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Comparison between Network Coverage Strategies in Wireless Sensor Network

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Abstract— one of the major issues in a wireless sensor network (WSN) is how to cover an interested area. In this paper, we consider the area coverage problem for variable sensing radii WSN. There are various coverage techniques but we compare the cluster based coverage scheme, Grid based deployment scheme and Computational Geometry Based on the basis of idle nodes. In the cluster based system if the sensing range of the sensor node is less. The number of idle node is increase so that idle node cannot communicate with the cluster head and cannot cover the target area Grid based is the segregation of resources from multiple sites so as to solve a problem that can't be solved by using the processing of a single computer. 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. 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. This presents an efficient coverage scheme for wireless sensor networks

Keyword: wireless sensor network, Clustering, Cluster head Delaunay triangulation, Grid based, Voronoi diagram

I. INTRODUCTION

A WSN can be defined as a network of devices, denoted as nodes, which can sense the environment and communicate the information gathered from the monitored field (e.g., an area or volume) through wireless links. The data is forwarded, possibly via multiple hops, to a sink (sometimes denoted as controller or monitor) that can use it locally or is connected to other networks (e.g., the Internet) through a gateway. The nodes can be stationary or moving. They can be aware of their location or not. They can be homogeneous or not [1].A WSN typically has little or no infrastructure. It consists of thousands of sensor nodes, deployed either randomly or according to some predefined statistical distribution, over a geographic region of interest. A sensor node by itself has severe resource constraints, such as low battery power, limited signal processing, limited computation and communication capabilities, and a small amount of memory hence it can sense only a limited portion of the environment[2]. WSNs have great potential for many applications in scenarios such as military target tracking and surveillance, natural disaster relief, biomedical health monitoring, and hazardous environment exploration and seismic sensing [3].

II. RELATED WORK

Despite the wealth of previous research studies conducted separately on sensor network and coverage of sensor network and coverage of sensor network which are surveyed i.e joint consideration of those two concepts for WSN is so common. Eyuphan Bulut, Zijian Wang and Boleslaw K.Szymanski[4] concludes a neighbor graph as the graph formed by the neighbors of a node and analyses the effect of different

levels of connectivity in neighbor graphs on the coverage redundancy of sensor nodes. J. Naskath, Dr.K.G.Srinivasagan, S.Pratheema[5] focuses on the sensor replacement problem in WSN consist of mobile sensors. Gao Jun Fan and Shi Yao Jin[4] presented a survey of coverage problem where two challenges are described, namely, maximizing network lifetime and network connectivity. Ridha Soua, Leila Saidane, Pascale Minet[6] proposed an approach to use a mobile robot to assist the initial sensor deployment and to improve sensing coverage and connectivity of monitored area. Fariha Tasmin Jaigirdar[7] provides a novel grid approximation algorithm for efficient and low cost deployment of inductive charger so that the minimum number of chargers along with their placement locations can charge all the sensors of the network

III. COVERAGE STRATEGIES

The strategies are divided into three categories cluster based coverage technique, Grid based and computational geometry based.

3.1 Cluster based coverage technique

Clustering is involving grouping nodes into clusters[8] and in the hierarchical network structure each cluster has a leader, which is also called the cluster head (CH) and usually performs the special tasks referred above (fusion and aggregation), and several common sensor nodes(SN) as members[9]. Members of a cluster can communicate with their CH directly or multi-hop.CH can forward the aggregated data. The sensor nodes periodically transmit their data to the corresponding CH nodes. Illustrated in Figure 1.1.The BS is the data processing point for the data received from the sensor nodes, and where the data is accessed by the end user

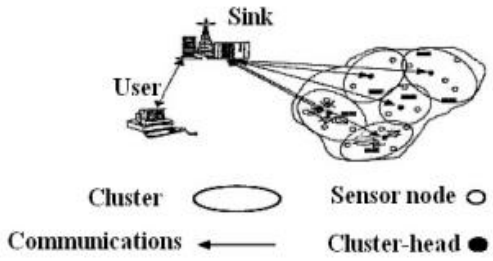

Figure 1.1 Clustering overview [5]

Algorithm

- In initial phase of each round a population and fitness function is be used to select cluster head and cluster member.
- **Step1:** Initially all nodes have same probability to become a cluster head.
- **Step2**: F(t) is the fitness function used to select the cluster head
- **Step 3:** After calculating this built in F(t) function. All nodes sort in descending order. For each network, network administrator decides number of cluster heads.[9]

