ISSN:0975-9646

S.Surekha et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 4 (6) , 2013, 796-799

Coverage Of Total Target Field To Form WSN Using Delaunay Triangulation

S.Surekha[1](M.Tech),M.KalyanRam[2](Ph.D)

[1,2]Department of Computer Science and Engineering
Aditya Engineering College
Surampalem,East Godavari district
Andrapradesh, India

***Abstract*— One of the major issues in wireless sensor network (WSN) is how to cover the target field. In this paper, we consider the area coverage problem for irregular shaped target fields. The major deployment schemes are Random deployment scheme and Grid based deployment scheme. Random deployment is not suitable in all cases. In this strategy more than one sensor node may lie on the same place or region. And also no nodes may be there in some regions, so that the WSN uncovers the target field. Grid based deployment scheme will cover the target field more effectively than the random node deployment scheme. The basic Grid based deployment schemes are triangular, square and hexagon deployment schemes. But as the target field is not regular it is not possible to apply the grid based deployment schemes directly on the target field. So, we proposed a method in which first the target field is divided into a collection of triangles using Delaunay Triangulation and then the triangular node deployment scheme is applied for each triangle.**

***Keywords*— wireless sensor network, target field, total area coverage, grid based deployment, Delaunay triangulation.**

I. INTRODUCTION

A wireless sensor network (WSN) consist of spatially distributed autonomous sensors to cooperatively monitor physical and environmental conditions such as temperature, sound, pressure, vibration, motion or pollutants. A sensor node is a node that is capable for performing some processing, gathering sensory information and communicating with other connected nodes in the network. Their features of self-organization and dynamic reconfiguration make them a perfect choice for applications to monitor and gather physical data in harsh environments. Sensor nodes provide absolute results in monitoring the target field. Wireless sensor network are used in many application such as military, agriculture and medical monitoring and environmental surveillance.

Coverage is critical for wireless sensor networks to monitor a target field. In many application scenarios, full target field coverage is required, which means every point inside the target field must be covered in the wireless sensor network. Sensor deployment can be classified into two kinds, random deployment and grid based deployment. Throwing the sensors from the flight into the target field is one of the examples of random deployment scheme. In this random deployment scheme there is a chance of occurring overlap of sensors on one another. And the deployment scheme may not cover the entire target field that means there may not be any sensor to monitor a particular region in the target field as shown in figure1. So Random deployment is not suitable for total coverage of the target filed to form the wireless sensor network. The other available deployment scheme is Grid based deployment scheme. In grid based deployment scheme

