Journal ELPER-Tech (Electronic Logic Power- Technology)
Vol.1, No.1, March 2025, pp. 20~26
ISSN (print): __________ , ISSN (online): _________
DOI:

Design of Earthquake Detection System Using MPU6050 and SW420 Sensors with Blynk Platform Integration

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Abstract

Earthquakes are natural disasters that can cause major damage and even loss of life in a short time. Therefore, an early detection system that can provide warnings before an earthquake occurs is very important to reduce the impact of damage. This study aims to develop an earthquake detection tool that utilizes Internet of Things (IoT) technology. This system uses the SW420 sensor to detect earthquake vibrations and the MPU6050 sensor to measure acceleration and changes in orientation. The method used in this study uses the Research and Development (RnD) method, where this research starts from problem identification, system design, to system testing and evaluation. This system uses ESP32 as a microcontroller to process data from sensors and send the data through the Blynk application in real time. The test results show that this tool is able to detect an earthquake when the magnitude reaches a predetermined minimum limit. With this IoT integration, it is hoped that it can increase community preparedness in facing the threat of earthquakes.

***Keywords**—Detection, Internet of Things(IoT), MPU6050, ESP32*

1. INTRODUCTION

Indonesia is a country located along the "Pacific Ring of Fire", which makes it prone to natural disasters, especially earthquakes [1]. High seismic activity in this region often causes significant damage to infrastructure and causes loss of life [2]. Therefore, an effective earthquake detection system is needed to provide early warning to the public so that they can evacuate and reduce the impact of the losses caused.

Along with the development of technology, various solutions in research have focused on the development of earthquake early warning systems to reduce the risk of this disaster. Several previous earthquake detection systems used simple sensor technology such as in previous research entitled "SIGEMPA: IoT-based Earthquake Early Warning System with ESP32" [3] which only used the SW420 sensor as the main component to detect vibrations. However, the challenge is how to create a more accurate system in detecting earthquakes by taking into account various parameters or more complete sensors, such as detectors of changes in slope that occur during an earthquake. Therefore, the development of more complete technology is needed to improve the accuracy and speed of detecting earthquakes.

One technology that can be used to increase the effectiveness of this earthquake detection system is the Internet of Things (IoT). With IoT, sensors, microcontrollers and applications on smartphones are interconnected to provide real-time warnings. In this study, one of the technologies that can be used to detect earthquakes is the MPU6050 sensor, which is able to detect changes in acceleration and rotation in three axes (X, Y, and Z) [4]. This sensor is very effective in capturing movements caused by earthquake vibrations. With this research, it is hoped that it can increase community preparedness in facing the threat of earthquakes.

2. RESEARCH METHODS

The method used in this study uses the R&D (Research and Development) method, which aims to design and develop an earthquake detection system. This method is carried out with systematic steps. As shown in Figure 1 where the water diagram of this study starts from problem identification, system design, to testing and evaluation of the developed system [5]. The data sources in this study come from several journals, websites and literature related to this study.

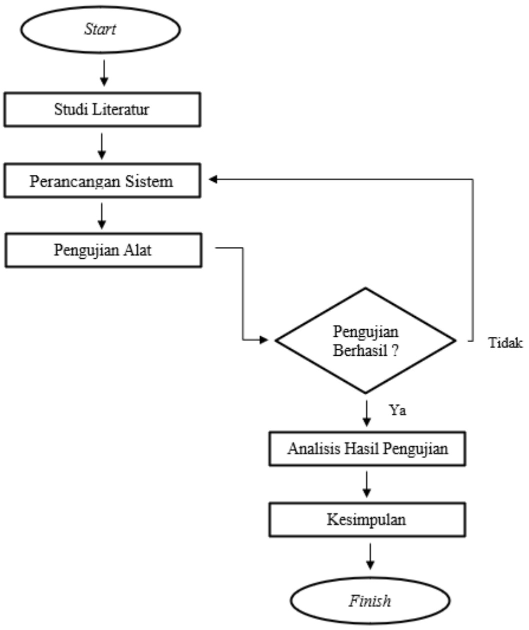

Figure 1. Research flow chart

The earthquake detection system is designed by utilizing several electronic components, this system uses two sensors as earthquake detectors, namely, MPU6050 which functions as a tilt sensor and SW420 as a vibration detector.

