



A Survey on Deployment Methods in Wireless Sensor Networks

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Abstract- *The efficiency of sensor networks depends on the coverage of the target area. Although, in general, a sufficient number of sensors are used to ensure a certain degree of redundancy in coverage, a good sensor deployment method is still necessary to balance the workload of sensors in target area. In a sensor network sensors can move around to self-deploy. The deployment deals with moving sensors from an initial unbalanced state to balanced state. Therefore, several optimization problems can be defined to minimize different parameters such as total moving distance, number of moves, communication cost. There is a unique problem called communication holes in sensor networks, areas not covered by any node. In this paper, we will work mainly to detect and remove communication hole in a heterogeneous wireless sensor network. For this we will study the existing techniques.*

Keywords – *Wireless sensor networks, load balance, sensor deployment, holes.*

1. Introduction

Wireless sensor network (WSN) is an infrastructure less, dynamic topology, application oriented, multihopping network design with small, sensing wireless distributed nodes. [1] WSN consists of thousands of wireless node distributed in a geographical area. The distributed nodes senses the current status of its region and supply to the next upper which collects different information from different nodes and supplied final information to the central node for further processing . The central node also removes the redundant information. Usually, sensor nodes are deployed in a designated area by an authority such as the government or a military unit and then, automatically form a network through wireless communications. Sensor nodes are static most of the time, whereas mobile nodes can move according to application requirements. One or several base stations (BSs) are deployed together with the network. A BS can be either static or mobile. Sensor nodes keep monitoring the network area after deployment. When an event occurs, one of the surrounding sensor nodes can detect it, generate a report, and transmit the report to a base station through multihop wireless links. Collaboration can be carried out if multiple surrounding nodes detect the same event. In this case, one of them generates a final report after collaborating with the other nodes. The base station can process the report and then forward it through either high-quality wireless or wired links to the external world for further processing. The WSN authority can send commands or queries to a base station (BS), which spreads those commands or queries into the network. Hence, a base station (BS) acts as a gateway.

Node deployment is a fundamental issue to be solved in Wireless Sensor Networks (WSNs). A proper node deployment scheme can reduce the complexity of problems in Wireless Sensor Networks (WSNs). Furthermore, it can extend the lifetime of Wireless Sensor Network (WSNs) by minimizing energy consumption. Heterogeneous wireless sensor network consists of sensor nodes with different ability, such as different power and different sensing range. As Compared with Homogeneous Wireless Sensor Network, deployment and topology control are more complex in Heterogeneous Wireless Sensor Network.

1.1 NODE TYPE

On the basis of sensing range nodes are divided into two types: homogeneous sensor network and heterogeneous sensor network. In which all the sensor nodes are identical and having the same capability is known as homogeneous wsn.

A group in which all sensor nodes are not identical and do not have the same capability i.e. some nodes are more powerful than others. These are called heterogeneous sensor network.