Step 4: Selection of Cluster Head BS selects the cluster head and the result is sent to the network. At the BS a predefined number of nodes introduced themselves as the candidate of cluster head.
Step 5: BS will send the information to selected cluster head
Step 6: Cluster Formation Selected cluster head send advertisement to normal nodes. Non cluster head nodes join to closest CH to form cluster
Step 7: Sensing unneeded node to sleep state

3.2 Grid based:-

Grid points are used in two ways in WSN deployment either to measure coverage as used in VFA or to determine sensors positions. Grid based deployment strategies used to determine sensors positions. Grid

based is the sampling method in which coverage is estimated as ratio of grid points covered to total number of grid points in the ROI. There are three types of grids commonly used in networking.
(a) Triangular Lattice (b) Square Grid (c) Hexagonal Grid
Triangular lattice is the best among the three kinds of grids as it has the smallest overlapping area hence this grid requires the least number of sensors. Triangular Lattice is shown in figure 1.2. In this Square grid is assumed and used. Square grid is shown in figure 1.3

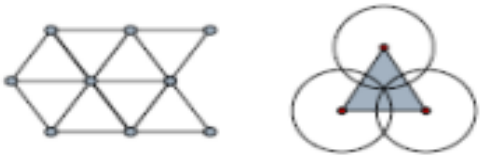

Figure 1.2: Triangle Lattice [10]

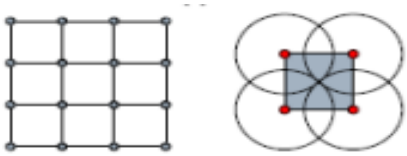

Figure 1.3: Square Grid [10]

Square grid provides fairly good performance for any parameters .Hexagonal grid is the worst among all since it has the biggest overlapping area, shown in figure 1.4

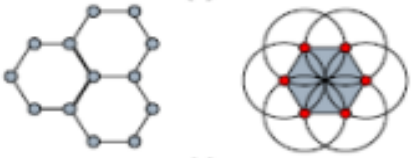

Figure 1.4: Hexagonal Grid [10]

For a highly dense network small size grids help in reducing coverage holes thus providing better result.[11]

3.2.1 Algorithm

We can generate the almost Square Grid Coverage strategy by the following steps.
Step 1: Sensor communicate if distance is >=R , where R is sensing range.

- Send a *hello* message within the distance by using distance formula.
- Upon receiving the *hello* message, acknowledge the sender alone with the location Information of the current node.

Step 2: Connect a node with the neighbor nodes in form of square.
Step 3: Two nodes connect only if the other nodes lie within the sensing range of the node.
The resulting graph *G* is our almost Square grid.In some situation square grid suffers from horizontal and vertical misalignment

3.3 Computational Geometry Based:

Computational geometry is frequently used in WSN coverage optimization,[10] the most commonly used computational geometry approach are
(a) Voronoi diagram (b) Delaunay triangulation.
A **Voronoi diagram** is a partitioning of a plane into regions based on distance to points in a specific subset of the plane. That set of points (called seeds, sites, or generators) is specified beforehand, and for each seed there is a corresponding region consisting of all points closer to that seed than to any other. These regions are called Voronoi cells Delaunay triangle is formed by three sites provided if and only if the sites [12] circumcircle does not contain other sites.Circumcircles of Delaunay Triangles is shown in figure 1.5. Figure 1.6 shows the Voronoi diagram and its corresponding Delaunay triangulation.

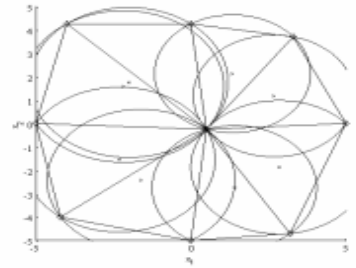

Figure1.5: Circumcircle of Delaunay Triangles

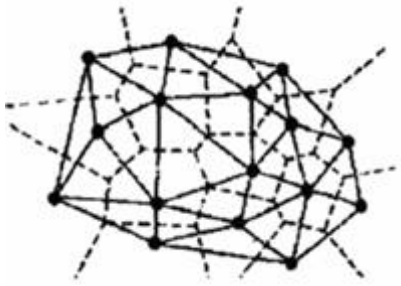

Figure 1.6 the Voronoi diagram to Delaunay triangulation

3.3.1 Delaunay Triangulation Coverage Strategy:

Delaunay triangulation for a set *P* of points in the plane is the triangulation DT(*P*) such that no points in *P* is inside the circumcircle of any triangle in DT(*P*). Delaunay triangulation has some interesting properties that make it unique. Firstly, external Delaunay edges in DT(*P*) constitute the boundary of *P*. Secondly, all circumcircle of the triangles of Delaunay triangulation are empty.

