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Controlling the Coverage of Wireless Sensors Network Using Coverage in Block Algorithm

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Abstract - This research investigate the modeling of Blocks, Present in the sensing field and its impact in the computation of coverage path in wireless sensor networks (WSNs). The solutions of these problems are proposed using techniques from Approximation algorithm. In order to accomplish the designated task successfully, sensors need to actuate, compute and disseminate the acquired information amongst them. Intuitively, coverage denotes the quality of sensing of a sensor node. While a sensor senses. It needs to communicate with its neighboring sensor nodes in order to disseminate the acquired data. That is where connectivity comes in to place. In fact, coverage and connectivity together measure the quality of service (QoS) of a sensor network. 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 sensor, as required by the underlying application, whereas by ensuring that the network is connected, it is ensured that the sensed information is transmitted to other nodes and possibly to a centralized base station (called sink) which makes valuable decision for the application. Many recent and ongoing research in sensor networks focus on optimizing coverage and connectivity by optimizing node placement strategy, minimizing number of nodes to guarantee required degree of coverage, maximizing network lifetime by minimizing energy usage, computing the most and least sensed path in the given region and so on. To solve these optimizing problems related to coverage, exiting research uses mostly probabilistic technique based on random graph theory, randomized algorithm, computational geometry, and so on. Of particular interest to us is the problem of computing the coverage in block (CIB), where given a set of homogeneous sensors deployed in a field and the initial location of an agent that needs to move through the field, determine the path that is most protected by the sensors.

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CONTROLLING THE COVERAGE OF WIRELESS SENSORS NETWORK USING COVERAGE IN BLOCK ALGORITHM

Strictly as per the compliance and regulations of:

Controlling the Coverage of Wireless Sensors Network Using Coverage in Block Algorithm

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Abstract - This research investigate the modeling of Blocks, Present in the sensing field and its impact in the computation of coverage path in wireless sensor networks (WSNs). The solutions of these problems are proposed using techniques from Approximation algorithm. In order to accomplish the designated task successfully, sensors need to actuate, compute and disseminate the acquired information amongst them. Intuitively, coverage denotes the quality of sensing of a sensor node. While a sensor senses. It needs to communicate with its neighboring sensor nodes in order to disseminate the acquired data. That is where connectivity comes in to place. In fact, coverage and connectivity together measure the quality of service (QoS) of a sensor network. 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 sensor, as required by the underlying application, whereas by ensuring that the network is connected, it is ensured that the sensed information is transmitted to other nodes and possibly to a centralized base station (called sink) which makes valuable decision for the application. Many recent and ongoing research in sensor networks focus on optimizing coverage and connectivity by optimizing node placement strategy, minimizing number of nodes to guarantee required degree of coverage, maximizing network lifetime by minimizing energy usage, computing the most and least sensed path in the given region and so on. To solve these optimizing problems related to coverage, exiting research uses mostly probabilistic technique based on random graph theory, randomized algorithm, computational geometry, and so on. Of particular interest to us is the problem of computing the coverage in block (CIB), where given a set of homogeneous sensors deployed in a field and the initial location of an agent that needs to move through the field, determine the path that is most protected by the sensors.

I. Introduction

The emerging field of wireless sensor networks combines sensing, computation, and communication into a single tiny device. Through advanced mesh networking protocols, these devices form a sea of connectivity that extends the reach of cyberspace out into the physical world. As water flows to fill every room of a submerged ship, the mesh networking connectivity will seek out and exploit any possible communication path any single device are minimal, the composition of offers radical new technological possibilities.

The power of wireless sensor networks lies in there ability to deploy large numbers of tiny nodes that assemble and configure themselves. Usage scenarios for these devices computing environments, to in situ monitoring of the health of structures or equipment.

While often referred to as wireless sensor networks, they can also control actuators that extend control from cyberspace into the physical world.

The most straight forward application of wireless sensor network technology is to plant could be easily monitored for leas by hundreds of sensors that automatically form a wireless interconnection network and immediately report the detection of any chemical leaks.

Unlike traditional wired system, deployment costs would be minimal. Instead of having to deploy thousands of feet of wire routed through protective conduit, installers simply have to place quarter-sized device, such as the one pictured in Figure 1-1, at each sensing point. The network could be incrementally extended by simply adding more devices-no rework or complex configuration. With the devices presented in this research, the system would be capable of monitoring for anomalies for several years on a single set of batteries.

In addition to drastically reducing the installation costs, wireless sensor networks have the ability to dynamically adapt to changing environments, adaptation mechanisms can respond to changes in network topologies or can cause the network to shift between drastically different modes of operation. For example, the same embedded network performing leak monitoring in a chemical factory might be reconfigured into a network designed to localize the source of a leak and track the diffusion of poisonous gases. The network could then direct workers to the safest path for emergency evacuation.

