Chapter 18
Lifetime Maximization of Target-Covered WSN Using Computational Swarm Intelligence

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ABSTRACT

In target-covered WSN, all critical points (CPs) are to be monitored effectively. Even a single node failure may cause coverage hole reducing the lifetime of the network. The sensor has non-rechargeable battery, and hence, energy supervision is inevitable. To maximize the lifetime of the WSN with guaranteed coverage and effective battery utilization, the activities of the sensors are to be scheduled and also the sensors may be repositioned towards the critical points. This chapter proposes an energy-efficient coverage-based artificial bee colony optimization (EEC-ABC) approach that exploits the intelligent foraging behavior of honeybee swarms to solve EEC problem to maximize the lifetime of the WSN. It also adheres to quality of service metrics such as coverage, residual energy, and lifetime. Similarly, energy-balanced dynamic deployment (EB-DD) optimization approach is proposed to heal the coverage hole to maximize the lifetime of the WSN. It positions the self-deployable mobile sensors towards the CPs to balance their energy density and thus enhances the lifetime of the network.

INTRODUCTION

Wireless Sensor Network (WSN) is an emerging technology that is gaining much importance owing to its immense contribution in a variety of day-to-day applications. The WSN comprises numerous small, inexpensive, distributed devices known as sensor nodes. A sensor, also known as a mote, is a self-contained unit of a WSN that is capable of performing some processing, gathering sensory information and communicating with the other connected nodes in the network (Cerpa & Estrin 2004).

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A sensor mote consumes extremely low energy, operates in high volumetric densities, is autonomous, operates unattended, and is adaptive to the environment. There exists a variety of sensors that measure environmental parameters such as temperature, light intensity, sound, magnetic fields, image, etc. The mobilizer and the location finding system are optional in a sensor mote. The mobilizer unit is used to move the sensor, and the location finding system uses Global Positioning System (GPS) to identify the location of a sensor.

Nowadays, WSN merges a broad range of information technology with hardware, software, networking, and programming methodologies. Hence it has many potential applications (Romer et al 2004, Sanoob et al 2016 and Akyildiz et al 2007) such as bio-medical health monitoring, biological detection, security surveillance, smart home management, automobile communication, pollution monitoring, natural disaster relief, hazardous environment exploration, wildlife habitat monitoring, forest fire detection, seismic sensing etc.

In the above applications, sensors are spread out in the target region to sense, measure or gather information from the environment. The process of spreading the sensor is called deployment (Peng et al 2011 and Younis & Akkaya 2007). The deployment of the sensor is either random or deterministic. In most of the applications, sensors ought to be deployed in hostile or unmanned environment. Under such circumstances, sensors are randomly deployed by air dropping. Here, all the deployed sensors may not monitor the target area, some of them may fail due to environmental hazards and certain other sensors may fall outside the interested region. For effective coverage, random deployment should be dense with more number of sensors. On the other hand, through deterministic deployment, sensors are deployed in predetermined fixed locations. To monitor the events of less importance, sparse deployment is used. The sparse deployment reduces the cost as the monitoring is managed with fewer sensors.

Wireless Sensor Network in Real-Time Scenario

In real-time scenarios, the deployed sensors configure by themselves and establish communication to their one hop neighbors and thus form the network.

As in Figure 1, out of all available sensors in the target area, some may detect the event, which is propagated through the next hop neighbours to the base station. The important information is intimated to the user via Internet.

Issues in Wireless Sensor Network

A sensor (Wang 2011, Alonso et al 2006) has limited energy, limited computation power, limited communication ability, limited memory, and restricted sensing and transmission range. This, in turn, affect the lifetime of theWSN.

Lifetime

Lifetime of the WSN can be defined in various ways, as the meaning of the statement “the network is alive” depends on the requirements of the network. One of the most frequently used definitions for the WSN lifetime is the period of time WSN is active satisfying the coverage requirements. The lifetime of the WSN comes to an end when it encounters the first coverage hole. However, the lifetime need of the WSN may range from some hours to several years based on the criticality of the application.