Algorithm

We can generate the almost Delaunay triangulation by the following steps.

Step 1: Distance between sensors is computed by distance Formula equation

Sqrt(x2-x1)^2+(y2-y1)^2

- Send a *hello* message within the distance by using distance formula.
- Upon receiving the *hello* message, acknowledge the sender alone with the location

Information of the current node.

Step 2: Connect *u* with the neighbor nodes in form of triangle. Let this graph be *G*1.

Step 3: Two nodes connect only if the other node lies within the sensing range of the node.

The resulting graph *G* is our almost Delaunay triangulation. After step 2, the graph *G*1 is a non-planar graph.

IV RESULT AND ANALYSIS

We compare the cluster based coverage technique, grid based, Delaunay Triangulation Coverage Strategy. Delaunay triangulation Coverage strategy is based on partition of site in triangle form. In Delaunay Triangulation three sensors are joint in form of triangle, so that sensing area of one node of triangle could not be overlapped by another node's sensing area.

Square grid based deployment coverage strategy is sampling method. Sensors are deploying in form of square grid. Square grid is average case of deployment strategy because overlapping of sensing area is minimum in this strategy.

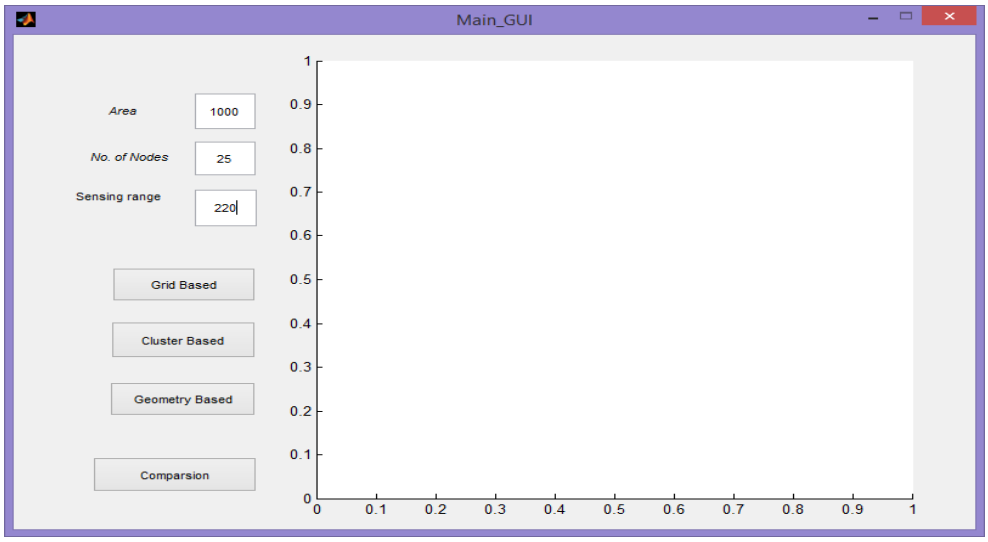

Figure 4.1: Main Graphical user interface Window

The figure 4.1 is the main window of the result where we will give the input and compare the output of every strategy.

4.1Clustering based Wireless sensor coverage scheme based on the nodes

In the figure 4.2, we give the area and number of nodes with the sensing range .In this technique the number of sensor deploy randomly and randomly select any node as the primary node also called cluster head which communicate with the sink node But if we create the single cluster there will be the problem like the number of node will be idle. Which mean they cannot connect to the cluster head as shown in the figure 4.2 and cannot help to cover the target area and if we create the cluster the complexity of the network will be increased.