1.2 APPLICATIONS

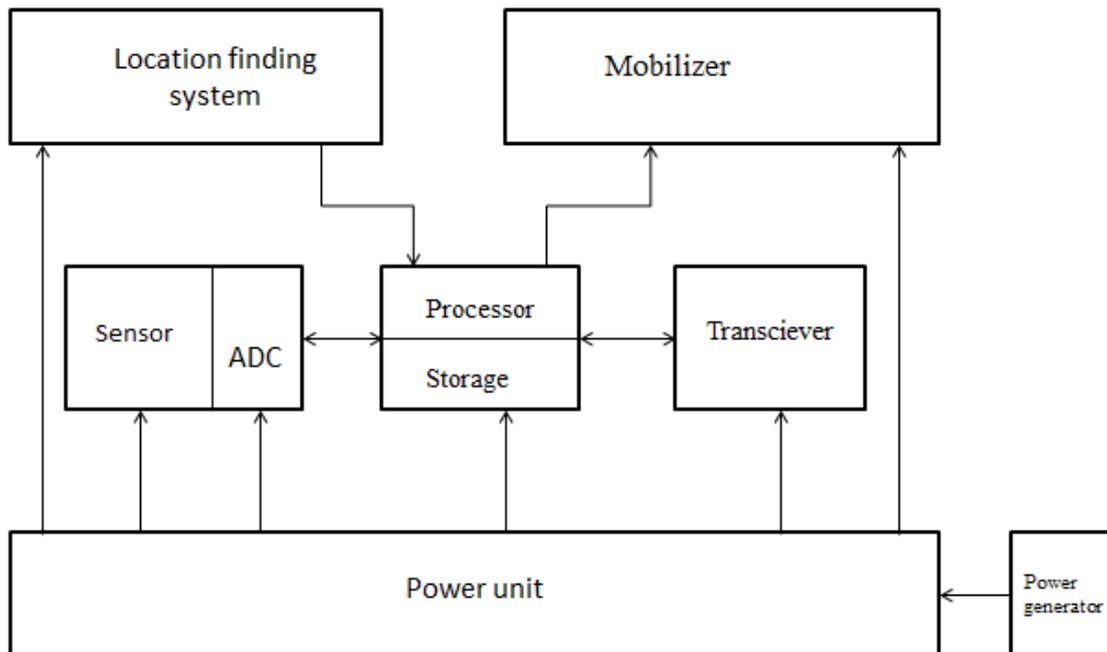
A wireless sensor network (WSN) consists of a large number of sensors to monitor physical or environmental conditions, such as temperature, pressure and sound etc. and to deliver their data through the network to a base station. The wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, industrial process monitoring, machine health monitoring and in agriculture also.

1.3 ARCHITECTURE

Sensor Networks mainly consists of following units:

- Sensing Unit
- Processing Unit

- Power Unit
- Communication unit



Sensing units are usually composed of two sub units: sensors and analog-to-digital converters (ADCs). The analog signals produced by the sensors based on the observed phenomenon are converted to digital signals by the analog-to-digital converters (ADCs), and then fed into the processing unit for processing. The processing unit, which is generally associated with a storage unit, manages the procedures. A transceiver unit connects the node and the network. The most important components of a sensor node are the power unit. Power units may be supported by power units such as solar cells. There are also other subunits that depend on the type of application. Most of the routing techniques and sensing tasks require knowledge of location with accuracy. Thus, it is necessary that a sensor node has a location finding system. Sometimes a mobilizer may be needed to move sensor nodes when it is required to carry out the assigned tasks.

1.4 SECURITY

Security is very important parameter in sensor network since sensor networks are data centric so there is no particular id associated with sensor nodes and attacker can easily inserted himself into the network and stole important data by becoming the part of the network without the knowledge of sensor nodes of the network. So it is difficult to identify whether the information is authenticated or not. The goal of security services in Wireless Sensor Network (WSNs) is to protect the information and resources from authentication, privacy, and confidentiality. The more the dependency on the information provided by the networks has been increased, the more the risk of secure transmission of information over the networks has increased.

2. Node Deployments

A sensor network deployment can be divided into 2 groups a dense deployment and a sparse deployment. A dense deployment has a high number of sensor nodes in the given field of interest while a sparse deployment would have fewer nodes. The dense deployment method 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 to achieve maximum coverage using the bare minimum number of sensors. Initially it is assumed that the sensor nodes are static i.e. they stay in the same place where they deployed. New sensor nodes have the ability to relocate their position after deployment, they are not stationary and these are known as mobile nodes. The algorithm in [3] has each sensor node determining the location it needs to move to in order to provide maximum coverage. The authors perform several experiments to show the network coverage and the deployment time of the algorithm. The key weakness in this algorithm is that each node must be within the sensing range of another node in order to determine the optimal location it needs to move to, if a node is not within the sensing range of its neighbor then that node cannot determine its relative location. In the deployment algorithm of [4], each node will communicate with its neighbors and tell them to move away until they are at a distance which maximizes coverage while maintaining connectivity among sensors. The simulations run by the author's show that a very high degree of coverage can be obtained within minutes of deployment. Actual sensors may not perform well if they are not able to calculate the distance of their neighbors with the same precision as the nodes in the simulation. The method introduced in [2] aims to maximize coverage while minimizing sensor movement. The authors show the method does achieve excellent coverage with low amounts of movement but it does require a complex algorithm.

