Chapter 11
An Intelligent Sensor Placement Method to Reach a High Coverage in Wireless Sensor Networks

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ABSTRACT

Adequate coverage is one of the main problems for Sensor Networks. The effectiveness of distributed wireless sensor networks highly depends on the sensor deployment scheme. Optimizing the sensor deployment provides sufficient sensor coverage and saves cost of sensors for locating in grid points. This article applies the modified binary particle swarm optimization algorithm for solving the sensor placement in distributed sensor networks. PSO is an inherent continuous algorithm, and the discrete PSO is proposed to be adapted to discrete binary space. In the distributed sensor networks, the sensor placement is an NP-complete problem for arbitrary sensor fields. One of the most important issues in the research fields, the proposed algorithms will solve this problem by considering two factors: the complete coverage and the minimum costs. The proposed method on sensors surrounding is examined in different area. The results not only confirm the successes of using the new method in sensor placement, also they show that the new method is more efficiently compared to other methods like Simulated Annealing(SA), PBIL and LAEDA.

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INTRODUCTION

Wireless sensor networks consist of certain amount of small and energy constrained nodes (Chong & Kumar, 2003; Pottie, 1998; Pottie & Caiser, 2000). A typical wireless sensor network 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. However, when a group of sensor nodes collaborate with each other, they can accomplish a much bigger task efficiently. One of the primary advantages of deploying a wireless sensor network is its low deployment cost and freedom from requiring a messy wired communication backbone (Chong & Kumar, 2003; Akyildiz, Su, Sankarasubramaniam, & Cayirci, 2002).

For instance, a sensor network can be deployed in a remote island for monitoring wildlife habitat and animal behavior (Mainwaring, Polastre, Szewczyk, Culleradn, & Erson, 2002; Qi, Iyengar, & Chakrabarty, 2001), or near the crater of a volcano to measure temperature, pressure, and seismic activities. In many of these applications the environment can be hostile where human intervention is not possible and hence, the sensor nodes will be deployed randomly or sprinkled from air and will remain unattended for months or years without any battery replacement. Therefore, energy consumption or, in general, resource management is of critical importance to these networks. 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. Three types of coverage have been defined by Gage (1992):

1. **Blanket coverage:** to achieve a static arrangement of sensor nodes which maximizes the detection rate of targets appearing in the sensing field.
2. **Barrier coverage:** to achieve a static arrangement of sensor nodes which minimizes the probability of undetected penetration through the barrier.
3. **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.

We will focus mainly on the Blanket coverage, where the objective is to deploy sensor nodes in strategic ways such that optimal area coverage is achieved according to the needs of the underlying applications.

In the distributed sensor networks, the issue of sensor placement is an importance paramount in researches. A sensor network can be arranged in two ways, one as a random placement and the second as a grid-based placement. Once the surrounding is unknown the random placement is the only option and the sensors may be disintegrated everywhere but when the features of the network were known before, then the sensor placement could be done with great scrutiny and we could guarantee the quality of providing services along with satisfying the limitations. The strategy of sensor placement depends on the application of the distributed sensor network (DNS). In this article the focus is on the grid-based placement. Here we applied the modified binary PSO algorithm for solving these NP-complete problems (Rostami & Nezam Abadi, 2006).

Considering the existence of many networks with high velocity and computational capabilities of these sensor networks, we can say that they have different applications for example in aviation, military, medical, robot, air forecasting, security and anti terrorism applications and also we can use them in very important infrastructures like power plants, environmental and natural resource

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