Development and implementation of a wireless sensor system for landslide monitoring application in Vietnam

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Abstract: The effect of climate change and human activities leads to a series of dangerous phenomena, such as landslides, flood, etc. Therefore, it is necessary to build a system to monitor environmental hazards. There are some studies that built landslide monitoring systems based on wireless sensor network (WSN). However, there is not any WSN that is the best standard for landslide monitoring system. The energy saving which helps extend the lifetime of the landslide monitoring system is very important. This paper focuses on the development of a WSN system with the proposed energy efficient scheme. In this work, we build a complete system that consists of sensor nodes, a gateway node, a database, a website interface and an Android application for landslide monitoring application. The energy efficiency scheme is applied at sensor nodes to increase the lifetime of sensor node up to 154 times and significantly increase the rate of successfully received packets. The system is also assembled and measured in the lab and the outdoor to analyse initial results.

Keywords: landslide; energy; wireless sensor network; WSN; power consumption; Vietnam.

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1   Introduction

Landslide which destroyed transport systems, houses and especially, killed a number of human beings is one of the most serious hazards in many regions of the world. Landslide monitoring systems built to warn this hazard can be classified into long-term warning and short-term warning. For long-term warning systems, works in Tarchi et al. (2003) used ground-based SAR interferometry to derive multi temporal surface deformation maps of the entire depletion zone of the landslide, works in Pachauri and Pant (1992) focus on the relationship between the terrain parameters and landslide hazard mapping; and works in Dai and Lee (2002) use of a geographic information systems (GIS) database, compiled primarily from existing digital maps and aerial photographs, to describe the physical characteristics of landslides and the statistical relations of landslide frequency with the physical parameters contributing to the initiation of landslides on Lantau Island in Hong Kong. For short-term warning systems, Terzis et al. (2006) proposed a network of sensor columns deployed at hills with landslide potential with the purpose of detecting the early signals preceding a catastrophic event, Kotta et al. (2011) use wireless sensor network (WSN) to build a landslide detection system which often encounters difficulties in data collection that came from the characteristics of landslides, causing some problems in research to predict and detect landslides, and Tejaswi et al. (2006) focus on building good localisation algorithms and routing protocols to increase the lifetime of WSN for the landslide prediction system. It can be seen that the long-term warning system is based on monitoring of geological features, topography, etc. while the short-term warning system focuses on efficient energy consumption for monitoring systems, developing routing algorithms, and assessment models of landslide. Especially, there is no one benchmarking right now for a complete landslide monitoring system. One of the techniques to be applied to monitoring systems is WSN which have some advantages such as real-time monitoring of geographical regions, remote monitoring or easily extended network as shown in Kotta et al. (2011), Tejaswi et al. (2006) and Ramesh (2014). Various studies relate to the use of WSN for the landslide monitoring system, and refer to the energy for WSN. For instance, Terzis et al. (2006) proposed to use the sensor column for detecting landslide potential by early signal preceding a catastrophic event, Kotta et al. (2011) provide the foundation for the application of WSN to establishing thorough and reliable early warning system (EWS) by detecting threshold of acceleration, and Lee et al. (2008) offer a power consumption estimation and energy efficient for consumption of water system based on ZigBee wireless protocol.

In this paper, we concentrate on developing of an efficient landslide monitoring system based on WSN in Vietnam. In Vietnam, the landslides occurred in many areas, especially in mountainous regions and in the rainy season. However, the studies of landslides were conducted mainly in geology such as in Lee and Dan (2005) which built a probabilistic landslide susceptibility mapping in the Lai Chau province of Vietnam.