. Li, K. Wong, Y. H. Hu, and A. Sayeed. Detection, classification and tracking of targets in distributed sensor network.
[6] P. Varshney. Distributed Detection and Data Fusion. Spinger-Verlag, New York, NY, 1996.
[7] Rappaport, T. S., Wireless Communications: Principles and Practice, Prentice Hall, 2002
[8] T. Couqueur, V. Phipatanasuphorn, P. Ramanathan, and K. K. Saluja. Sensor deployment strategy for target detection. In Proceeding of The First ACM International Workshop on Wireless Sensor Networks and Applications, pages 169– 177, Sep 2002.
[9] K. Chakrabarty, S. S. Iyengar, H. Qi, and E. Cho. Grid coverage for surveillance and target location in distributed sensor networks. IEEE Transactions on Computers, 51(12):1448–1453, December 2002.
[10] S. Meguerdichian, F. Koushanfar, M. Potkonjak, and M. B. Srivastava. Coverage problems in wireless ad-hoc sensor networks. INFOCOM’01, pages 1380–1387, 2001.
[11] H. Zhang and J. C. Hou, Maintaining sensing coverage and connectivity in large sensor networks, Wireless Ad Hoc and Sensor Networks: An International Journal, Vol. 1, No. 1-2, pp. 89--123, January 2005.
[12] D. Tian and N. D. Georganas, A coverage-preserved node scheduling scheme for large wireless sensor networks. In Proceedings of First International Workshop on Wireless Sensor Networks and Applications (WSNA’02), pages 169– 177, Atlanta, USA, Sep 2002.
[13] X. Wang, G. Xing, Y. Zhang, C. Lu, R. Pless, and C. D. Gill. Integrated coverage and connectivity configuration in wireless sensor networks. Sensys, 2003.
[14] T. Yan, T. He, and J. A. Stankovic, Differentiated surveillance for sensor networks.,SenSys ’03: Proceedings of the 1st international conference on Embedded networked sensor systems, 2003.
[15] F. Ye, G. Zhong, S. Lu, and L. Zhang, Peas: A robust energy conserving protocol for long-lived sensor networks, 23rd International Conference on Distributed Computing Systems (ICDCS’03), pages 169–177, May 2003.
[16] G. Xing, C. Lu, R. Pless, and Q. Huang, On Greedy Geographic Routing Algorithms in Sensing-Covered Networks, In Proc. of MobiHoc'04, Tokyo, Japan, May 2004.
[17] J. Carle, J.F. Myoupo, and D. Semé. A Basis for 3-D Cellular Networks. In Proc. of the 15th International Conference on Information Networking, 2001.
[18] Catherine Decayeux and David Semé: A New Model for 3- D Cellular Mobile Networks, ISPDC/HeteroPar 2004.

©IJRASET (UGC Approved Journal): All Rights are Reserved



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)