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Wireless Sensing Node Network Management for Monitoring Landslide Disaster

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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.

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).

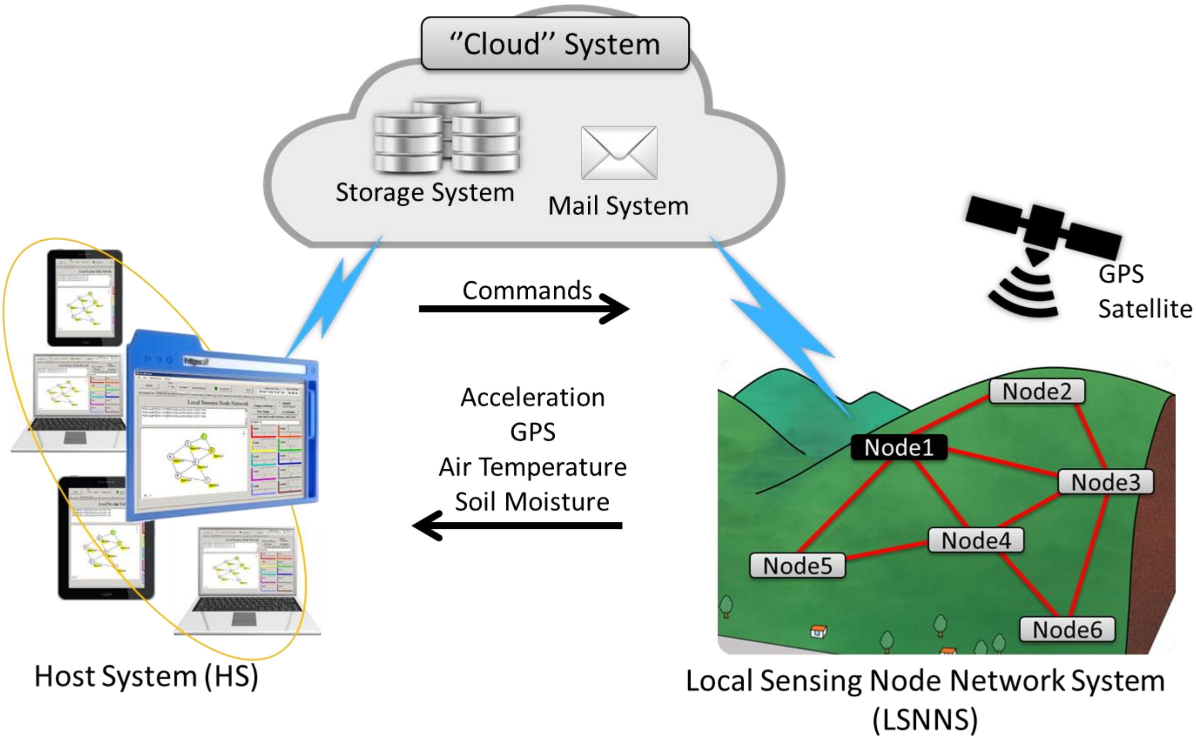
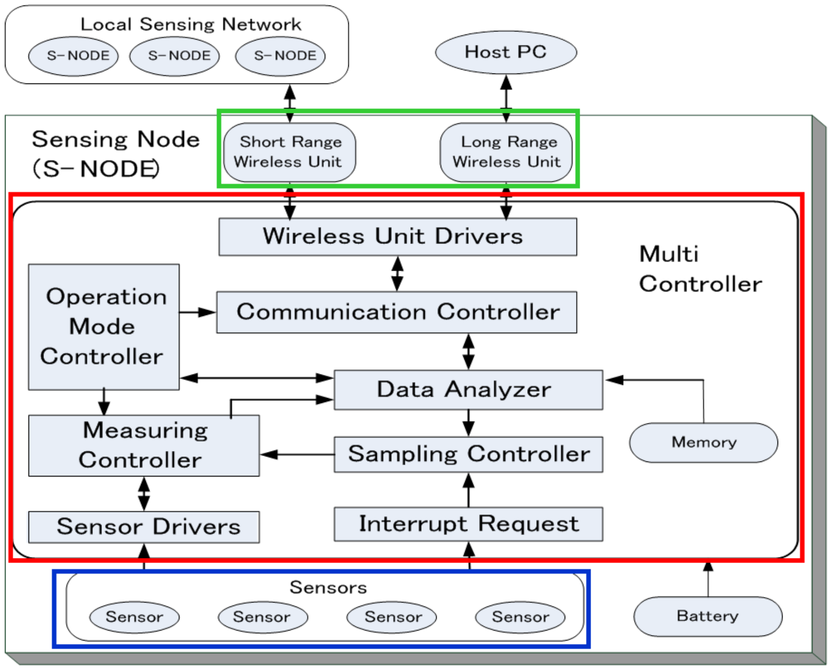


Figure 1. System construction of total measurement network to monitor landslide disaster

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 (Figure 2, Figure 3). 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 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.

