Journal of Network and Computer Applications 34 (2011) 1671–1682

Contents lists available at ScienceDirect

Journal of Network and Computer Applications

journal homepage: www.elsevier.com/locate/jnca

Linear wireless sensor networks: Classification and applications ☆

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ARTICLE INFO

Article history:
Received 10 November 2010
Received in revised form
14 April 2011
Accepted 12 May 2011
Available online 27 May 2011

Keywords:
Ad hoc and sensor networks
Applications of linear sensor networks
Networking frameworks
Routing

ABSTRACT

Wireless sensor networks (WSNs) constitute a rapidly growing technology, taking advantage of advances in electronic miniaturization that consume less energy for both processing and communication. The cost of these devices is also constantly decreasing, making it possible to use a large number of sensor devices in a wide array of commercial, environmental, military, and health care fields. Many of these applications involve placing the sensors in a linear form, making a special class of these networks which we define as a Linear Sensor Network (LSN). In this paper, the concept of LSNs is expanded, along with a set of applications for which this type of network is appropriate. In addition, motivation for designing specialized protocol is provided that explores linearity of the network to increase the communication efficiency, reliability, fault tolerance, energy savings and network lifetime. Furthermore, classification of LSNs from both topological and hierarchical points of views, is presented and various characteristics, research challenges and underlying opportunities are discussed. Simulation experiments are also presented to compare the performance and reliability of LSNs.

1. Introduction

The advent of technology in computing and electronics evolving innovation of tiny wireless sensors has opened an unprecedented opportunity for a wide array of real-time applications. In recent years, wireless sensor networks (WSNs) have been emerging as a new suitable tool for a spectrum of new applications. These tiny sensor nodes are low cost, low power, easily deployable, and are self-organizing. They are usually capable of doing limited local processing. However, information collected from a large number of such nodes at a central location known as base stations (BSs) or sink nodes, before reaching a network control center (NCC) enables detailed representation of a given physical environment. Thus, a WSN can be described as a collection of sensor nodes which collaborate to arrive at some specific decision. Unlike traditional networks, a WSN depend on dense deployment and adequate co-ordination of data transfer to a BS. These unique characteristics make it very useful. WSNs were initially introduced for defense applications such as target detection, surveillance of enemy activities in a battlefield environment and counterterrorism. However, their advantages over traditional networks have resulted in many other potential civilian applications that range from infrastructure security to industrial control. Some examples are environment and habitat monitoring, health applications, home automation, traffic control, etc. Another possible example is protecting and monitoring a large pipeline system.

Research in the field of WSNs is relatively active and involves a number of interrelated issues, including efficient routing protocols (Akkaya and Younis, 2005, 2003; Akyildiz et al., 2002; Chong and Kumar, 2003; He et al., 2003; Schurgers and Srivastava, 2001; Soharabi and Pottie, 2000), QoS support (Jawhar and Wu, 2005), security (Fernandez et al., 2005), and middleware (Hadim et al., 2006). Most of these are investigated under the assumption that the network used for sensors does not have any infrastructure support. Fortunately, WSN needed for a monitoring linear infrastructures ought to be a structured network in which all sensor nodes are to be placed in a line. This characteristic can be utilized for enhancing the communication sequencing and reliability of the network.

We define LSNs as a new category of WSNs where the nodes are placed in a strictly linear or semi-linear form. A WSN is considered linear if one of the following conditions are true: (1) if all the nodes are aligned on a straight line, strictly forming a line, or thin LSN; (2) if all of the nodes exist between two parallel lines that extend for a relatively long distance as compared to their transmitting range and the distance separating them constitute a semi-linear or thick LSN. We introduced a general concept of LSNs along with some specialized routing protocols and addressing scheme in Jawhar et al. (2007).

☆ A primary version of some parts of this paper were presented in the Eighth Wireless Telecommunication Symposium (WTS'09), published by the IEEE Communication Society. This work was partially supported by UAEU Research Grant 03-03-9-11/08.

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doi:10.1016/j.jnca.2011.05.006