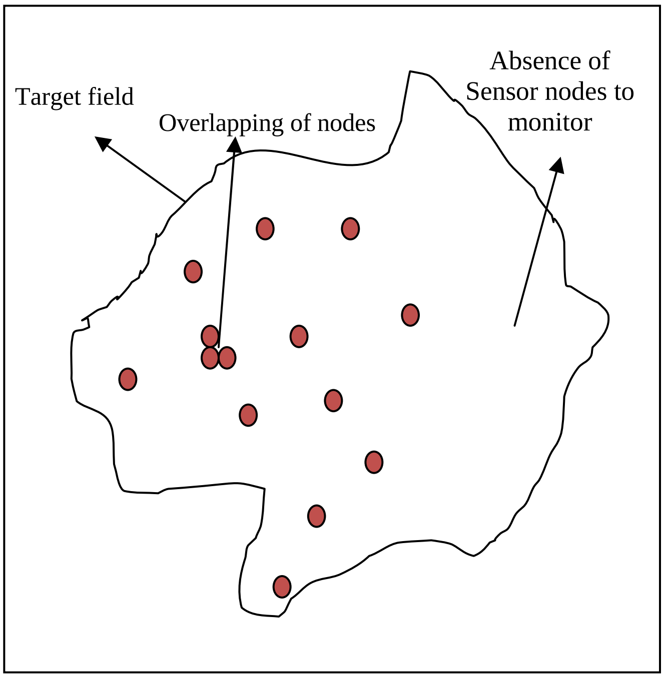

Figure 1: Random deployment in the target field

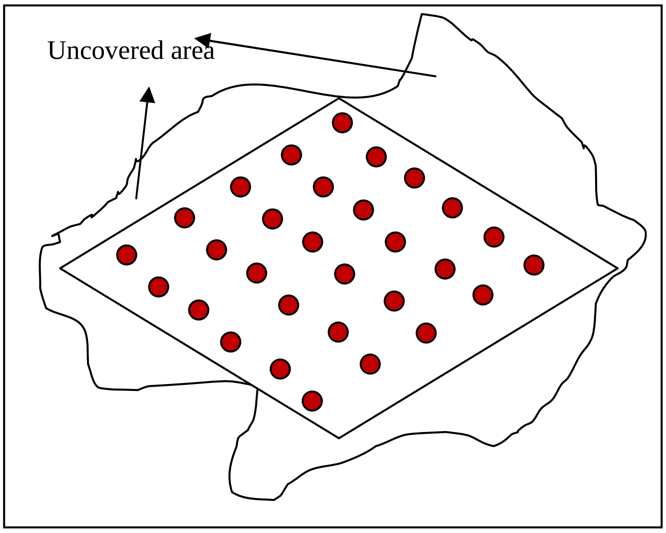

Figure 2: Grid based deployment in the target field

the available deployment strategies are square grid deployment, triangular deployment and the hexagonal deployment[1]. But the target field may not be any of these shapes. Suppose the maximum possible shape that will be fitted into the target field is identified and then the nodes are deployed according to the grid based deployment, we can't achieve the total coverage as the WSN is not formed in the remaining area of the target field as shown in the figure 2. Then in order to deploy the nodes first the target field must be divided into the grids then the grid deployment scheme should be implemented. The target field may be divided into a collection of squares or triangles or hexagons called as tilings as shown in figure 3. In this paper we are using the Delaunay triangulation scheme for dividing the target area into a collection of triangles.

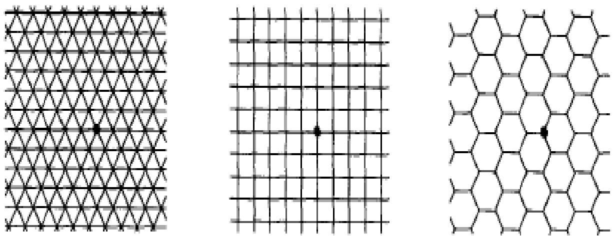

Figure 3: Homogeneous tilings

II. RELATED WORK

The coverage problems for sensor networks can be categorized into three broad types [2] - area coverage (where every point inside an area is to be monitored), target coverage (where the main objective is to cover a set of discreet targets), and breach coverage (the goal here is to minimize the numbers of uncovered targets or the ratio of uncovered portion to the whole area). In this paper, we focus on area coverage in sensor deployment.

Deploying sensors to provide complete area coverage is an essential design problem in many wireless sensor network (WSN) applications. Mainly three alternative deployment approaches have been proposed. One among them is application-specific deterministic deployment, another is random deployment and the third one is grid based (also known as pattern-based) deployment [3]. In deterministic deployment, the sensor nodes are placed deliberately in the required region. This type of deployment is suitable only for small-scale applications. Non-deterministic deployment is scalable to large scale applications or hostile environments. In this type of deployment, the sensor nodes are thrown randomly to form a WSN. However, it could be very expensive since excess redundancy is required to overcome uncertainty. Grid-based deployment is an attractive approach for moderate to large-scale coverage-oriented deployment due to its simplicity and scalability. There are three types of grid-based deployment corresponding to three regular shapes which can tile a plane without holes, namely, hexagon, square and triangle [4].

In this paper we are assuming that the triangular grid based deployment scheme is used to deploy the nodes. So we are concentrating on how to divide the target field into set of triangles. We have chosen Delaunay Triangulation method [5] to divide the 2D space into a set of triangles. A Delaunay triangulation for a set of vertices is a triangulation graph with the defining property that for each circumscribing circle of a triangle formed by three vertices in, no vertex of is in the interior of the circle. In Figure 4, we show a Delaunay triangulation and the circumscribing circles of some of its triangles. In this paper we are using the algorithm which is given by Watson to generate Delaunay triangulation.

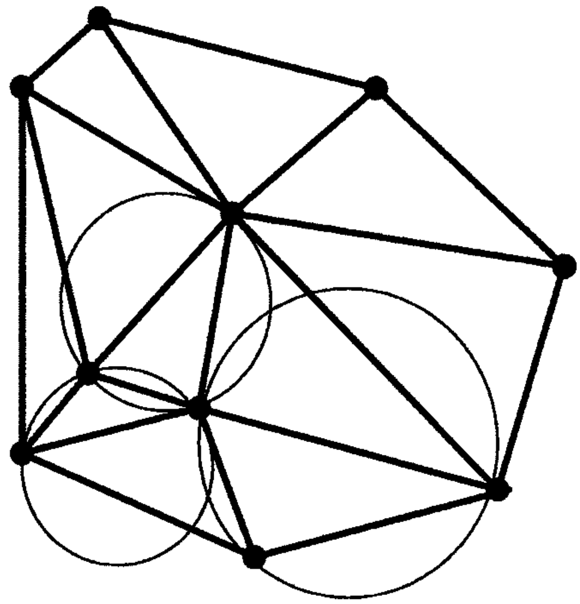

Figure 4: Delaunay triangulation.

