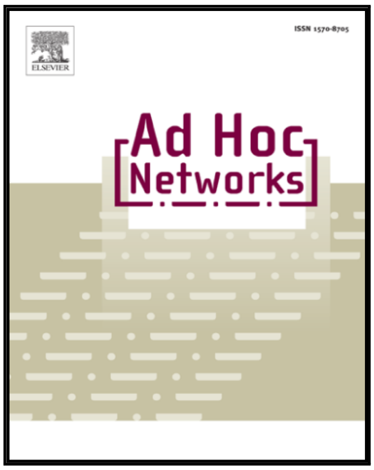

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Recovery from Simultaneous Failures in a Large Scale Wireless Sensor Network

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Abstract

The Wireless sensor networks (WSNs) become more and more recognized these recent years and their applications spread in several domains. In general, these applications require that the network presents a minimum degree of reliability, effectiveness and robustness. However, the specificity of the nodes used in this type of networks makes them prone to failures. Indeed, the multichannel communications are generally privileged in the interference context which is very frequent in several WSNs' applications due to the density of sensors and the harsh environment in which they are deployed. Moreover, in real applications, the occurrence of some faults (for example fire) may alter an entire zone of the network especially in the case of large scale deployment. Therefore, in this paper, we propose a network fault recovery approach from simultaneous failures in a large scale multichannel WSN. To make our solution as realistic as possible, we consider the case of the precision agriculture application and propose a detailed deployment of the WSN for that application. The choice of precision agriculture application is motivated by the fact that this application require large scale WSN (thousands and thousands of sensors) to supervise such a large area. Based on such precision agriculture scenario, we propose our fault recovery approach, called Simultaneous Failure Recovery based on Relay Node Relocation (SFR-RNR), that aims to restore the connectivity and partially the coverage in the network. The performance of the proposed approach is evaluated by simulation.

Keywords: Simultaneous failures, Connectivity restoration, Failure recovery, Precision agriculture, Wireless sensor networks

1. Introduction

In the recent years, wireless sensor networks (WSNs) [1] have been dedicated to ensure different tasks, going from simple data collection to critical system monitoring and control, in several domains. Many applications such as smart grids, precision agriculture and border protection, require a large scale WSNs' deployment to ensure the monitoring tasks by collecting data and sending them to the sink in an autonomous way. Thus, they expect that the coverage of the monitored zone and the connectivity between the nodes are maintained as long as possible without human intervention. However, the characteristics of sensor nodes, powered by limited batteries, as well as the harsh environments in which they are deployed, lead to many problems that affect the WSN reliability. In such hostile environment, where WSN are generally deployed with high density, another problem arises -the interference problem- which alters the correct network functioning. As an alternative to the interference problem, the multichannel communications can be used [2, 3, 4, 5, 6, 7]. Moreover,in large scale WSNs' applications, a large number of nodes can be subject to simultaneous failures which may affect a whole zone within the network. For instance, in an application of precision agriculture, an important part of the deployed WSN can be damaged because of fires or floods.

In literature, many researches focused on simultaneous failures in WSNs [8, 9, 10]. However, the proposed solutions do not consider the large WSN deployment. In addition, all these solutions were restricted to the monochannel context. The novelty of this paper is that it targets the simultaneous failure recovery in large scale WSNs while considering the multichannel communications. Moreover, to make our solution exploitable in a real context, we consider an application suited to large WSN deployment the "Precision Agriculture application" [11, 12, 13, 14]. In this application, the sensors are scattered in large number (Thousands of sensors) to ensure the monitoring tasks (soil salinity, pressure, temperature, humidity, etc). For this application, the sensor nodes are always exposed to variable climate conditions (floods, fire, lightning,...) which increase the probability of simultaneous failures' occurrence in the network.

Therefore, regarding the precision agriculture applica-

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