Chapter 18
Application of Computational Intelligence Techniques in Wireless Sensor Networks the State of the Art

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ABSTRACT

A wireless sensor network may contain hundreds or even tens of thousands of inexpensive sensor devices that can communicate with their neighbors within a limited radio range. By relaying information on each other, they transmit signals to a command post anywhere within the network. Worldwide market for wireless sensor networks is rapidly growing due to a huge variety of applications it offers. In this chapter, we discuss application of computational intelligence techniques in wireless sensor networks on the coverage problem in general and area coverage in particular. After providing different types of coverage encountered in WSN, we present a possible classification of coverage algorithms. Then we dwell on area coverage which is widely studied due to its importance. We provide a survey of literature on area coverage and give an account of its state-of-the art and research directions.

INTRODUCTION

Revolutionary advances in Micro-Electro-Mechanical Systems (MEMS), wireless networking, and information processing have taken place during the past decade, resulting in the emergence of small-size and low-cost wireless sensors. These miniature sensors are self-content and capable of sensing the environment, data processing, and reporting via wireless network. The availability of such wireless sensor networks has opened up an exciting new opportunity to monitor the physical world like never before. WSN is mainly differentiated from the traditional wireless ad hoc network by their unique and dynamic network topology which owing to the time-varying link condition and node variation, diverse applications emphasizes on different sensory date requirement in terms of quality of service (QoS) and

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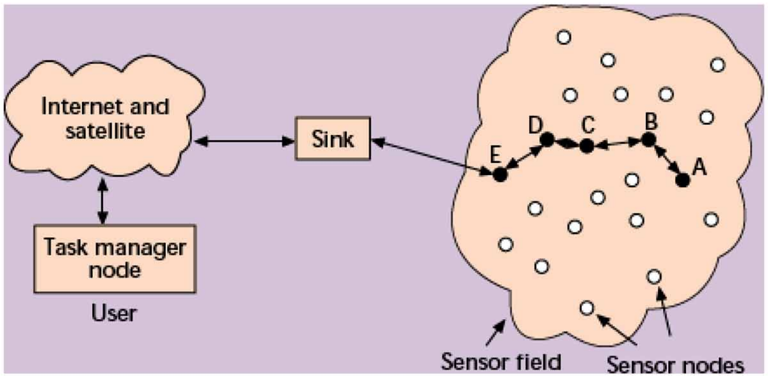
Figure 1. Typical WSN components



reliability. Furthermore, sensor nodes' limitation in power, computational capacities and memory are often deployed in large numbers and high density, for example to sense, process, and disseminate information of physical environments, thus resulting in upstream direction traffic from the sensor nodes to the sink whereas traditional networks are mostly point-to point or point-to-multipoint data forwarding (Lyas et al.,2005). Hence, one needs to carefully cope with such problems as energy conservation, reliability, and quality of services (QoS) to meet application requirements. Our major in this chapter focuses on the coverage problem of WSN. Coverage is a basic research issue in WSN because it can be considered as the measure of QoS of sensing function for a sensor network. For example, in an application of forest monitoring, one may ask how well the network can monitor a given area and what the chances are that a fire starting in a specific location of forest will be detected in a given time frame. Additionally, coverage formulations can try to find weak points in a sensor field and suggest future deployment or reconfiguration schemes for improving the coverage performance. The major components of a typical sensor network are: sensor nodes, the sensor field, the sink and the task manager, as shown in Figure 1.

- **Sensor Nodes:** Sensor nodes (also called Field devices) are capable sensing the environment, process data; transmit data to other devices and route data packets on behalf of other devices.
- **Sink (Access Points):** A Sink enables communication between Host application and field devices.
- **Task Manager:** A Task Manager is responsible for configuration of the network, scheduling communication between devices (i.e., configuring super frames), management of the routing tables and monitoring and reporting the health of the network.

A sensor node plays a major role in the sensor network. A typical sensor node is made up of a sensor board and a mote. A mote is made up of a processor, memory, radio transceiver (communication device), and power supply.

Wireless sensor networks are mugged with lots of challenges, mainly due to the communication failure, storage and computing constraints and limited power supply. Computational Intelligence CI paradigm has been effectively used in recent years to address issues such as the optimal allocation, data aggregation and integration, energy aware routing, task scheduling, security, and localization challenges. CI presents exhibit complex dynamic environment, intelligent behavior as adaptation mechanism for wireless sensor networks. CI fetches flexibility, autonomous behavior, as well as changes in the topol-