Sensor network nodes are deployed in an area by either placing them in predetermined locations or on the randomly location. Dropping sensors from a plane is an example of random placement. It is easier to develop a good coverage scheme for sensor nodes that are deterministic placed as compared with sensor that are random placed. A more sophisticated deterministic deployment method is given in [6]. The authors propose to arrange the sensors in a diamond pattern which would correspond with a Voronoi polygon. The pattern achieves four way connectivity from each of the nodes with full coverage when the communication range divided by the sensing range is greater than the square root of two. The drawback of this method is that the pattern is not practical for actual deployment. It assumes that the sensing range and the communication ranges of every node are a perfect circle and having the ability to place the sensors in exact locations. Random deployments of sensor nodes are usually dense deployments so it is necessary to deploy additional sensors in order to achieve total coverage if the sensor nodes are stationary. Networks that consist of mobile sensors generally start out with a random deployment and utilize the mobility property in order to relocate to the optimal location.

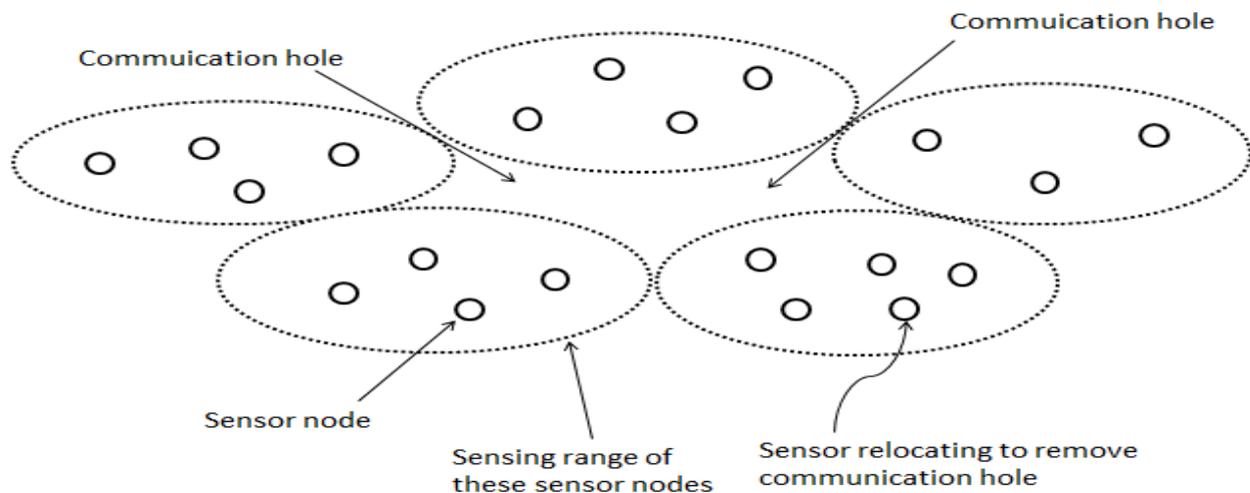
3. Types of Holes [7]

3.1 COVERAGE/COMMUNICATION HOLES:

Coverage holes, areas not covered by any node, due to random aerial deployment creating voids, presence of obstructions, and, more likely, node failures etc. Similarly, nodes may not be able to communicate correctly if routing holes, areas devoid of any nodes, exist in the deployed topology. Thus the network fails to achieve its objectives if some of the nodes cannot sense or report the sensed data. Some of these anomalies may be deliberately rated by adversaries that are trying to avoid the sensor network. These malicious nodes can jam the communication to form jamming holes or they can overwhelm regions in the sensor network by denial of service attacks such as sink/black/worm holes.

