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Prototype of Telemetry Vibration and Tilt Devices Based IoT (Internet of Think) As an Early Warning of Landslides

Riesa Syariful Akbar[1], Wahyu Kusuma Raharja[2]
[1]Electrical Engineering Master's Program, Gunadarma University, Depok, Indonesian
[2]Electrical Engineering Master's Program, Gunadarma University, Depok, Indonesian
Email address: [1]rsyarifulakbar@gmail.com, [2]wahyukr@staff.gunadarma.ac.id

***Abstract*— *The design of the tool with the many components will be swelling in expenditure and the length of time in the process, another problem is the reading of monitoring can only be seen through the software application from a computer / laptop. So that it cannot be monitored over long distances. Furthermore, prototype design of telemetry equipment can be detected that can detect vibration and slope of land in landslide-prone areas, as well as the ability to measure and transmit data as IoT-based telemetry (Internet of Think) from the sensor position at the test point to web hosting.The sw420 sensor and the mpu6050 sensor will give a command in the form of a voltage of 3.3vdc to 5vdc to the esp8266 nodemcu module. The next voltage sensor is processed into the Arduino Idea program. The input is analog voltage, the program will be coded v = 1000 which will produce an adc data display (analog to digital converter).Information on data that has been uploaded to the esp8266 module nodemc, then the angle x, angle y, angle z, and vibration data are sent over the internet (WiFi), the vibration and slope telemetry results have been presented on the website (http: // monitoring-longsor.000webhostapp.com/index.php). Based on the telemetry testing that has been done, that the sirens and early warning lights will be active if there is a slope at <30^0.*

***Keywords*—** *Sensor sw420; sensor mpu6050, esp8266.*

I. Introduction

According to BNPB data Landslides have occurred in many parts of Indonesia including Karanganyar Regency, Central Java Province (pp. 21-31, 12 images), especially during the rainy season. Landslide disasters that occurred began with the widening of soil cracks, easily fragile volcanic rocks, and with the climate in Indonesia in the form of wet tropical, so the potential for landslides to be high because the cracks widened and cohesion of rocks weakened. Batu City is also one of the areas that are often hit by landslides. According to BPBD data from Batu City, in the period of January 1 to July 31, 2016 in Batu City there have been 62 disasters. [1] So that in order to create an landslide hazard warning system, several other supporting instruments and sensors are needed. In addition, simple methods and the use of low-cost devices are certainly a challenge in creating an effective and accurate warning system (ELEMENTER Journal. Vol. 1 No. 2, November 2015).[3]

II. Design Vibration and Tilt Telemetry

Hardware Design

The design of this tool requires a voltage of 3.3 volts - 5 volts and 12 volts. The SW420 sensor works when there is a vibration and the mpu6050 sensor works when there is a tilt. All sensors will provide information in the form of 3.3v - 5v voltage to the Arduino Esp8266 nodemcu module. After everything is connected, then processing the Arduino IDE application program. The results of processing can be displayed on web hosting, an internet network is required to open a web server page.

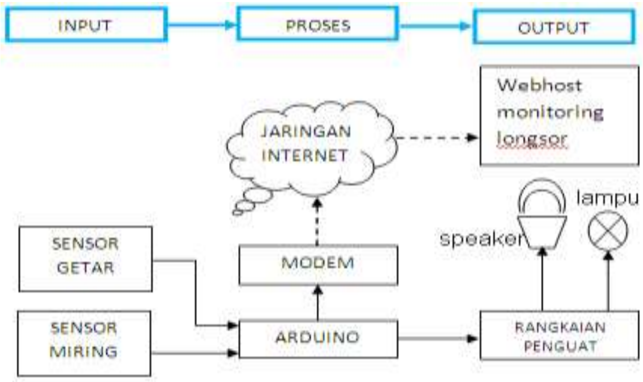

Fig. 1. Hardware design

Figure 2 is a prototype of a vibration and tilt instrument based on IoT (internet of Think) as an early warning of landslide disasters.

