Wireless Sensing Network Management for Landslide Disaster Monitoring

S. Takayama, J. Akiyama, T. Fujiki, N. A. B. Mokhtar

Ritsumeikan Univ.BKC, Shiga, JAPAN
Email: s-tkym@se.ritsumei.ac.jp

Abstract. *This paper shows the network management and operation to monitor landslide disaster at slop of mountain and hill. Natural disasters damage a measuring system easily. It is necessary for the measuring system to be flexible and robust. The measuring network proposed in this paper is the telemetry system consisted of host system (HS) and local sensing nodes network system (LSNNS). LSNNS operates autonomously and sometimes is controlled by commands from HS. HS collects data/information of landslide disaster from LSNNS, and controls LSNNS remotely. HS and LSNNS are communicated by using "cloud" system. The dual communication is very effective and convenient to manage a network system operation.*

Keywords: Network Management, Wireless Sensing, Landslide Disaster

1. Introduction

Natural disasters are terrible and so important concerns for us. They destroy social infrastructures, loss human lives, and damage economic condition of people, companies, organizations and governments. It is very hard for measuring system to monitor landslide disasters. Measuring instruments are broken easily by the disaster. By reason of dangerousness, measuring person cannot be with the system. Measuring system must monitor at a wide area not only a point. As landslide disaster is occurred suddenly, the system waits and senses it at a moment after long time monitoring.

Wireless sensing node network system (WSNNS) is one of effective solution to monitor the landslide disaster. The network formation is mesh. The distributed sensing nodes operate cooperatively. Then the WSNNS becomes possible to measure acceleration, soil moisture and land position at a wide area for long time. As sensing nodes are supporting each other, the WSNNS can continue the measurement even if some nodes have been destroyed by landslide disaster. The sensing node analyses measuring parameters to find a sign of landslide disaster and to estimate the condition of system and sensor devices. The WSNNS operates autonomously as a local system (LSNNS). Then the measurement data and estimated information are transmitted to Host system (HS) at other place where measuring person monitors and collects them safely. There are several kinds of communication method between WSNNS and HS. "Cloud" system presents so useful services to realize a dual way communication method between them. As HS does not demand measuring data transmission from LSNNS in real time, the communication is enough asynchronously. The storage and mail system of "Cloud" realize an effective and convenient communication to transmit the data/information from LSNNS and the command from HS.

In monitoring landslide disasters, the total measurement network system constructed by LSNNS, HS and the communication method using "cloud" system realizes so useful and convenient measurement system. In following, the network management is shown.

2. Measurement Network System for Monitoring Landslide Disaster

Fig.1 shows the system construction of total measurement network to monitor landslide disaster. The system is consisted with Host System (HS), "Cloud" system, Local Sensing Node Network System (LSNNS).