Figure 2. A sensing node



◆ Wireless communication unit : MU-1-1216
◆ Control board : SH3DSP
◆ Sensors : Acceleration, GPS, Temperature

Figure 3. System construction of sensing node

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). The system is so convenient to exchange data and information from everywhere. Storage capacity in commercial “Cloud” system is 25GB freely. This measurement network system uses this “Cloud” system to communicate commands and data/information between HS and the top node of LSNNS by the mail system. They are packaged in a mail message each other. Now, the top node of LSNNS can send 13 messages per minute maximally which is depended on the characteristic of smartphone mounted in top node. As the communication is asynchronously, HS and top node of LSNNS check mail messages regularly. Figure 4 shows a series of measuring data transmitted by mail messages. Figure 5 shows the situation of growth of local sensing node network which is informed by measuring data. Data transmission rate will be increased more by using direct access technology to storage system. But in actually, as the analysis of continuous measuring data like acceleration is processed at sensing nodes in LSNNS (transformation to information), data message via "Cloud" system is limited to temperature and absolute time/position by GPS. Then huge number of mail messages is not occurred in this measurement network system.

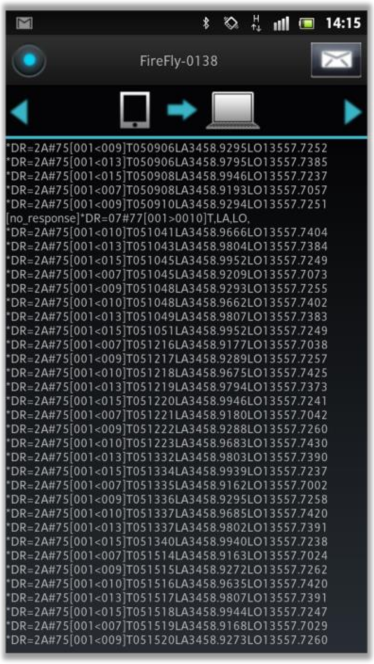


Figure 4. A series of measuring data transmitted

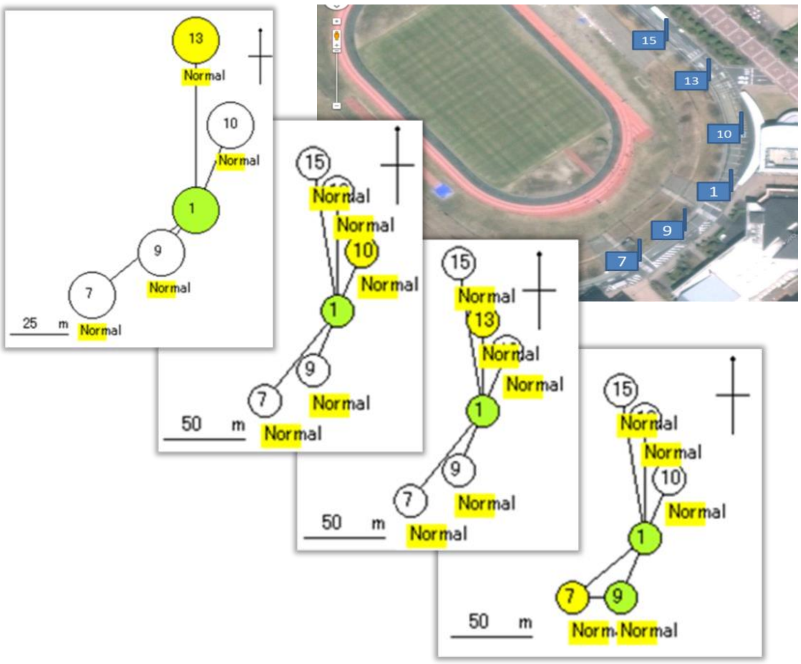


Figure 5. Situation of growth of local sensing node network which is informed by measuring data

2.3. Host System

HS takes some roles for system management with measuring person far from LSNNS. As HS is designed to exchange data/information to "Cloud" system with wireless communication network, the hardware is various like desktop, mobile, PC, tablet and any other which can access to internet. HS checks mail arrivals regularly in "Cloud". At finding, it takes data/information from mail messages and distinguishes them according to their characteristics. In HS, they are displayed sequentially as graph and table to measuring persons. At getting the information of occurrence of landslide disaster, HS alarms it to them autonomously. Using the measuring data of absolute position by GPS, HS forms some kinds of routing table of LSNNS. The routing table is a map of ways which commands and data are transmitted in LSNNS. The plural routing tables are prepared as risk management for local broking of sensing nodes in LSNNS. HS sends several kinds of command to LSNNS, which change the operation modes (initialization and normal), request to any nodes to send measuring data and operation conditions.