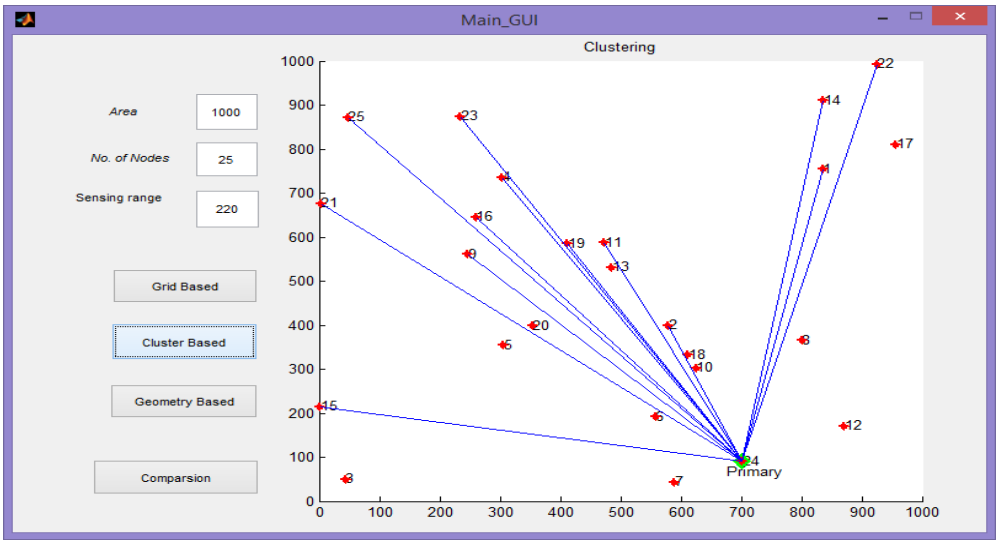

Figure 4.2: clustering window

4.1.2 Grid based Technique:

We have divide the target are in square grid shape by using the mesh grid function. As we have done in the cluster technique we will give the same area, node and their sensing range.

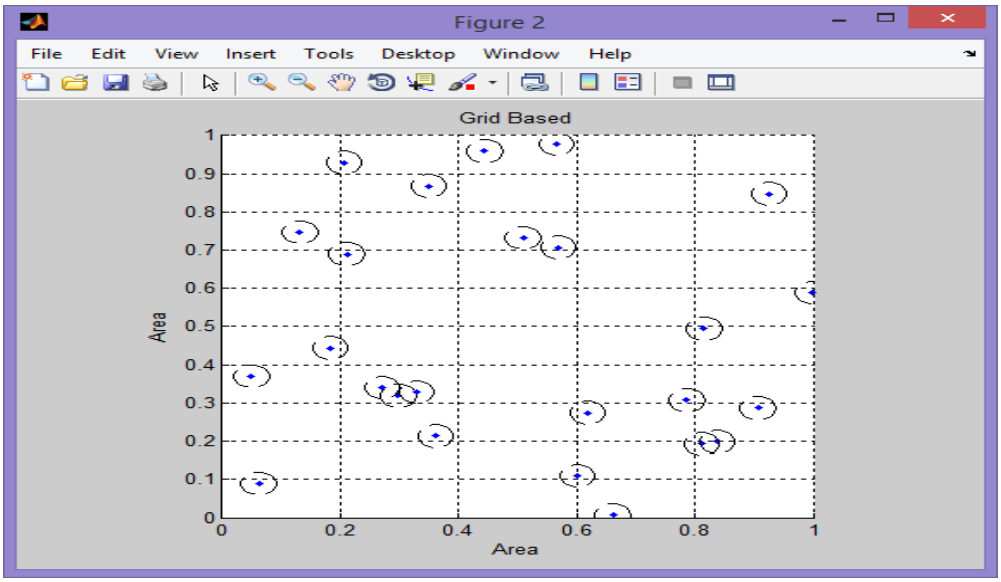

Figure 4.3: Grid based Strategy Result

Compare the result of this strategy and find which technique will give best result for given area, deployed sensor and for their sensing range.

4.1.3 Delaunay Triangulation: Delaunay triangulation is more efficient coverage strategy as compared to square grid deployment strategy. In Delaunay, if we increase the sensing range of sensors than each node can communicate with other nodes in the network