II. Wireless Coverage Problems

Coverage is the measure of QoS of sensing function and is subject to a wide range of interpretations due to large variety of sensors and applications. Considering the coverage concept, different problems can be formulated, based on the subject to be covered (Area versus discrete points) and on the design choices, such as sensor development method, additional critical

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requirements, sensing and communication radius N. Xu et al. (2004).

A wide classification can be done with respect to the type of algorithm used as well. Centralized versus distributed/localized. We also compare these approaches and algorithm based on their goals, assumption, complexities and usefulness in practical scenarios. Objective of these design choices are either to maximize network lifetime; minimize number of sensors or optimize degree of coverage, and so on a a comprehensive study on coverage connectivity research can be found in Akyidiz et al. (2002).

Coverage can be classified of three types based on the subject to be covered. Area coverage, point coverage and barrier coverage. The most studied problem is the area research is going on in both the static and mobile sensor network D. Tian et al. (2002).

The design choices are given bellow:

1. Sensor deployment strategies: deterministic versus random. A deterministic sensor placement may be feasible in friendly and accessible environments. Random sensor distribution is generally considered in military applications and for remote or inhospitable areas.
2. Energy Requirement: In the most typical scenarios, energy requirement is a big factor as sensors are usually limited with respect to its battery life. Several research work has been done on energy efficient coverage.
3. Sensing and communication Radii: Homogeneous/ Heterogeneous sensor network is the subject of interest here. While constraints are less in homogeneous sensor network heterogeneous sensor network has a wider scope in applications.

A broader classification of coverage problems can also be done in terms of their goals, assumptions, algorithm complexities and practical applicability. The three categories are

1. Coverage based on the exposure path
2. Coverage based on sensor deployment strategies
3. Miscellaneous strategies

III. Minimal Exposure Path: Worst Case Coverage

Coverage is a measure of how well a sensing field is covered with sensors.

Informally stated, it can be defined as the expected average ability of observing a target moving in the sensing field. The minimal exposure path provides valuable information about the worst case coverage in sensor networks.

The basis of the proof adopted to compute the exposure path of one sensor lies in the fact that since any point on the dotted curve is closer to the sensor than any point lying on the straight line segment along the edge of the square; the exposure is more in the former case.

Also, since the length of the dotted curve is longer than the line segment, the dotted curve would induce more exposure with an object travels along it, given that the time duration is the same in both the cases. Furthermore, this method is extended when the sensing region is a convex polygon and the sensor is located at the center of that inscribed circle.

This intuition can further be extended to compute the minimal exposure path under the scenario of many sensors. To simplify, the problem can be transformed from the continuous domain into a tractable discrete domain by using an m ₤ n grid. The minimal exposure path is then restricted to straight line segment connecting any two consecutive vertices of a grid square. This approach transforms the grid into an edge weighted graph and computes minimal exposure path using Dijkstras single source shortest path algorithm.

IV. Maximal Exposure Path: Best Case Coverage

A maximal exposure path between two arbitrary points's and t in a sensing field is a path following which the total exposure is maximum. It can be interpreted as a path having the best case coverage. It has been proved by Z. Butler (2004. That finding the maximal exposure path is NP-hard because it is equivalent to finding the longest path in an undirected weighted graph, which is known to be NP-hard. However, there exist several heuristics to achieve near-optimal solutions under the constraints that objects speed, path length, exposure value and times.

V. Maximal Breach Path: Worst Case Coverage

A minimal exposure path is equivalent of finding a worst case coverage path, which provides valuable information about node deployment density in the sensing field. A very similar concept to find out worst case coverage path is the notation of maximal path Meriall (2003).

A maximal breach path through a sensing field starting at s and ending at t is a path, such that for any point p on the path, the distance from p to the closest sensor is maximum. The concept of Voronoi diagram, a well known construct from computational geometry is used to find a maximal breach path in a sensing field.

It is also proved intuitively since by construction, the line segments in a Voronoi diagram maximizes the distance from the closest sites, the maximal breach path must lie along the Voronoi edges. The algorithm then checks the existence of a path from s to t using breadth-first-search (BFS) and uses binary search between the smallest and largest weight in the computed Voronoi graph to find the maximal breach path.

VI. Maximal Support Path: Best Case Coverage

A maximal Support path through a sensing field starting at s and ending at t is a path, such that for any point p on the path, the distance from p to the closest sensor is minimized. This is similar to the concept of maximal exposure path. However, the difference lies in the fact that a maximal support path algorithm finds at any given time instant.