Fig. 2. Telemetry vibration and tilt

Software Design

Software from figure 3 as a flow diagram. After getting an internet network, open the web link monitoring-

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longsor.000webhostapp.com. Then enter the initial page, the start page that is presented there are 2 choices, namely monitor and profile. On the landslide monitoring page, changes in numerical data / bite works when the vibration sensor and tilt sensor get instructions from the soil conditions. If there is a widening movement with the steering angle being tested, the siren and warning lights will be active.

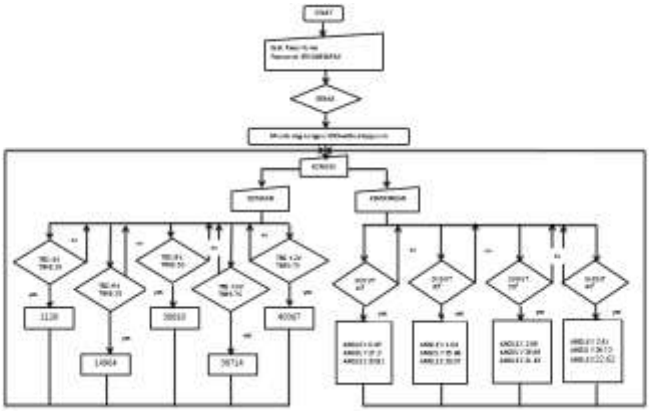

Fig. 3. Prototype flow chart of vibration and tilt telemetry devices

```
#include <Wire.h>
#include <ESP8266WiFi.h>
#include <MPU6050.h>
```

The program block which is a library used in IoT telemetry vibration and slope.

```
const char* host = "monitoring-longsor.000webhostapp.com";
String url = "/add_data.php?";
url += "x=";
url += x;
url += "&y=";
url += y;
url += "&z=";
url += z;
url += "&vibration=";
url += vibration;
client.print(String("GET ") + url + " HTTP/1.1\r\n" +
"Host: " + host + "\r\n" +
"Connection: close\r\n\r\n");
```

The next programming is a condition where the url string will send data in the form of numbers at the angle x, angle y, angle z and vibration. Sent on the host page.

Figure 4 Program vibration and Tilt Software from Figure 4 as a program to communicate from Arduino to web hosting. The web will receive data from devices that are located in the location.

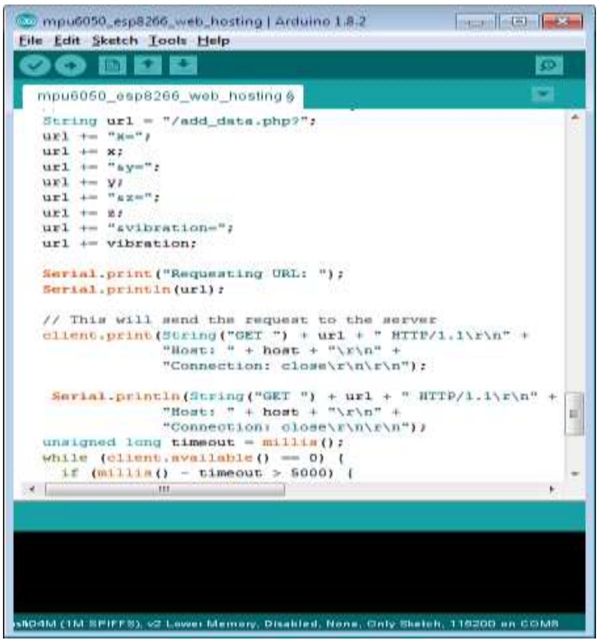

Fig. 4. Program vibration and tilt

III. Testing Tools

The tool that has been made, then it will be tested to get output results that can work in accordance with the research objectives. Figure 5 is a design of prototype IoT (internet of Think) vibration and slope devices as early warning of landslide disasters.

Fig. 5. Tool design

All parts of this tool have functions that support each other. With this IoT-based vibration and wireless telemetry tool, tests will be carried out in the form of measurements, calculations and analyzes including testing of vibration sensors against earthquakes, testing of tilt sensors against the width of the ground cracks, response time when sending data and the overall test results.