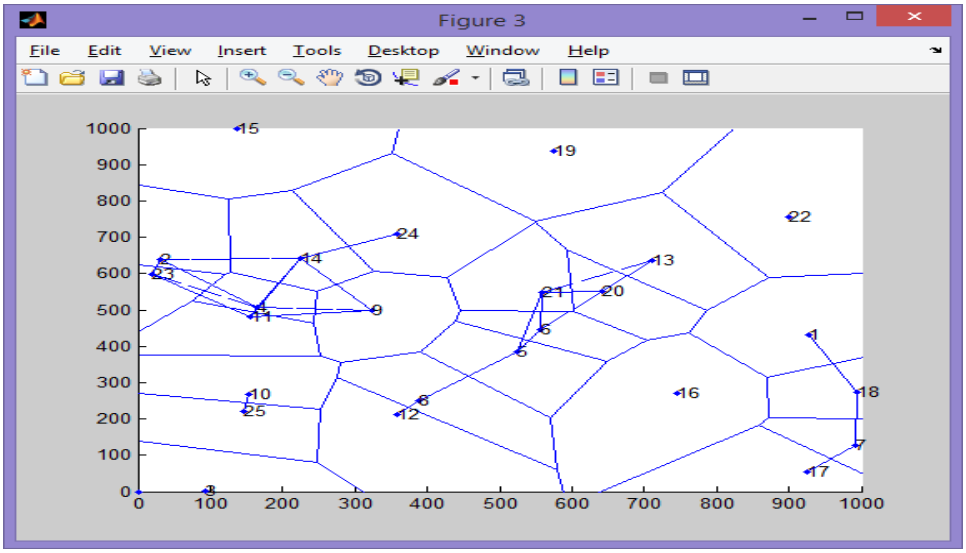

Figure 4.4: Delaunay triangulation with Voronoi diagram

As shown in figure 4.3. More nodes are connected as compared to figure4.4 .The number of node is completely connected with other nodes. This is because sensing range of sensors is increased, so that three sensors can easily link to each other.

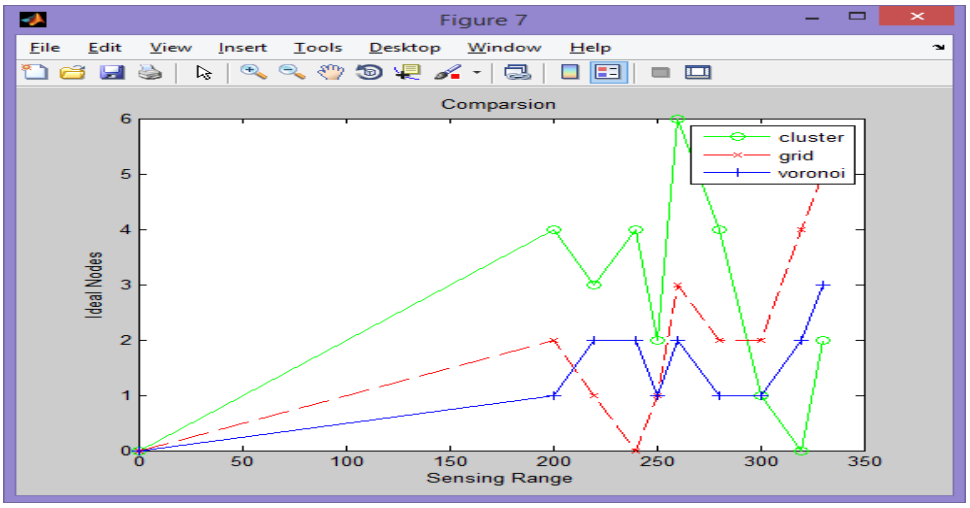

Figure4.5: comparison graph

Figure 4.5 shows the achievement of Delaunay triangulation Coverage Strategy. The final comparison of three strategies where green line shows the cluster, red line shows grid and blue line show for result for the Delaunay triangulation which shows that the number of idle node in the Delaunay triangulation is less

V. CONCLUSION AND FUTURE WORK

5.1 CONCLUSION

Wireless sensor networks (WSNs) have attracted Significant attention over the past few years. A growing list of civil and military applications can employ WSNs for increased effectiveness; especially in hostile and remote areas. Examples include disaster management, border protection, combat field surveillance. Delaunay triangulation is more efficient coverage strategy because node are link in triangle form and if sensing range of the sensor is increased than each node can communicate with other node in the network whereas square grid deployment strategy is also used in different applications but this strategy suffers Horizontal misalignment, Vertical misalignment and Random misalignment. If sensing range is increased in square grid coverage strategy than overlapping of sensing area is increased which is not desirable for valid data in coverage of region of interest.

5.2 FUTURE WORK

In our proposed comparison of coverage strategy between Delaunay triangulation and square grid deployment strategy in wireless sensor network, we compared on two parameters sensing range and number of idle nodes. Further research could be continued to implement the same algorithm for multiple parameters such as Energy efficiency, Number of Active nodes and sleeping nodes etc. Misalignment of nodes in square grid still needed solution**.**

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