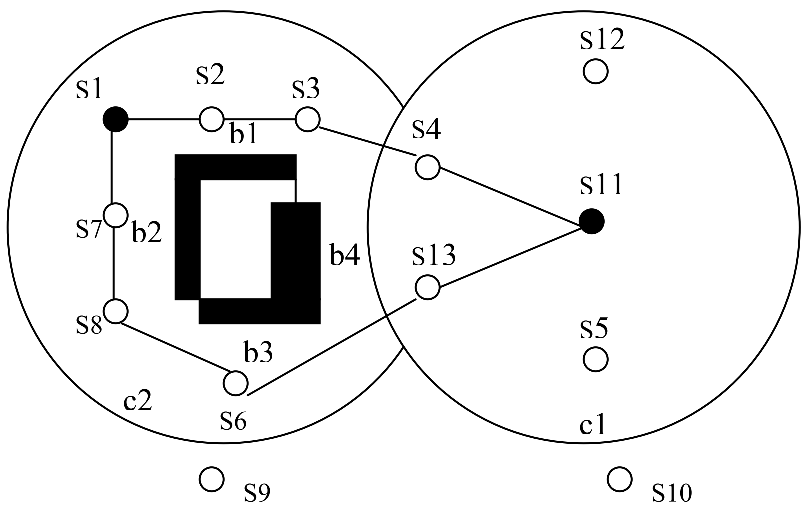
Such that the exposure on the path is no less than some particular value which should be maximized. A maximal support path in a sensing field can be found by replacing the Voronoi diagram by its dual, Delaunay triangulation where the edges of the underlying graph are assigned weights equal to the length of the corresponding line segments in the delaunay triangulation Z. Butler (2004). This ends our brief discussion on coverage problems based on exposure path in WSNs. Next, we discuss different deployment strategies which impact coverage in WSNs.

VII. Coverage Based on Sensor Deployment Strategies

The second approach to the coverage problem is to find sensor deployment strategies that would maximize the coverage as well as maintain a globally connected network graph. Several deployment strategies have been studied for achieving an optimal sensor network architecture that would minimize cost, provide high sensing coverage, and be resilient to random node failure etc. the most usual deployment strategy of sensor nodes are random deployment.

However, random placement does not guarantee full coverage because it is stochastic l nature, hence often resulting in accumulation of nodes at certain areas in the sensing field whereas leaving other areas deprived of nodes. Keeping this in mind, some of the deployment algorithms try to find new optimal sensor locations after an initial random placement and moves the sensors to those locations, achieving maximum coverage. These algorithms are applicable to only mobile sensor networks.

Research has also been conducted in mixed sensor networks, where some of the nodes are mobile and some are static; and approaches are proposed to detect coverage holes after an initial deployment and trying to heal or eliminate those holes by moving sensors. It should be noted that an optimal deployment strategy should result not only in a configuration that would provide sufficient coverage, but also satisfy certain constraints such as node connectivity and network connectivity [40].



Sensor Field with Four blocks b1, b2,…, b4 and sensors

VIII. Algorithm: Find Best Coverage(S:s:T)

1. Find closest sensor node of the starting point s if itself is not a sensor node. Assume S7 is the closest sensor node. Similarly, find the closest sensor node S13 of the ending t.
2. Each sensor node S locally constructs all edges Sv of the relative neighborhood graph broadcasts its location information and listen to the broadcasting by its neighbors. Thus, after this step, we assume that each node S has the location information of Nl(S).
3. Assign each constructed edge Sv with weight 1.
4. Run a distributed shortest path algorithm to compute the shortest path Connecting Ss and St. Here, the weight of a path is the maximum weight of all of its edges.

Here a path is the shortest path if it has the minimum weight among all paths connecting Ss and St. the Bellman-Ford algorithm M. Bauer (2004) can be modified to solve this shortest path problem.

IX. Conclusion

In this thesis we present an overview of coverage and the coverage related problems in the presence of block. We also present an algorithm to overcome this problem by using approximation algorithm called CIB coverage in block algorithm. The upcoming technological advances will most likely be applied to decreasing the power consumption of the device. In trun, this will enable a reduction of physical size of the energy storage required for any given application. as for tighter levels of integration, the cost/size point represented by the spec platform has reached the point of diminishing returns. Further reduction in the physical size of the radio, processing, and storage is no longer necessary. Only a select few application have the need for a device that is smaller that 2.5 mm × 2.5 mm. However, all application scenarios can benefit from reduced power consumption which is translated into longer network lifetime and / or increased sample rate.

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