Sensor Testing sw420 Against Vibration

Vibration testing is carried out using the sw420 sensor. The sw420 sensor will be supported by a dynamo with a

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voltage of 4 Vdc to 12 Vdc in order to obtain data values from vibration / vibrator. The voltage setting with the time to be tested is shown in Figure 6.

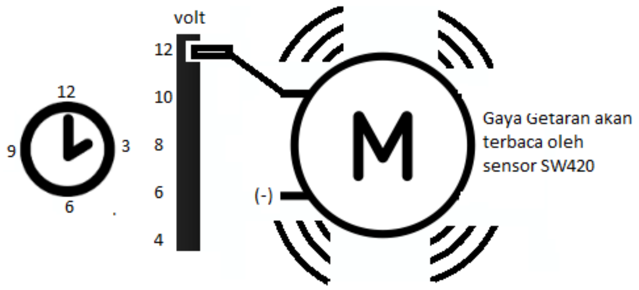

Fig. 6. Voltage settings with time

Settings are made to get the measurement results from the vibration sensor. The result in the form of an adc index will be displayed on the web by selecting a vibrator. Output in the form of data can be seen in table 2.

Testing of Gyroscope Sensor against Slope

Testing of slope is done using the mpu6050 sensor. Testing on the mpu6050 sensor is also supported by dynamo. Measuring the angle of the axis with the arc shown in figure 7.

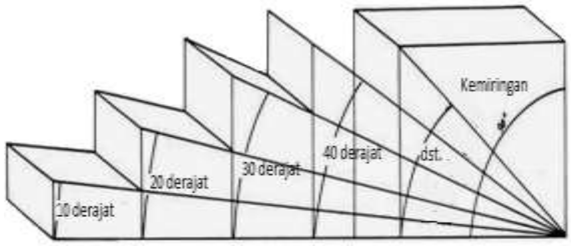

Fig. 7. Measurement of slope angles

Settings are made to get the measurement results from the tilt sensor. The result in the form of an adc index will be displayed on the web by selecting angle x, angle y, and angle z. Output in the form of data can be seen in table 2.

Observation Response Time When Data Delivery

Monitoring the location points tested with the tools that have been made. One thing to note is to observe the capacity and response time when sending data. The webpage presented is (http://monitoring-longsor.000webhostapp.com/ index.php). Observation of response time can use statistics that are presented by webhost with running status. Figure 8 is the value of the esp8266 nodemcu module data transfer to webhosting.

In Figure 8 is a graphical display of data transfers. the graph used to send telemetry data to web hosting for 2 seconds. If the bandwidth runs out, the statistics will increase and the telemetry data transmission will be long. Table 1 is the test results to observe the response time of datatransmission.

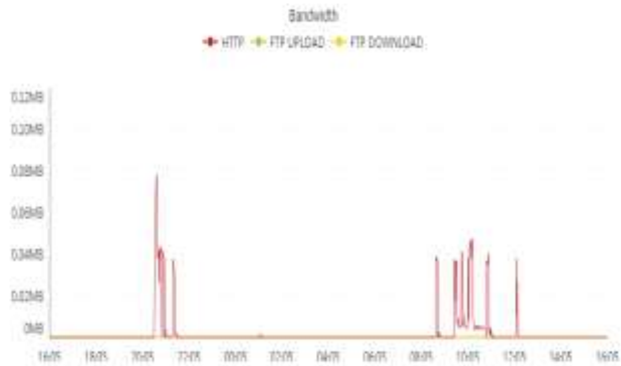

Fig. 8. The esp8266 module data transfer value nods to webhosting

TABLE 1. Observation results response time data delivery

NO.	TIME of TEST (WIB)	TIME SEND (S)
1	19.20	02.4
2	19.30	02.3
3	19.45	05.6
4	19.50	01.3
5	20.00	01.4
6	20.20	03.3
7	20.40	02.4
8	22.00	03.8
9	22.10	03.4
10	22.20	02.9

Analysis of the 10 observations in table 1 can be searched for the average time sent and proved in the results of the image 6. looking for the average value in the calculation below:

$$\overline{X} = \frac{1}{n}\sum_{i=1}^{n} xi$$

= 1/10 (02.4 +02.3 +05.6 +01.3 +01.4 +01.3 +02.4 +03.8 +03.4 +02.9)
= 1/10 (2.88)
= 2.88 second

The results of the calculated average values of the 10 observations in table 1 are 2.88 seconds. Furthermore, the display of data transfer values will be compared with the calculation of observations to determine the magnitude of the relative error.