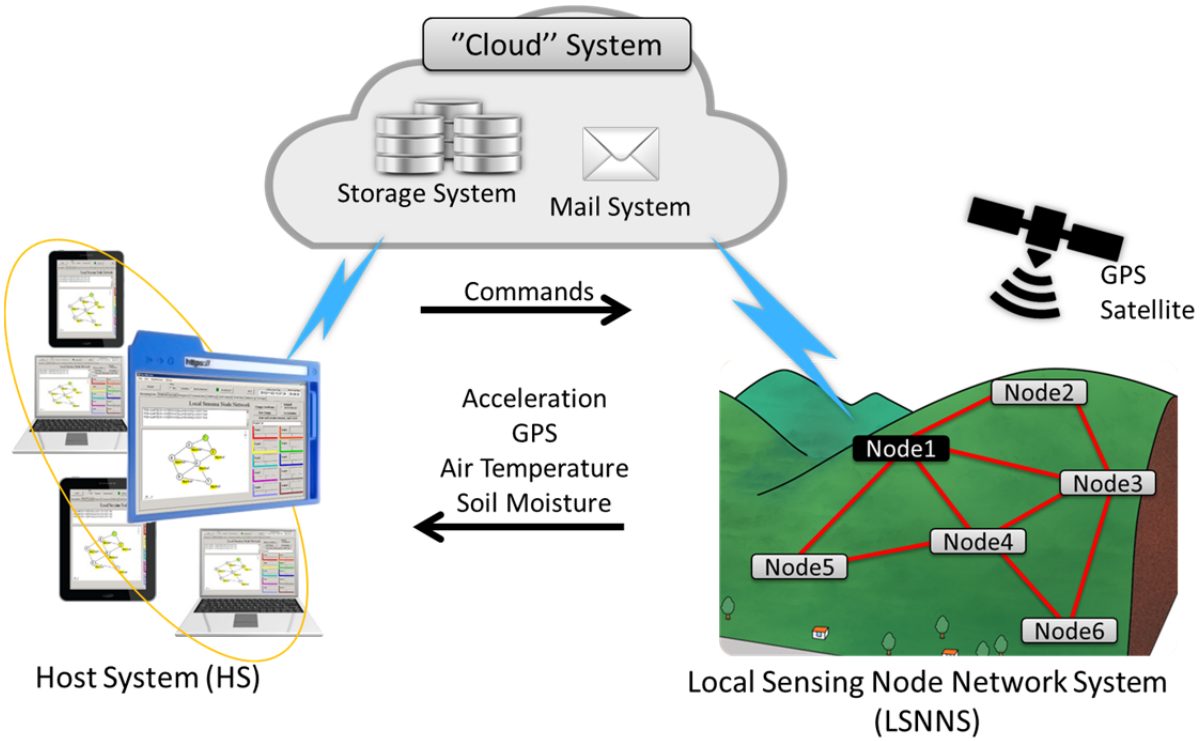


Fig.1 System Construction of Total Measurement Network to Monitor Landslide Disaster

2.1 Local Sensing Node Network System

LSNNS is the local measuring network which is consisted of plural distributed sensing nodes connected with near field wireless communication at around slope of mountain and hill. One of them is a top node which is the gateway of LSNNS for data and command. The top node mounts a smart phone to communicate data and command with "Cloud" system. Each sensing node mounts some sensors, control board and wireless communication device (Fig.2). The sensors are 3D acceleration, GPS, temperature and soil moisture. The 3D acceleration sensor is used to monitor ground acceleration by landslide disaster. The occurrence and types (slide down, rolling down) of landslide are recognized by continuous analyse of 3D acceleration angles and power spectrum of acceleration signal for 1 sec.. GPS is used to know the ground position and movement of sensing node. The position precision is within

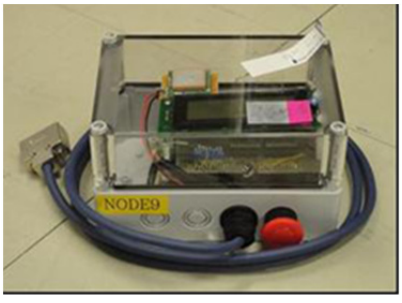
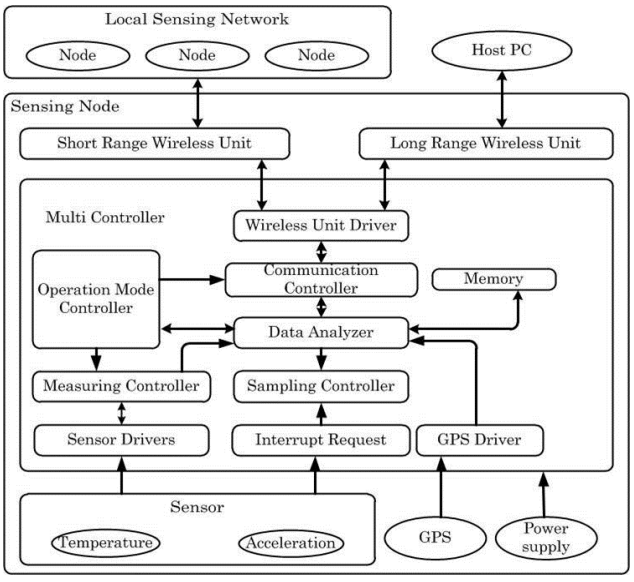