3.2 ROUTING HOLES:

A routing hole consist of a region in the sensor network where either nodes are not available or the available nodes cannot participate in the actual routing of the data due to various possible reasons. These holes can be formed either due to voids in sensor deployment or because of failure of sensor nodes due to various reasons such as malfunctioning, battery depletion or an external event such as fire or structure collapse physically destroying the nodes.



Communication Hole in WSN

3.3 JAMMING HOLES:

An interesting scenario can occur in tracking applications when the object to be tracked is equipped with jammers capable of jamming the radio frequency being used for communication among the sensor nodes. When this happens, nodes will still be able to detect the presence of the object in the area but unable to communicate the occurrence back to the sink because of the communication jamming. This zone of influence centered at the jammer.

4. Existing Techniques To Detect And Remove Communication Hole:

Node deployment is one of the main design challenges of WSN. Sensor network can be deployed randomly in geographical area. In [1] authors discussed various design challenges of WSN. In node deployment after deployment, they can be maintained automatically without human presence. In sensor network deployment falls into two categories either a dense deployment and sparse deployment. In dense deployment we have we have relatively high number of sensor node in the targeted field while in a sparse deployment we have a fewer nodes and it is used when the cost of sensor nodes increases and prohibited the use of dense deployment. The dense deployment is used when there is a need to detect the every moment or when we have multiple sensors for covering an area. Yi Zou and Krishnendu Chakrabarty proposed a scheme [8] virtual force algorithm (VFA) as a sensor deployment strategy to enhance the coverage after an initial random placement of sensors. The VFA algorithm is inspired by the virtual force field concept from robotics [2].

For a given number of sensors, VFA attempts to maximize the sensor coverage using a combination of attractive and repulsive forces. During the execution of the VFA algorithm, sensors do not physically move their position but a sequence of virtual motion paths is determined for the sensors that are randomly placed. Once the effective sensor positions are identified, a movement is carried out to redeploy the sensors at these positions. Energy constraints are also included in the sensor repositioning algorithm. VFA has the drawbacks that it is a centralized algorithm having single point of failure and bottleneck of processing. In [5], in this paper, we propose two sets of distributed protocols for controlling the movement of sensors to achieve target coverage: basic protocols and virtual protocols. In the basic protocols, sensors move iteratively, eventually reached the final destination. In each iteration, sensors detect communication holes using a Voronoi diagram. If there are holes, they calculate the locations to remove those holes. In the virtual movement protocols, sensors do not perform physical movement. It calculates the target locations and then sensors exchange these new virtual locations with the sensors which would be their neighbors if they had actually moved. The actual movement only occurs when the communication cost to reach their logical neighbors is too high or when they determine their final destinations. These methods simulate the attractive and repulsive forces between nodes. Sensors in a dense region will explode slowly according to each other's repulsive force and head toward a sparse region. In this way, the whole target area can achieve an equal distribution of sensors. However, these methods can have long deployment times since sensors move independently, and method fail if all the sensors achieved force balance but not load balance.

An enhanced method [9], that is based on scanning assume that sensors are deployed randomly into the square monitoring area without considering any physical obstacle. They partition the monitoring area into many small regions and use the number of sensors in a region as its load, thus the sensor deployment problem can be viewed as a load balance problem. One unique problem in Wireless Sensor Network (WSNs) is "communication hole", where some area has no deployed sensors. To overcome this problem Seed Planting concept is used before scanning. The target of this method is to achieve most balanced final state, which leads to more sensor movements.

5. Conclusion:

Today the wireless sensor network is used in every area. This technology has reduced the work load of the people. Still a good node deployment technique is essential for wireless sensor network. The existing method shows that some schemes are based on coverage concept and some methods works on the basis of load balancing concept.

6. Future Work:

The objective of our work is to find an efficient method for detecting and removal of communication hole in heterogeneous wireless sensor network. We will try to improve the existing scheme efficiently and effectively.

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