Using human interface windows in HS, Measuring person can monitor a list of measuring data (acceleration, GPS, temperature)(Figure 4), status of network topology(Figure 5), status of communication and time transition of measuring data. Figure 6 shows a command operation window. At left area, operator can select (1) target sensing nodes in LSNNS, (2) measuring data of GPS, acceleration sensor, temperature sensor which he wants to collect. HS converts these requests to a command message in an edit box shown at left top. By click "Send" button of right side of the command line box. HS sends the command to LSNNS. The command is displayed in right above box. At receiving the responses from sending nodes, the message lines are shown in right below box.

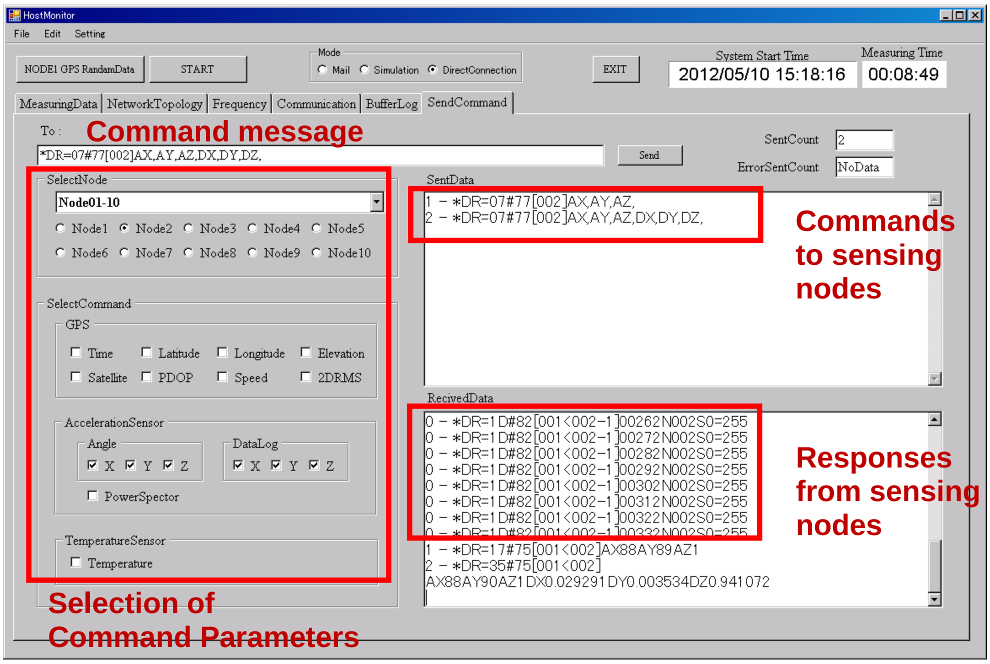


Figure 6. Command operation window in HS

Figure 7 shows the monitoring window of sensing node conditions. The conditions (3D body inclination, absolute position, inside temperature and so on) are recognized autonomously by the sensing node itself. The information is requested and collected by commands from HS. In Figure 7, body inclinations of a sensing node are shown.

Figure 8 shows the information flow of landslide disaster detected by the analysis of acceleration signal measured at a sensing node. To avoid communication conflictions in LSNNS, usually,