III. DELAUNAY TRIANGULATION

In the Watson algorithm [6], the Delaunay triangulation is assembled by introducing each point one at a time To begin the process, three points are chosen to form a 'super triangle' which completely encompasses all of the points to be triangulated Initially the Delaunay triangulation is thus comprised of a single triangle defined by the super triangle vertices When a new point IS Introduced into an existing triangulation, the circum centre of each existing triangle is computed together with its circum circle radius Any triangles which contain the new point within their circum circles are flagged as being intersected Since the super triangle encompasses all of the points to be triangulated, each new point must intersect at least one of the existing triangle circum circles When added together, the triangles that are intersected form a polygon, with all of their vertices lying on its boundary All of the Intersected triangles are replaced, and the new point forms triangles with each pair of vertices on the boundary of the polygon (noting that the new point is always interior to the polygon) After each new point is inserted, the net gain in the total number of triangles must be exactly two This is because each polygon formed by the intersected triangles always has two more edges than triangles Thus, when the triangulation of N points IS complete, there must always be 2N+ 1 triangles (including the triangles formed with the vertices of the super triangle)

The fundamental steps in Watson's algorithm are as follows

(1) Sort the N points to be triangulated in ascending sequence of their x-co-ordinate
(2) Define the vertices of the super triangle in anticlockwise order. It is convenient to number these vertices as N+1, N+2 and N+3. Set the co-ordinates of these vertices so that all of the points to be triangulated lie within the super triangle. Add the super triangle to a list of triangles formed and flag it as incomplete.

(3) Introduce a new point from the list of sorted points with the co-ordinates (X new, Y new)

(4) Examine the list of all triangles formed so far and for each triangle which is flagged as incomplete, do steps 5to9

(5) Compute the co-ordinates of the triangle circum centre, (X c, Y c), and the square of its circum circle radius, R 2

(6) Compute the square of the x-distance from the new point to the triangle circum centre, i.e. the quantity

D2x = (x c – X new) 2

(7) If D2x>>-R ~, then the circum circle for this triangle cannot be Intersected by any of the remaining points Flag this triangle as complete and do not execute steps 8 and 9

(8) Compute the square of the distance from the new point to the triangle circum centre, i.e. the quantity

D2 = O2x + (Y c –Y new) 2

(9) If D2<R 2, then the new point intersects the circum circle for this triangle Delete this triangle from the list of triangles formed and store the three pairs of vertices which define its edges on a list of edges If D 2 >>R 2, then the new point lies on or outside the circum circle for this triangle and the mangle remains unmodified

(10) Loop over the list of edges and delete all edges which occur twice in the list. This removes all edges which are interior to the polygon formed by the intersected triangles Since the vertices defining the edges of each mangle are always recorded in an anticlockwise sequence, this step may be executed efficiently by searching for ordered pairs

(11) Form the new triangles by matching the new point with each pair of vertices an the last of edges The new point forms new triangles with each pair of vertices on the boundary of the polygon formed by the intersected triangles Define each new triangle such that Its vertices are always listed in an anticlockwise sequence and flag at as incomplete

(12) Repeat steps 3 to 11 until the list of points to be triangulated IS exhausted.

(13) Form the final triangulation by removing all triangles which contain one or more of the super triangle vertices. This may be achieved by scanning the list of triangles and deleting any of those which have vertex numbers which are greater than N.

As the shape of the target is not known first some random/selective points will be placed as shown in Figure 5.

