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Deployment Techniques in Wireless Sensor Networks

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Abstract: ***In this paper, we study coverage with connectivity properties in large wireless sensor networks (WSN). Coverage is one of the main research interest in wireless sensor network, it is use to determine the quality of service of the networks. Therefore this paper aims to review the common strategies use in solving coverage problem in WSN. The strategies reviewed are categorised in to three groups based on the approaches used; force based, grid based or computational geometry based approach.***

Index Terms: Connectivity, coverage, network lifetime, sensors, Voronoi diagram.

I. INTRODUCTION

Recent advancement in microelectronics, digital signal processing, and low power RF techniques have enabled the deployment of large wireless sensor networks. Wireless sensor networks can be deployed in areas without infrastructure support, in hostile fields, and harsh environment. Applications of such sensor network include spatially in temporally dense environmental monitoring, battle field monitoring seismic structure response study, precision farming, traffic monitoring, etc. The deployment of wireless sensor networks we have significant impact on both scientific adventures and our daily life.

We consider a wireless sensor network where sensor nodes have both sensing ability and communication ability. Coverage and connectivity are basic requirements in a wireless sensor network. The objective of such a network is to detect events of interests or collect data and then report the obtained information to a fusion center. Therefore, connectivity, i.e., the ability to report information to the fusion center, is as critical as sensing coverage. Thus, we consider the coverage with connectivity property in sensor networks. We focus on large sensor networks. Because it is often either impossible or undesirable to deploy sensor nodes precisely, we specifically consider the case where sensor nodes are randomly deployed in a large field.

Coverage is one of the main research interests in wireless sensor networks; it is used to determine the quality of service of the networks. The coverage is calculated based on the placement of the sensors on the region of interest.

II. LITERATURE REVIEW

Wireless sensor networks gather data from places where it is difficult for humans to reach and once they are deployed, they work on their own and serve the data for which they are deployed [1].

A wireless sensor network consists of sensor nodes deployed over a geographical area for monitoring physical phenomena like temperature, humidity, vibrations, seismic events, and so on. Typically, a sensor node is a tiny device that includes three basic components: a sensing subsystem for data acquisition from the physical surrounding environment, a processing subsystem for local data processing and storage, and a wireless communication subsystem for data transmission [2].Minimizing energy dissipation and maximizing network lifetime are important issues in the design of protocols and applications for sensor networks. Energy-efficient sensor state planning consists in finding an optimal assignment of states to sensors in order to maximize network lifetime. For example, in area surveillance applications, only an optimal subset of sensors that fully covers the monitored area can be switched on while the other sensors are turned off. Typically, any sensor can be turned on, turned off, or promoted as a cluster head, and a different power consumption level is associated with each of these states [3]. Coverage is usually interpreted as how well a sensor network will monitor a field of interest. Typically we can monitor an entire area, watch a set of targets, or look for a breach among a barrier. Coverage of an entire area otherwise known as full or blanket coverage means that every single point within the field of interest is within a the sensing range of at least one sensor node [5].A sensor network deployment can usually be categorized as either a dense deployment or a sparse deployment. A dense deployment has a relatively high number of sensor nodes in the given field of interest while a sparse deployment would have fewer nodes. The dense deployment model is used in situations where it is very important for every event to be detected or when it is important to have multiple sensors cover an area. Sparse deployments may be used when the cost of the sensors make a dense deployment prohibitive or when we want to achieve maximum coverage using the bare minimum number of sensors [5]. Coverage problem in WSN basically is caused by three main reasons; not enough sensors to cover the whole ROI, limited sensing range and random deployment. Since the sensors are operated using limited power supply some of them might die out therefore resulting in inadequate sensors to fully cover the whole ROI causing holes to exist. A sensor's sensing range is restricted to certain radius which consequently brings coverage problem. This problem can be solved by using sensor with larger sensing range, but this type of sensor is more expensive. One of the appealing aspects of WSN is the ability to be randomly deployed without the need to do it manually.