The process of finding errors relative to the response time when sending data is below.

$$\text{kesalahan relatif} = \frac{\text{nilai terhitung} - \text{nilai terukur}}{\text{nilai terhitung}} \times 100\%$$

$$= \frac{2.88 - 2}{2.88} \times 100\%$$

$$= 0.3\ \%$$

The results obtained a relative error of 0.3%

Test Results for the entire tool

The final result of testing tools is accessing the web to the page (http://monitoring-longsor.000webhostapp.com). The results of the data from the sw420 sensor at the time of vibration and the results of data from changes per 100 angles, for the gyroscope sensor when the slope of the ground will be shown in table 2. The following are the results of testing all the tools in five experiments in table 2.

TABLE 2. Testing the overall tool

No	Pengatur Getaran		Keluaran Sensor sw420	Pengukuran Kemiringan	Keluaran Sensor Gyroscope			Hasil Tampilan Web
	Tegangan Kendali Motor (Volt)	Lama Waktu Putaran Motor (sekon)	Indeks (ADC)	Sudut (^{0})	Angle			
					X	Y	Z	
1	4	3	1128	0	-	-	-	Gambar 4.8
2	6	3	14964	10	0.43	27.2	20.81	Gambar 4.9
3	8	5	30818	20	1.04	25.48	20.07	Gambar 4.10
4	10	7	38714	30	2.06	26.66	21.43	Gambar 4.11
5	12	7	48367	40	2,41	26.72	22.62	Gambar 4.12

Fig. 4.8 Results of display Table 2 No. 1

Fig. 4.9 Results of display Table 2 No. 2

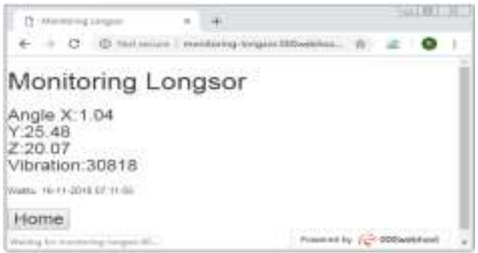

Fig. 4.10 Results of display Table 2 No. 3

Fig. 4.11 Results of display Table 2 No. 4

Fig. 4.12 Results of display Table 2 No. 5

Information on the results of the data in Table 2 can be seen, starting at angle 0^0 just give a vibration 1128. Furthermore, from the slope of 10^0-20^0 that has been identified there are cracks and widening from the ground surface. At 30^0 angles with the help of vibration 38714 buzzers and emergency lights will be activated to provide early warning to the surrounding population. Then a very steep slope occurs at an angle of 40^0 with the help of vibration 48367. In addition to the early warning the adc index data from the sensor will be displayed by web monitoring on IoT-based landslide monitoring page views.

IV. CONCLUSIONS

1. This study has succeeded in designing an IoT (internet of think) vibration and tilt telemetry device as a good avalanche early warning. Vibration and tilt telemetry results have been presented on the website (http://monitoring-longsor.000webhostapp.com).
2. Telemetry is arranged based on several components from the input section using sw420 as a vibration sensor and gyroscope mpu6050 as a tilt sensor. The process section uses the esp8266 nodemcu module, the arduino idea application and webhost app. The output part consists of data angle x, data angle y, data angle z, and data vibration in the form of adc index numbers on the web hosting display.
3. Based on the telemetry testing that has been done, that the siren and early warning lights will be active if there is a slope at$<30^0$.
4. based on observations of the results of the time response pengriman data from the tool to the web display, requires an average time - average 2.88 seconds and the results of the calculation of the relative error between the value of data transfer data with time response observations of 0.3%.

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