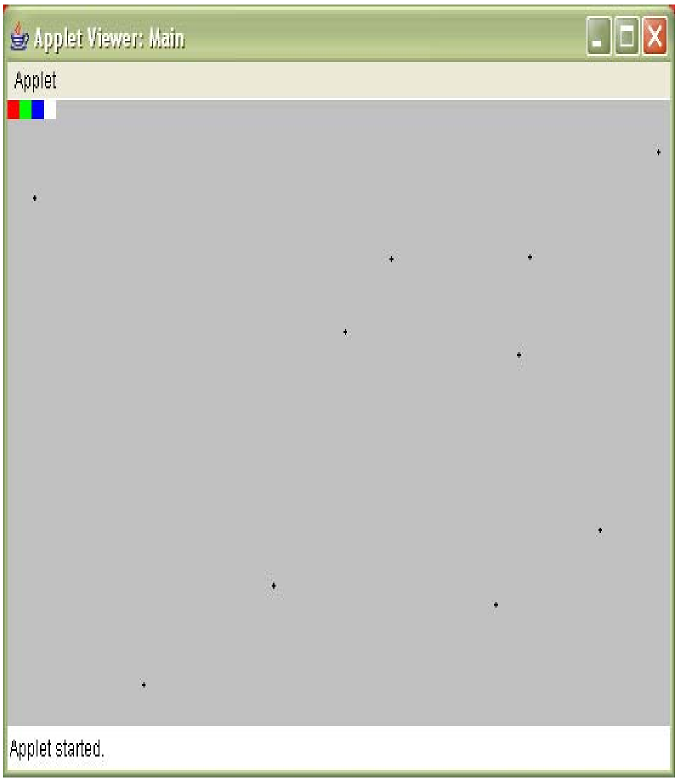

Figure 5:Random points in the target field

Then Delaunay triangulation method is applied on those points to divide the target field into a set of triangles as shown in figure 6.And then triangular deployment scheme is used to form WSN.

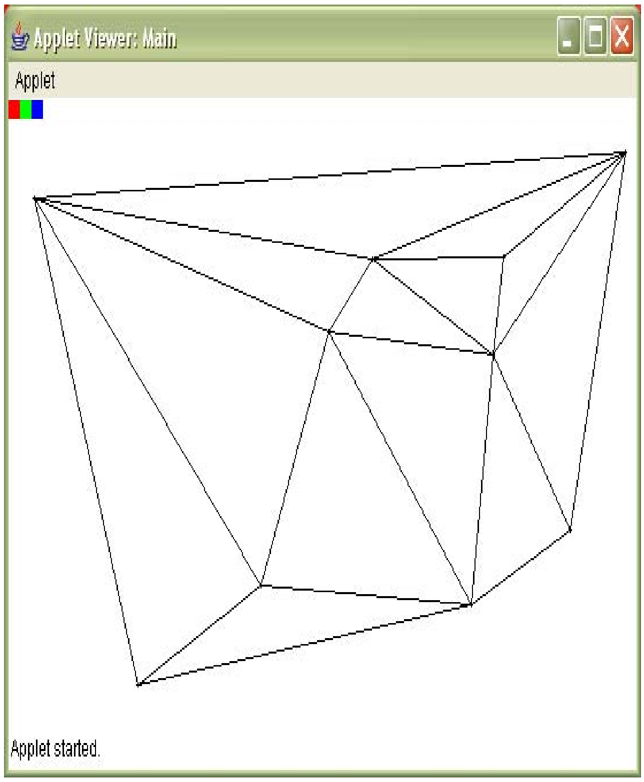

Figure 6: Delaunay triangulation for the target field

CONCLUSION

In this paper we focused on the area coverage of the Wireless Sensor Network i.e. we mainly concentrate on how to divide the target field into set of triangles as we assumed the deployment scheme to be used is triangulation deployment. By using the Delaunay triangulation deployment scheme the target field is divided into set of triangles. Now by deploying the nodes in them the total target field is covered.

ACKNOWLEDGMENT

The authors would like to thank to Aditya Engineering College, Surampalem authorities for their constant support and cooperation.

REFERENCES

[1] P. Saritha Hepsibha and G. Sanjiv Rao , “Comparative Analysis of Area Coverage in WSNs Using Various Grid-Based Node Deployment Schemes” International Journal of Future Computer and Communication, Vol. 2, No. 6, December 2013

[2] M. Cardei and J. Wu, Energy-Efficient Coverage Problems in Wireless Ad Hoc Sensor Networks, Journal of Computer Communications on Sensor Networks, 2004

[3] Kenan Xu , Glen Takahara, Hossam Hassanein, On the robustness of grid-based deployment in wireless sensor networks.

[4] Monica and Ajay K Sharma, “Comparative Study of Energy Consumption for Wireless Sensor Networks based on Random and Grid Deployment Strategies“ International Journal of Computer Applications (0975 – 8887) Volume 6– No.1, September 2010

[5] Jörg Liebeherr, Member, IEEE, Michael Nahas, Member, IEEE, and Weisheng Si, ” Application-Layer Multicasting With Delaunay Triangulation Overlays”, IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, VOL. 20, NO. 8, OCTOBER 2002

[6] Watson D 1" Computing the n-dimensional Delaunay triangulation with application to Voronoi polytopes The Computer Journal 1981, 24 [2),167