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Design of Earthquake Warning Alarm Using Accelerometer Sensor Based on Internet of Things

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Abstract: Earthquake is natural event due to release of energy suddenly from within that creates seismic waves. The vibrations are usually caused by movement of earth's plates. It cannot be predicted when they are coming. Therefore, need to build an early warning system. It is for anticipation of save the community when an earthquake occurs. It provides solutions to minimize the impact of earthquake events. This system uses accelerometer sensor and arduino nano as a main controller and it is accompanied by Blynk application. This works for sent notification via smartphone. This tool has been successfully designed with manual testing to be able to see the sensitivity of earthquake sensor made. Accelerometer sensor works is using Tilt Method. Accelerometer sensor will tilt on surface as parable of earthquake. Accelerometer sensor will send vibration signal when earthquake occurs. Signal processing is done by Arduino nano as the main controller in system. If the signal is received by sensor then value of earthquake will be displayed on LCD screen. Status of earthquake was separated into 4 levels such as standby, alert, dangerous, dangerous and dangerous. After earthquake value appears on the LCD screen and the status is known then buzzer will sound. It indicates that the earthquake warning alarm is properly functioning. Next, NodeMCU also sends information to Blynk application, which is used as a notification and monitoring of earthquake conditions. Buzzer will sound as a warning alarm to notify peoples to save themselves. This sensor has three output coordinate points, namely X, Y, Z, which have analog values on Arduino Nano. This analog value can be converted into Richter Scale. Based on experimental results, an analog value is 100 – 400.

Keywords: Earthquakes, Internet of Things, Accelerometer Sensor, Blynk, Smartphone

1. Introduction

Earthquake is a natural phenomenon that can be caused by human hands or natural disaster. Earthquake is a natural event that cannot be predicted when it occurs. Therefore, earthquake can be known using early warning system. Residential areas close to source of earthquake are very vulnerable areas. Therefore, this is an early effort in anticipating to impact of earthquake and a strategic step to reduce or minimize impact of losses or damage.

Early warning system is a warning for given to community around an earthquake area. This is for immediately action to save themselves, home crashes and animals died.

A lot of researches about early warning system such as an earthquake warning alarm device has a vibration signal in the vertical and horizontal directions using a spring attached to surface of piezoelectric sensor [1, 2]. An earthquake detector is using UGN3503 sensor that conducted an output in alarm sound [3-5]. Earthquake warnings using Faraday position sensors [6-8].

Earthquake is very dangerous because it could be human victims. So we need a tool that can be used for earthquake warnings. How to design an earthquake warning alarm using accelerometer sensor based on Internet of Things (IoT) [9, 10]. This system generates information and be displayed on LCD. User use android device that user will receive a notification in real-time. It is usage of Blynk application. Arduino Nano is the main controller to conduct various components such as button modules, accelerometer sensors and buzzers. Apart from receiving these notifications, it also has other additional features that can remind users to immediately save themselves. Finally, we designed the earthquake warning alarms using ADXL335 accelerometer sensor Based on Internet of Things (IoT).

2. Method

2.1. Components

Components used are Arduino nano microcontroller, NodeMCU ESP8266, ADXL335 accelerometer sensor, LCD 1602 I2C, Buzzer, Box X6, USB cable, PCB Module, Battery Lithium 18570, IC LM2596, Resistor 220 Ohm, Push button switch and wire.

2.2. Step by Step

How earthquake detector works is using Tilt Method [11-13]. Accelerometer sensor will tilt on surface as parable of earthquake [14, 15]. Accelerometer sensor will send vibration signal when earthquake occurs. Signal processing is done by Arduino nano as the main controller in system [16, 17]. If the signal is received by sensor then value of earthquake will be displayed on LCD screen. Status was separated into 4 levels such as standby, alert, dangerous, dangerous and dangerous. After earthquake value appears on the LCD screen and the status is known then buzzer will sound. It indicates that the earthquake warning alarm is properly functioning. Next, NodeMCU also sends information to Blynk application, which is used as a notification and monitoring of earthquake conditions. Buzzer will sound as a warning alarm to notify peoples to save themselves.

If an earthquake is detected by accelerometer sensor and it is known 2-3 in richter scale then buzzer will sound as an early warning alarm. It will appear notifications on Blynk as status “standby”. If parameter is 3-5 in richter scale then status is “alert”. Parameter is 5-7 in richter scale, then status is “dangerous”. Parameter is 7-10 in richter scale, then status is “dangerous and dangerous”.

