Optimal Overlapping and Coverage Hole by Mobile Sensor Nodes

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Abstract- **Before mobile sensor node, static node were used for providing coverage. But static nodes are not suitable in the areas where human can't be reached to deploy node manually. MSN are moveable and can deploy themselves. Coverage hole occurs when sensor nodes are located far from each other and when sensor nodes are positioned improperly. In this paper we will discuss about the main issue in sensor network i.e. overlapping and coverage holes i.e. area outside sensing range of sensors.**

***Keywords*- Wireless Sensor Network, Mobile Sensor Network, Coverage Holes**

I. INTRODUCTION

Wireless sensor networks (WSNs) have gained considerable worldwide attention in different research communities in recent years, due to their widespread applications in many scenarios. Such applications include battlefield surveillance, forest fire detection, disaster monitoring, and postdisaster operations. They significantly improve the capabilities to control and monitor the physical environment. In WSNs, sensor nodes can be deployed randomly or deterministically.

Deploying sensor nodes with the aid of an aircraft or similar vehicles randomly is one of the possible ways in such environments. However, using this technique (random deployment), the initial landing positions of sensors cannot be uniform or controlled, due to the existence of obstacles such as buildings, trees, and wind, causing some areas of the sensing field (SF) to be more dense than others. Thus, the sensor nodes may not adequately cover the SF, and the highly dense area will cause the sensor network to be an unusual or abnormal network.

WSNs in terms of mobility control are of two types: centralized and distributed. In centralized WSNs, sensors are controlled by a sink node or a central server. However, in the distributed networks, sensors are self-controlled.

Directed coverage is used to monitor the area in between two boundaries by a sensor network. The appropriate location to place sensors nodes is vital, in monitoring smaller or larger region. In most of the distributed movement algorithms, monitoring field (MF) is partitioned into subareas, with different sensor node assigned to a particular location. These partitioned subareas cover the entire MF; if the sensor node assigned to monitor a particular subarea cannot detect any expected event within its subarea, no other sensor node can detect it. Therefore, examination of each subarea for coverage hole and calculation of new candidate location is the responsibility of deployed sensor node in that subarea. When a sensor node is unable to cover its own subarea, then there exists a coverage hole (uncovered area).

Mobile sensor networks rely heavily on inter-sensor connectivity for collection of data. Nodes in these networks monitor different regions of an area of interest and collectively present a global overview of some monitored activities or phenomena. A failure of a sensor leads to loss of connectivity and may cause partitioning of the network into disjoint segments.

Recent advances in micro-electro-mechanical systems (MEMS) technology, wireless communications, and digital electronics have enabled the development of low-cost, low-power, multifunctional sensor nodes that are small in size and communicate untethered in short distances. These tiny sensor nodes, which consist of sensing, data processing, and communicating components, leverage the idea of sensor networks based on collaborative effort of a large number of nodes. Sensor networks represent a significant improvement over traditional sensors, which are deployed in the following two ways [1] [2]:

- Sensors can be positioned far from the actual phenomenon, i.e., something known by sense perception. In this approach, large sensors that use some complex techniques to distinguish the targets from environmental noise are required.

- Several sensors that perform only sensing can be deployed. The positions of the sensors and communications topology are carefully engineered. They transmit time series of the sensed phenomenon to the central nodes where computations are performed and data are fused.

A sensor network is composed of a large number of sensor nodes, which are densely deployed either inside the phenomenon or very close to it. The position of sensor nodes need not be engineered or pre-determined. This allows random deployment in inaccessible terrains or disaster relief operations. On the other hand, this also means that sensor network protocols and algorithms must possess self-organizing capabilities.

Since large numbers of sensor nodes are densely deployed, neighbour nodes may be very close to each other. Hence, multihop communication in sensor networks is expected to consume less power than the traditional single hop communication. One of the most important constraints on sensor nodes is the low power consumption requirement. Sensor nodes carry limited, generally irreplaceable, power sources.