Fig.2 Sensing Node



5 m. By information of ground positions of sensing nodes, HS can monitor the topology of LSNNS which becomes the basic information to construct the routing table of LSNNS. The ground movement of sensing node is referred to find a sign of very slow landslide. The wireless communication device connects sensing nodes in near field. The operation frequency is 1.2GHz. The transmission baud late is 9600 bps. The communication distance in wood is about 50-60 m. The control board takes some kinds of role to manage the communication control, to decode and operate commands from HS, to acquire measuring data from sensors and to estimate information of landslide disaster and system condition by analysing the data.

LSNNS has three kinds of operation mode which are initialization, normal and urgency mode. In the initialization mode, sensing nodes recognize the condition of mutual connections each other by beacon test signal transmissions. By these connection data, HS estimates the topology of LSNNS and constructs the routing table. In the normal mode, the sensing node operates on demand by HS. According to the command from HS, the sensing node replaces system parameters like sampling time. And that returns measuring data, estimated information and system conditions to HS. In the urgent mode, the sensing node recognized the occurrence of landslide disaster send urgent information to neighbour nodes. The nodes known the urgent information also send it new neighbour nodes. Repeating this transmission between sensing nodes, the urgent information is influence node to node. Finally, that information reaches to the top node of LSNNS. The top node sends the information to HS via "Cloud" system urgently.

2.2 "Cloud" System

"Cloud" is a collection system of several kinds of service (Storage system, Mail system and so on) which is accessed from everywhere. By using the mail system, the top node of LSNNS accesses "Cloud" system by 13 messages per minute. The command from HS and data/information are packaged in a mail message. As the communication is asynchronously, HS and top node of LSNNS check mail messages regularly. Fig.3 shows series of measuring data transmitted by mail messages. Fig.4 shows the growth of local sensing node network which is informed by measuring data. Data transmission rate is increased by direct access to storage system. It is possible to use 25GB free in commercial "Cloud" system.