This warning alarm will sound according to status. It’s more dangerous then alarm sound is longer. It has been programmed in Arduino nano and notification appears on Blynk application. This notification can be monitored by smartphone and it’s guidance about earthquake state.

2.3. Electrical Circuit Schematic

Electrical circuit schematic is shown in figure 1 below.

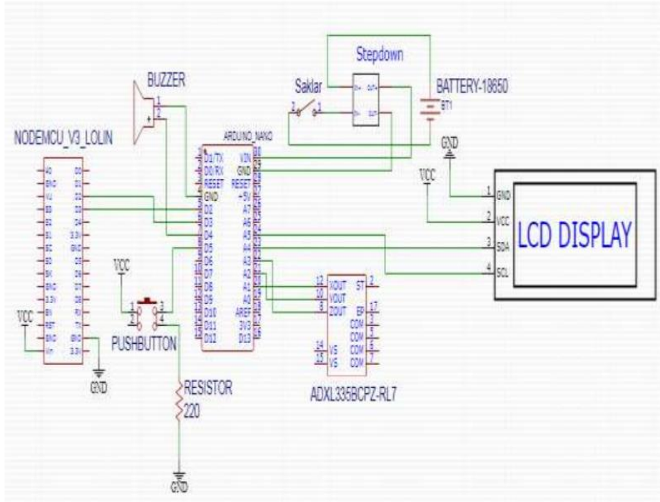

Figure 1 *Electrical circuit schematic*

3. RESULTS

3.1. Testing of ADXL335 Accelerometer Sensor

Testing of accelerometer sensor aims to determine whether sensor can work according to what we want to or not. Testing is also to determine sensitivity of sensor. This testing process is carried out by placing an earthquake warning alarm device on the floor with lay position. Then test sensor by changing slope angle start from 15 degrees, 30 degrees, 45 degrees, and 90 degrees to see changes in Richter scale values. Table 1 is result of accelerometer sensor testing and status is displayed by LCD as figure 2.

Table 1 *Testing of accelerometer sensor*

Slope angle	Status	Richter Scale
0 degrees	-	0
15 degrees	Standby	2-3
30 degrees	Alert	3-5
45 degrees	Dangerous	5-7
90 degrees	Dangerous and Dangerous	7-10

Figure 2 *Status in LCD*

3.2. Testing of Connectivity

NodeMCU ESP8266 connectivity testing is done by running programs. This module see connectivity with wi-fi existing or hotspot. The testing procedure is to activate smartphone hotspot according to the name that has been programmed. Wait a few moments later, if the device's connectivity is successful then on smartphone that used as a hotspot will appear 1 device connected to the hotspot.

The NodeMCU module will receive a notification when a earthquake occurs in an area. If the connectivity is successful, then NodeMCU has works well on the Blynk application and it will appear that Blynk has connected with the NodeMCU ESP8266 Wi-fi module. Device startup notification can be seen in figure 3. Sensor receive vibrations that exceed the provisions of the tolerance value of the earthquake has been determined, then a notification of possibility of an earthquake will appear in figure 4.

Figure 3 *Display when connected.*

Figure 4 *Earthquake warning display.*

3.3. Analysis

The results of testing can be analyzed by using simple statistics to determine the level of accuracy of each component. For analysis of power dissipation data from Arduino nano IC regulator, it can be compared by input voltage so that IC regulator does not high temperatures. The test result is carried out by measuring output voltage and total current by using a digital multimeter.

Analyzing of sensor accelerometer to find out how big percentage of sensor error. Every tilt changes is shown degrees changes. Tilt degrees is converting into richter scale. There are some analog value on every tilt changes. Analog value is on accelerometer sensor. According to experimental, analog value is about 100-400. We deployed in program provided such as:

15 degrees = 100 = 2-3 richter scale
30 degrees = 200 = 3-5 richter scale
45 degrees = 300 = 5-7 richter scale
90 degrees = 400 = 7-10 richter scale

4. Conclusion

ADXL335 accelerometer sensor can be used to detect vibrations in underground caused by earthquakes. This sensor has three output coordinate points, namely X, Y, Z, which have analog values on Arduino Nano. This analog value can be converted into Richter Scale. Based on experimental results, an analog value is 100 – 400. This analog value can be converted into Richter Scale by using MAP program under Arduino IDE Software.

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