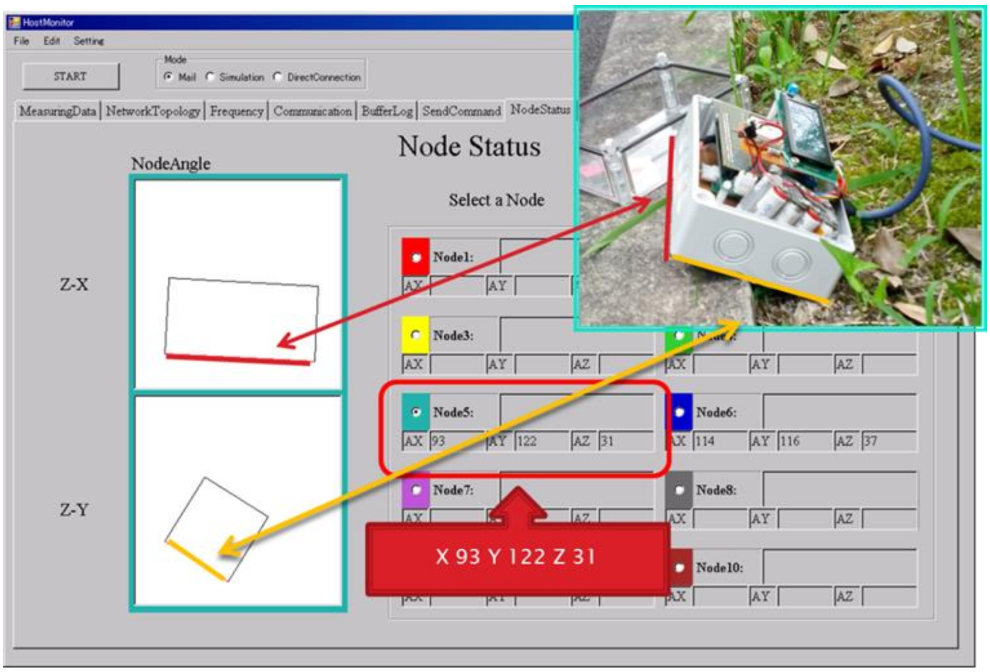


Figure 7. Monitoring window of sensing node conditions in HS

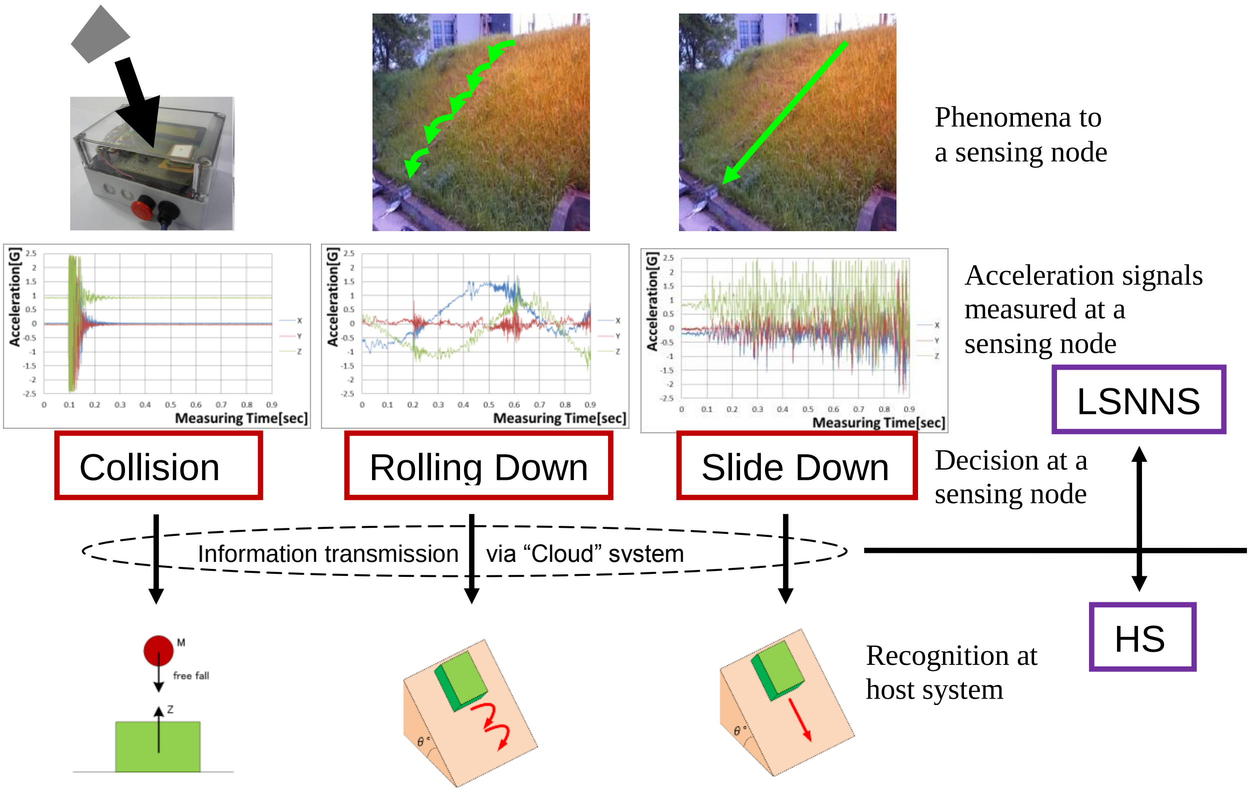


Figure 8. Information flow of landslide disaster detected by the analysis of acceleration signal measured at a sensing node

measurement data is analysed at a sensing node. And the information as results is transmitted from LSNNS to HS via "Cloud" system. By reconstruction of HS software as WEB software, measuring person can operate measurement network system and monitor landslide disasters by any PC and Tablet from everywhere.

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). The measurement system to monitor natural disasters is needed robust, flexible, useful and reliable operation management. LSNNS is so robust, flexible system for landslide disaster. That reforms the network routing autonomously. "Cloud" system presents usefulness to access the system from everywhere and the flexibleness to communicate data/information and command between HS and LSNNS. In addition to them, HS as WEB software realizes portability of total measurement network system for measuring persons.

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