Development of Data Acquisition System of Moving Object for Landslide Monitoring System

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Abstract

This paper presents the design of data acquisition systems for the landslide monitoring system. These systems required for developing a mitigation system of the landslide disaster on the island of Lombok. Development of data acquisition system based on ATmega2560 microcontroller and ultrasonic sensor that used to detect the object displacement in the mechanic instrument system. The information about displacement data is used as landslide information. Embedding of a data logger system which integrated with the wireless communication is used to record the data and displayed on the web. The results of performance test system which developed shows that information data of the object shift can be recorded and displayed properly. The relative error maximum measurement is about 2%.

Keywords: *mitigation, landslide, data logger, wireless, microcontroller*

1. Introduction

Landslide disaster is the most destructive mass movement phenomena that occur as a result of the rocks collapse or the slopes movement. These phenomena can be detected earlier based on monitoring and analyzing the land movement that trigger the landslide. There are various sensors and methods are developed for monitoring purposes. Intrieri et al. (2012) combine an extensometer sensor with the rainfall sensor, a camera and thermometers for the development of early warning system (EWS)[1]. Lisnawati et al. (2013) develop an electric extensometer based on the changes in resistance value of potentiometer [2] and Zhu et al. (2011) develop an optic fiber transducer for landslide monitoring [3].

In order to obtain an accurate analysis and prediction from monitoring, we need data acquisition systems that have a high accuracy, precision. This system allows to the wireless monitoring especially facilitating the development an early warning system of landslide mitigation.

In this work, we design a low cost and robust data acquisition system for the land movement monitoring. To detect the land movement, ultrasonic sensor was proposed as a part of data acquisition instrumentation systems. The ultrasonic sensors was used in the measuring of 3D positions of an indoor mobile object [4], in determination of the vibration frequency of the object [5], measuring the wind speed and direction detection [6].

2. Materials and Methods

2.1. System Design

In the purposes for landslide monitoring, the design of a data acquisition consists of an ultrasonic sensor as a proximity sensor and the acquisition device. The acquisition device was built up using a data logger system and a wireless communication that embedded in the ATmega2560 microcontroller Arduino platform. This microcontroller is the main unit that collects data from the sensor and handles all the tasks of the system. To controlling and performing all the tasks of acquisition, the programming script was setup using the Arduino sketch and implanted into the

ATmega2560 chip. The block diagram of the data acquisition system is shown in the Figure.

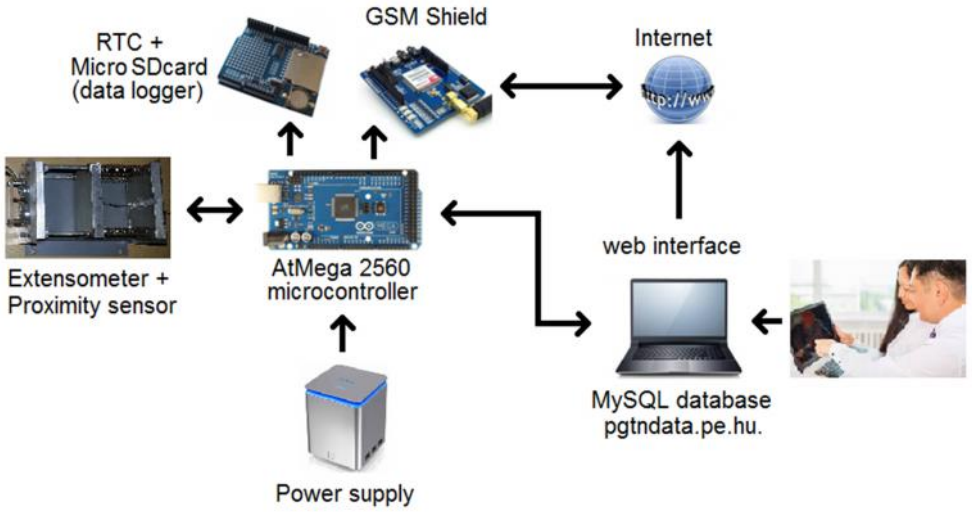

Figure 1 Block diagram of the data acquisition system

2.2. Output of System Design

For analyzing reasons, the resulting data acquisition will be saved in the MySQL database. In order to display the measured data, we built the connection between MYSQL database and the website using PHP programming with the flowchart as shown in the Figure 2.

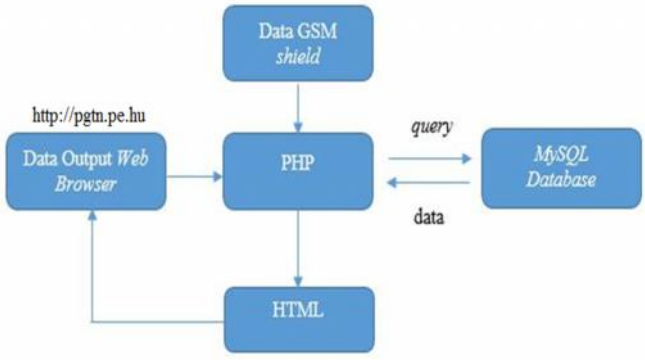

Figure 2 Flowchart of displaying data on the website

3. Results and Discussion

3.1 Implementation of the Acquisition Design

Figure 3 shows the physical system of data acquisition system in order to detect the object displacement in the mechanic instrument system of the landslide monitoring system. A system was controlled by the ATmega2560 microcontroller. The supply of power for the system comes from the external battery. For the indication of the land movement, we are using the PING Parallax ultrasonic as a proximity sensor to detect the object displacement (moving plate) in the mechanic instrument system (extensometer).

