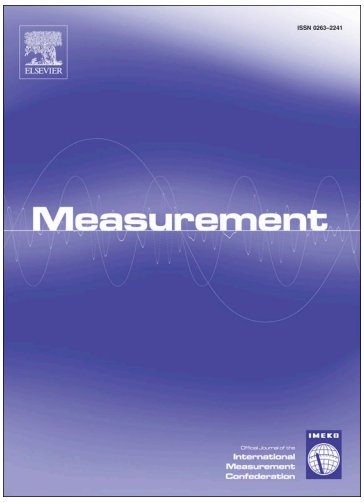

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WIRELESS SENSOR NETWORK IN LANDSLIDE MONITORING SYSTEM WITH REMOTE DATA MANAGEMENT

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Abstract – This paper describes a system that uses a wireless sensor network (WSN) to monitor landslide disasters in remote areas. The system consists of 3 subsystems called the Local Sensing Node Network System (LSNNS), the Cloud System (CS), and the Host System (HS). To monitor the field status and condition of the nodes remotely, we set up an appropriate management scheme in which the HS collects various data types in categories: node status, node data, LSNNS status, and LSNNS data. Equivalent lists are available to manage the HS and CS. Each data type contributes to 1 or 2 key analyses in determining a temporary situation. Experiments are conducted to investigate some featured data for landslide monitoring application, including node posture, dynamic change of topology, landslide occurrence recognition, and node location change. Where WSN is a candidate for monitoring natural disasters, this remote management scheme provides the surveillance process with extra information and helps the operator to comprehend the situation and maneuver with less effort.

Keywords: Wireless sensor network; disaster mitigation; telemetry system

1. INTRODUCTION

Every year, dozens of landslides occur on almost every continent. Landslide are happening more frequently due to various causes including climate changes, human activities, and geological structure [1]. The occurrences are usually triggered after a heavy rain where the groundwater is already morphed by different reasons as an antecedent condition. In rare cases, landslide happens suddenly without warning, making their prediction and forecast difficult. Continuous monitoring is necessary to track the changes of important factors for forecast purpose and to quickly recognise the instantaneous landslides.

Landslides involving mountain slopes could damage nearby structures. The primary purpose of monitoring landslides is to protect people and these structures. With current technologies, a system can cover a large area where there is the potential for landslide occurrences. It is impossible to deploy a system in all high-risk areas, so the system should focus on protecting residents and traffic areas. The roads and houses in hill and mountain areas become priority objects. Besides some solutions to improve the geomechanical features of the slopes, discovering landslides quickly and accurately is another aim of the monitoring activity.

Wireless sensor networks (WSN) are a well-known solution for monitoring environmental status. With a variety of sensors, WSN can detect changes in different parameters used to produce a geomechanical model of the slope including temperature, water flow, movement speed, and humidity. In landslide monitoring, the ability to detect sudden changes of the mountain slope is essential. A landslide starts with the reduction of soil cohesion or an increase in rock cleaving. When the reduction reaches the threshold or an external factor breaks the bond of the ground or rock elements, the landslide happens. The immediate consequence is that an amount of rock, soil, sand, mud, and other matter moves down the slope. The safety of the local people is the most important issue, but some social barriers may not allow them to evacuate their hometown unless physical evidence of a landslide is shown. To maintain the daily activities of nearby residents and traffic, it is necessary to inform people of any landslide occurring in real time. With this observation, this research focuses on the physical measuring of occurring events to announce warnings and evaluate aftereffects, rather than predicting and preventing disasters.

This system should be configured as an event-driven system because landslide occurrences require special consideration. Nevertheless, in a normal situation where no landslide is happening, the sensors must still work to monitor any transformations of the field. So a management scheme is needed to manage the network in both situations. The system must be robust and reliable to run smoothly without any failures. A management scheme is designed to inform the operators of environmental status and conditions. For many reasons, the operators are not near the monitored field, and without a management system, it is difficult or sometimes impossible to perceive the situation in the field.

Previously, other research on the management of WSN introduced different results such as management methods and ideas [2,3,4,5]. The frameworks and models come along the introduced systems, provided broad views and specific prospective [10,11,12,13]. Besides research on management aspects, there are many other studies related to landslide disaster mitigation system [6,7,14,15]. Some features of these studies are summarized in Table 1. Current research is motivated by both the strong and weak points of the previous studies. Management structure and entities are motivated from the idea of MANNA, WinMS, and RRP [2,3,4,10]. System operation is related to one of BOSS [5], while message structures are related to SNMP [12,13]. LI [11] shows a system with contrast characteristics. The systems of Ramesh [6], Dixon [7], and Sheth [15] require an enormous amount of time and effort in deployment: placing the device into ground and sampling local rock. These examples prompt us to adopt a different methodology with our system. The approach of Sheth [15] is also beneficial in geological