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The random deployment can be done using method such as air drop, this enable the WSN to be applied in hostile and unreachable environment such as battlefield and a steep terrain. However random deployment could cause some of the, sensors being deployed too close to each other while others are too far apart. In both situations coverage problem will arise, for the first condition, the sensing capabilities of the sensors are wasted and the coverage is not maximized, while in the later state, blind spots will be formed. In predetermine deployment the WSN coverage is improved by carefully planning the positions of the sensors in the ROI prior to their deployment. The sensors later are placed according to the plan either by hand or with the help of mobile robot [4].

III. STRATEGIES

The strategies used in solving coverage problem in WSN are analysed during deployment stage. The strategies are divided into three categories force based, grid based and computational geometry based**.**

Force Based -Force based deployment strategies rely on the sensors mobility, using virtual repulsive and attractive forces the sensors are force to move away or towards each other so that full coverage is achieved. The sensors will keep moving until equilibrium state is achieved; where repulsive and attractive forces are equal thus they end up cancelling each other. Grid points are used in two ways in WSN deployment; either to measure coverage as used in VFA or to determine sensors positions.

Computational geometry is frequently used in WSN coverage optimization, the most commonly used computational geometry approach are Voronoi diagram. Voronoi diagram can be used as one of the sampling method in determining WSN coverage; with the sensors act as the sites, if all Voronoi polygons vertices are covered then the ROI is fully covered otherwise coverage holes exist.

Let S = $\{p_1, p_2. \ . \ . \ p_i, . \ . \ . \ . \ , p_n\}$ be a set of points in a two-dimensional Euclidean plane. These points are called sites. A Voronoi diagram decomposes the space into regions around each site, such that all points in the region around pi are closer to pi than any other point in S. Consider two points p1 and p2. Let B $(p_1, p_2) = B_{12}$ be the perpendicular bisector of the segment p_1 p_2. Then every point x on B_{12} is equidistant from p_1 and p_2. This can be seen by drawing the triangle (p_1, p_2, x) as depicted in Fig 1. By Euclid's side-angle-side theorem, $|p_1x| = |p_2x|$. To sum up, given input points presented in Fig 2, the corresponding Voronoi diagram is depicted in Fig 3.

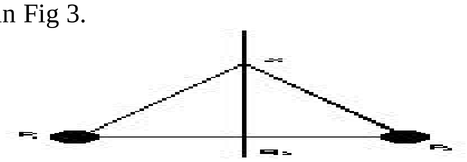

Fig 1: Two points | p_1x| = | p_2x|

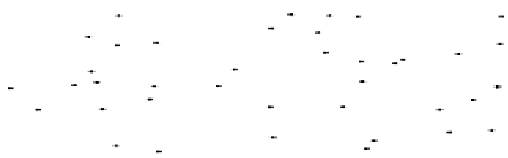

Fig 2: Input points

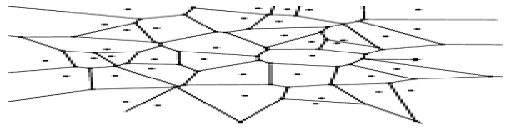

Fig:3 Voronoi Diagram

IV. METHODOLOGY

The nodes are simulated using ns-2.23 software and stored with .tcl extension.

Operating System: LINUX.

Programming language: C++.

V. RESULT

The simulation results of WSN using different topologies. The parameters could be the energy consumption and lifetime of the WSN.

VI. FUTURE SCOPE

Our work will focus on study and comparison of different deployment techniques used in WSN, energy-optimal topology that maximizes network lifetime while ensuring simultaneously full area coverage and sensor connectivity to cluster heads, which are constrained to form a routing technique based on the topology.

VII. CONCLUSION

A high-density network can introduce a fault tolerant-mechanism, increase precision, and provide multi-resolution data. The network density control depends on the application. We propose a method to set up which node should be turned off or on. The management may take the sensor node out of service temporally. Our design uses a Voronoi diagram, which decomposes the space into regions around each node. The scheme could be used in management architecture for a wireless sensor network.

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