Figure 3. A prototype of data acquisition system.

The ATmega2560 microcontroller controlling of the measurement values from landslide sensor, the time of acquisition from RTC (Real Time Clock) and save onto the MicroSD card. The displayed data of the system include the measuring time and the distance of a moving object from the ultrasonic sensor.

3.2. Implementation of Output System Design

In the purposes of real time monitoring, a GSM shield SIM900 Quad-band is used for wireless communication. GSM supports outgoing and incoming data communication. This device was used to facilitate data transfer from the microcontroller input (sensor output) to the database. Furthermore, it will be displayed in the website of pgtndata.pe.hu. In Figure 4, we can see the recorded data from the simulation measurement that conducted. The data was displayed in the website.

Recording of the measured values and the time of acquisition is saved onto the MicroSD card as shown in the Figure 5. The stored data in the memory card with the file name that set is PGTNDATA.TXT and can be read in the TXT and CSV format.

ID	Waktu	X_Plat (Cm)
781	2016/11/29,17:23	6.760
780	2016/11/29,17:23	6.780
779	2016/11/29,17:22	6.760
778	2016/11/29,17:20	6.290
777	2016/11/29,17:20	6.210
776	2016/11/29,17:18	6.290
775	2016/11/29,17:17	6.120
774	2016/11/29,17:16	6.210
773	2016/11/29,17:15	6.210
772	2016/11/29,17:15	6.210
771	2016/11/29,17:14	6.210
770	2016/11/29,17:14	6.210
769	2016/11/29,17:13	6.120
768	2016/11/29,17:8	5.780
767	2016/11/29,16:58	5.980
766	2016/11/29,16:57	6.340
765	2016/11/29,16:55	6.470
764	2016/11/29,16:54	5.980
763	2016/11/29,16:53	5.980
762	2016/11/29,16:53	5.980

Figure 4 Displayed of sample data in the web database.

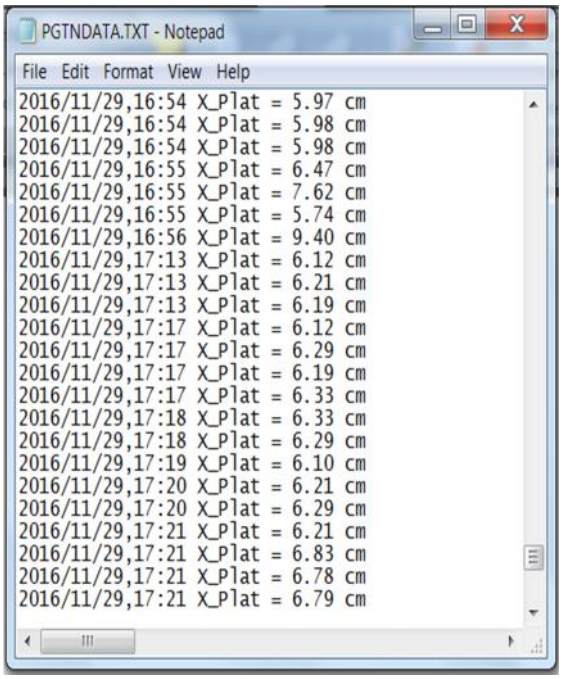

Figure 5 Recorded of sample data in data logger

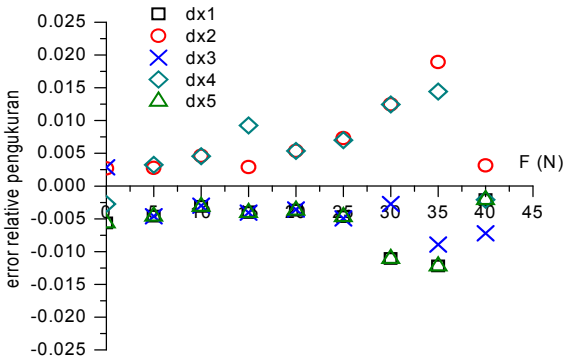

Figure 6. Relative error of measurement.

The measurement test result of the mechanical instrument of data acqusition system (extensometer), especially for the relative error of measurement was depicted in the Figure 6. From data analyzing result, we get the maximum error is about 2%. According the result, data acqusition systems have a good precision.

4. Conclusion

It has built a prototype of data acquisition system based on ATmega2560 microcontroller, data logger and a wireless communication SIM900 Quad-band GSM/GPRS. The results of a performance test which developed shows that information measured data of the moving object (land movement) can be recorded and displayed properly with the relative error maximum measurement is 2%.

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