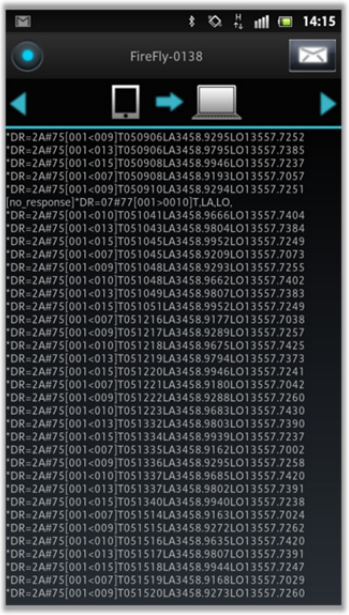


Fig.3 Series of Measuring Data by Mail Messages

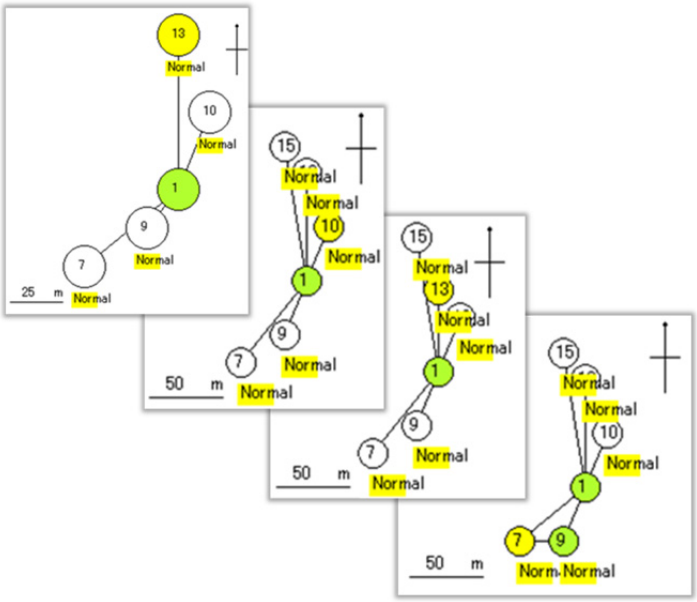


Fig.4 Growth of Local Sensing Node Network by Measuring Data

2.3 Host System

Host system take roles to collect measuring data, show measurement parameter conditions, alarm the occurrence of landslide disaster to measuring person, construct a routing table of LSNNS and make/send the operation command to manage LSNNS. These functions of HS are realized with software. Measuring person can monitor a list of measuring data (acceleration, GPS, temperature soil moisture), status of network topology, time transition of measuring data, status of communication. Fig.5 shows command operation window. By making it as a web program, measuring person can operate measurement network system by any PC and Tablet from everywhere.

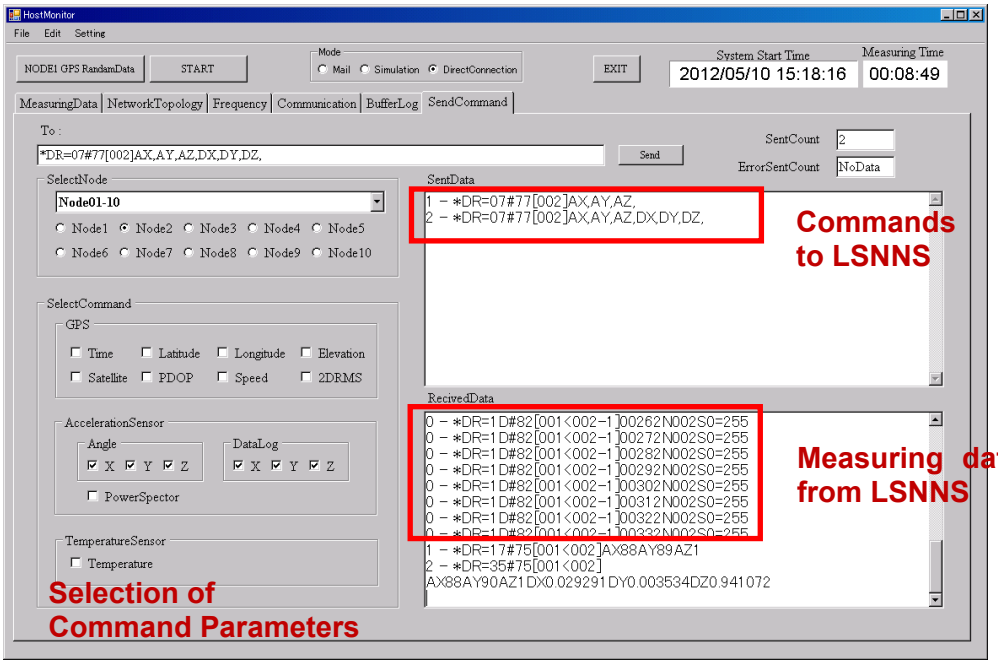


Fig.5 Command Operation Window in Host System

3. Conclusion

In this paper, the system construction of total measurement network to monitor landslide disaster, which is consisted with Host System (HS), “Cloud” system, Local Sensing Node Network System (LSNNS). On the measurement system to monitor natural disasters, robust, flexible, useful and reliable network management is demanded. LSNNS is designed as a robust and flexible system for landslide disaster. “Cloud” system presents usefulness to access the system from everywhere and the flexibleness to communicate data/information and command between HS and LSNNS.

References

[1] S.Taenaka, Y.Watanabe and S.Takayama, “Construction of Wireless Sensing Network System for Landslide Disaster Monitoring”, ACTA IMEKO 2012, pp.TC19-P-5, 2012.

[2] Rahman, F.; Kumar, A.; Nagendra, G.; Gupta, G.S., “Network approach for physiological parameters measurement”, IEEE Trans. Instr. and Meas., Vol.54, pp. 337 - 346, 2005.

[3] S.Taenaka, J.Akiyama, T.Fujiki and S.Takayama, “Design of Flexible Wireless Sensing Network System for Landslide Disaster Monitoring”, Proc. of SICE International Conference 2012, pp.1443-1459, 2012.