A New Method for Prolonging Network Lifetime and Maintaining the Connectivity in Wireless Sensor Network Through Controlling the Transmission Power

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ABSTRACT

Energy preservation constitutes a very critical challenge in wireless sensor network surveillance applications. On one hand, transmitting data by using additional transmission power is among the biggest sources of energy consumption. On the other hand, using a small transmission power degrades the connectivity between nodes. In this paper, a Distributed transmission Power Control Method (DPCM) to minimize the consumed energy is proposed. Moreover, it aims to keep a good connectivity between nodes. These purposes are accomplished by adjusting, dynamically, the transmission power taking into account the connectivity information of the neighbors at one and two-hop. Simulation experiences are carried out to measure the performance improvements of the presented method in both static and mobile networks by using Castalia simulator. According to the obtained results, the authors’ method minimizes the consumed energy without penalizing the connectivity between nodes compared to DPCS and farthest neighbor methods. In addition, DPCM achieves good performances in spite of node mobility.

Keywords: Connectivity, Consumed Energy, Energy Preservation, Lifetime, Mobility, Transmission Power Control, Wireless Sensor Networks

DOI: 10.4018/ijertcs.2014010101
INTRODUCTION

During the recent years, wireless sensor networks (WSNs) has witnessed a widespread in a variety of applications including military (Lee & Reichardt, 2005; Mielke, Brennan, Smith, Torney, Maccabe, & Karlin, 2005), production and delivery (Bertocco, Gamba, Sonc, & Vituri, 2008; Antifakos, Michahelles, & Schiele, 2002), medical (Baldus, Klabunde, & Muesch, 2004), and environment invigilation (Allen, 2006; Mainwaring, 2002; Hartung, 2006). WSN consists of tiny devices randomly deployed over a large area. Wireless sensor networks are highly dependent to the application type. Therefore, the density of the network is narrowly related to the type of application (Baldus, Klabunde, & Muesch, 2004).

A sensor node (Vieira, 2003; Estrin, 2001; Romer & Mattern, 2004) is capable to sense and process physical phenomena and to communicate it to one or more collection points in a multi-hop manner. The sensor nodes are often equipped with a energy limited battery. This battery is irreplaceable due to the random deployment and the inaccessibility to the environment where the network is deployed. Therefore, sensors must monitor the area as long as possible. For that reason, improving the energy efficiency (Jeon, 2009; Luiz, 2007; Mohit & Rakesh, 2013) in wireless sensor network surveillance applications became the first and the most important challenge. Thereby, the energy problem represents a barrier for the smooth running of the network. Since the energy required for data transmission takes 70% of the total energy consumption of a wireless sensor network (Kumar, S.P, Chee-Yee, Chong, 2003), the transmission power control methods (Lin, 2006; Lavratti, 2012) represent important mechanisms that aim at achieving a power-efficient communication. These methods rely on the idea that the node must transmit data at the lowest power while ensuring the connectivity and the reliability of the network. Thus, the connectivity becomes, besides to the consumed energy, a crucial challenge. Many transmission power control methods have been proposed in the literature. However, most of them require a static network, while applications which require mobile sensors emerge (Enrico & Loser, 2013; Haas & Small, 2006; Juang, 2002). It is important to point out that the connectivity between nodes can be degraded by their mobility. This work provides a Distributed transmission power control method called DPCM. It aims to minimize the consumed energy for each sensor node and to ensure a good connectivity even when the nodes are mobile. In this method, power control which can be embedded in many routing protocols is provided. This is carried out by adjusting the transmission power based on the connectivity information of its immediate neighbors (the information about the neighbors of neighbors). i.e. the node adjusts its transmission power according to the one-hop neighbor that reaches the farthest two-hop neighbor. The experiences carried out by OMNET platform through Castalia simulator show the efficiency of the method. The performance metrics are the consumed energy, the average of received packet and the network lifetime. Moreover, DPCM maintains a good connectivity even in mobile WSN. The remainder of this paper is structured as follows: The second section presents a review of some transmission power mechanisms in Wireless sensor networks, followed by the description of DPCM in the third section. Simulation results and analysis of the proposed method take place in the fourth section, while the last section concludes the paper.

RELATED WORK

The transmission power control methods for wireless sensor networks are widely explored in the literature, these methods aim at reducing the radio wasted energy in the transmission state. In this section, we review some techniques of transmission power control proposed in the literature. These transmission power control methods for wireless sensor network may be classified on two main categories: power control based on topology information and power control based on the quality of link.
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