II. COVERAGE AND CONNECTIVITY

Sensor deployment strategies play a very important role in providing better QoS, which relates to the issue of how well each point in the sensing field is covered. However, due to severe resource constraints and hostile environmental conditions, it is nontrivial to design an efficient deployment strategy that would minimize cost, reduce computation, minimize node-to-node communication, and provide a high degree of area coverage, while at the same time maintaining a globally connected network is nontrivial. Challenges also arise because topological information about a sensing field is rarely available and such information may change over time in the presence of obstacles. Many wireless sensor network applications require one to perform certain functions that can be measured in terms of area coverage. In these applications, it is necessary to define precise measures of efficient coverage that will impact overall system performance.

Historically, three types of coverage have been defined by Gage [5]:

- *Blanket coverage:* to achieve a static arrangement of sensor nodes that maximizes the detection rate of targets appearing in the sensing field.

- *Barrier coverage:* to achieve a static arrangement of sensor nodes that minimizes the probability of undetected penetration through the barrier.

- *Sweep coverage:* to move a number of sensor nodes across a sensing field, such that it addresses a specified balance between maximizing the detection rate and minimizing the number of missed detections per unit area

The coverage provided in the sensor networks is a critical criterion of their effectiveness, and its maintenance is highly essential to form a robust network. The study of such coverage issues means summing of the sensing and communication range, which should be ideal in the monitoring area to provide good QoS for different applications.

Area coverage and connectivity in wireless sensor networks are not unrelated problems. Therefore, the goal of an optimal sensor deployment strategy is to have a globally connected network while optimizing coverage at the same time. By optimizing coverage, the deployment strategy would guarantee that optimum area in the sensing field is covered by sensors.

III. OPTIMAL OVERLAPPING AND COVERAGE HOLE

In wireless sensor networks (WSNs), the sensors are deployed randomly over a monitoring region with a high degree of density of nodes. Due to the random deployment of sensors, certain areas of the monitoring region may have coverage holes [3] [4] and serious coverage overlapping which significantly degrade the network performance. The failure of electronic components, software bugs and destructive agents could lead to the random death of the nodes. Sensors may be dead due to exhaustion of battery power, which may cause the network to be uncovered and disconnected. Based on the deployment nature of the nodes in remote or hostile environments, such as a battlefield or desert, it is impossible to recharge or replace the battery. However, the data gathered by the sensors are highly essential or may be of scientific and strategic importance for the analysis, and therefore, the collaborative detection of coverage holes have strategic importance in WSNs.

In WSNs, due to the random deployment of the nodes, some areas cannot be covered or have no connectivity. If a coverage region is sensed by at least *k* nodes, this sensing method is called *k*-covered. The coverage probability plays a fundamental role in coverage hole detection and other applications of WSNs, because of existing errors in the sensing and communication range.

Holes are hardly avoided in WSNs due to the various geographical environments of the monitoring region, such as the presence of ponds, obstacles or even due to physical destruction of the nodes. Ignoring the detection of holes affects the efficiency of geographic routing, data congestion and the excessive energy consumption of the hole boundary nodes. Additionally, for information flow, the hole could also affect the overall capacity of the network. Thus, the identification of the holes in sensor networks is of primary interest, because their presence often has a physical correspondence and may also map to one of the special events that are being monitored by the sensor networks.

IV. LITERATURE SURVEYS

In this research paper [6] authors have proposed Edge Based Centroid (EBC) algorithm for enhanced area coverage with minimal energy consumption in mobile sensor network. It is based on Voronoi diagram that partitions sensing field into polygon with one sensor node each to monitor any event in its respective region. Mobile sensors move to new calculated candidate location i.e., at centre position of each polygon from its current or initial location.

In this paper [7] sensing field is modelled as an arbitrary polygon with obstacles and fewer sensors are required for sensing field full coverage and network connectivity. To improve reliability of network more columns of sensors among adjacent row are added.

In this paper [8] by using contour points generation approach coverage holes are eliminated which are near obstacles and boundary of sensing area. It adds new sensors repeatedly through candidate positions by scoring mechanism evaluation which is based on probabilistic sensor detection model.

V. CONCLUSION

In this paper we have discussed about the coverage and connectivity in Sensor network and also the issues in sensor network i.e. coverage holes. Coverage holes occur when the sensor nodes are far away from each other or a node is dead. Mobile sensors are moveable and can deploy themselves. Due to mobility feature, mobile sensor can cover the whole area without any coverage hole. Through our research notion of connectivity is also very important equally along with coverage in sensor networks. Sensor network robustness and throughput are directly relates to connectivity.

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