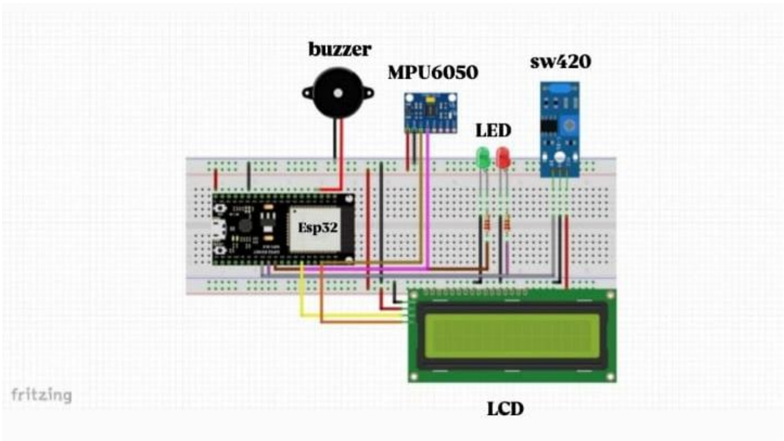

Figure 2. Wiring Diagram

In Figure 2, a wiring diagram is shown that has been created using the fritzing software application, with the aim of facilitating the design and understanding how this tool works. This schematic represents a clear visual form of the connection or relationship between components in this system [6]. By using ESP32 as the main microcontroller that functions to process data from connected sensors [7]. After being connected to ESP32, MPU6050 which functions as a tilt sensor that detects changes in angle [8] and SW420 which functions as a vibration sensor that detects seismic vibrations [9] will send magnitude data to the Blynk application which allows users to monitor conditions in real time [10]. When the sensor detects vibration and tilt, ESP32 will activate the buzzer as a warning alarm, which gives a sound signal to the user and if a large enough vibration and tilt are detected, the red LED component will light up together with the buzzer. In addition, information about the detection status will be displayed on the I2C LCD which presents data visually so that users can easily understand the current conditions [11]. This system is designed to receive power input from a 5V or 12V source.

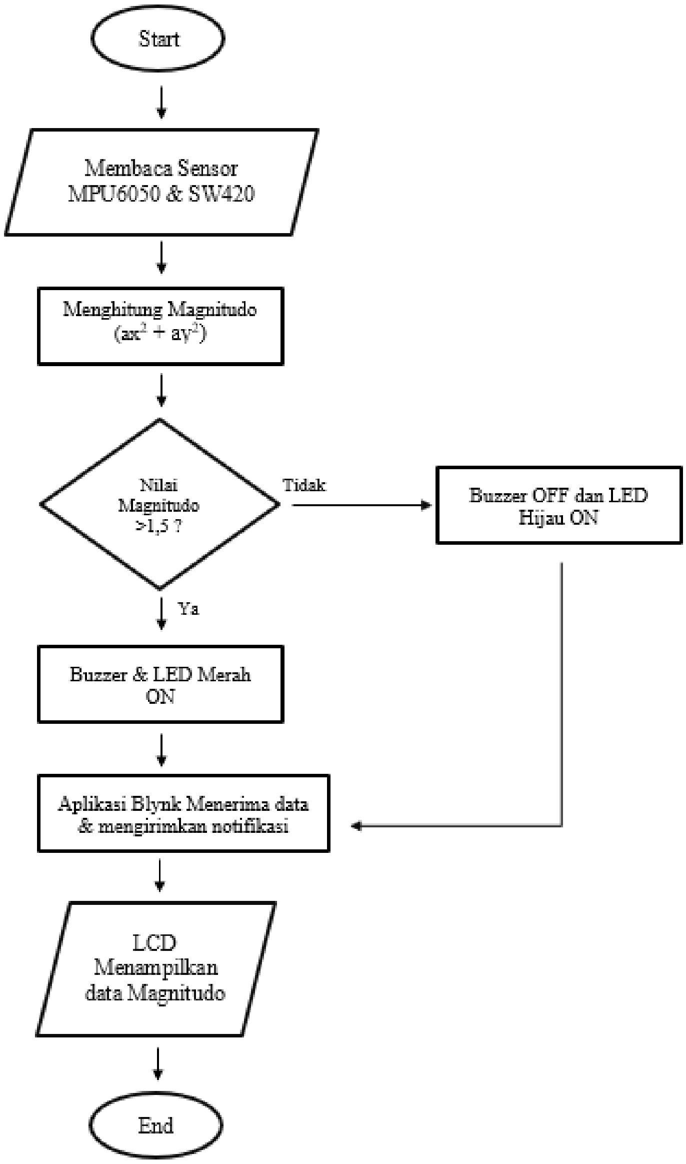

Figure 3. Flow diagram

In the system design in this study, Figure 3 shows the system flow diagram. The work process is explained as follows:

1. Starting with the MPU6050 & SW420 sensors reading or detecting the existing slope and vibration [12].

2. Next, the magnitude calculation process is carried out with the formula (ax2 + ay2).
3. If the magnitude calculation results show more than 1.5, the Buzzer and LED will light up. Conversely, if the calculation results show less than 1.5, the buzzer will not light up and the green LED will light up.
4. After that, the data generated will be received by the Blynk application, then the Blynk application will send a notification in real time to the user.
5. Furthermore, the data that has been obtained will be displayed on the LCD.
6. Process Complete.

4. RESULTS AND DISCUSSION

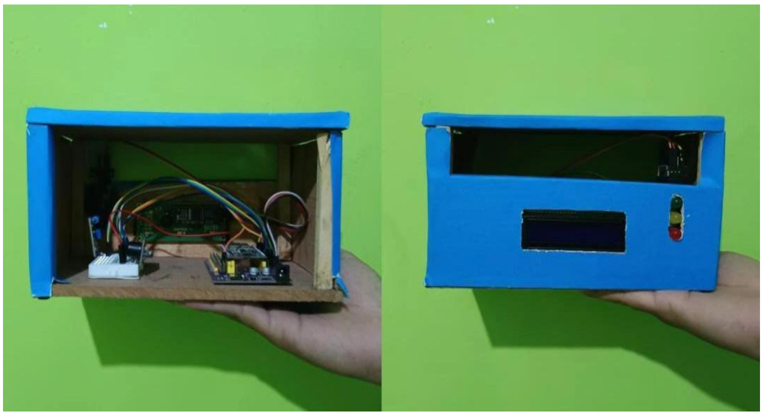

Figure 4. Earthquake Detection System Design

The tool designed in this research has been successfully completed and its functionality tested, the tool can be seen in Figure 4.

System Testing

As previously mentioned, this tool has been tested for functionality, where testing is carried out after the tool is assembled, several indicators of success that are visible include as in Figure 5 shows the Blynk display on a smartphone, it is known that in Figure 5 there is a red LED on and a blue LED on, indicating that vibration is detected and a tilt is detected.

Figure 5. Blynk and system view during an earthquake

When no vibration or tilt is detected, the green LED will light up and the system will send data to blynk as shown in Figure 6. It can be seen that the blynk display will also display a green LED in the application.

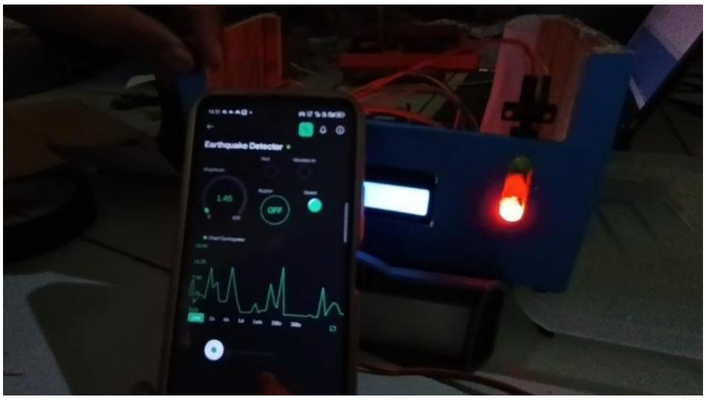

Figure 6. Blynk display when there is no earthquake

Table 1. the result of Testing

No.	Skala Magnitudo (M)	Status Buzzer	Condition
1	< 0.5	Inactive	Small vibration, green LED on.
2	0.5 - 1.0	Inactive	Light vibration, green LED on and no alarm trigger.
3	1.1 - 1.4	Inactive	Weak vibration, green LED on and not trigger alerts.
4	1.6 - 2.0	Active	Vibrations start to be felt, the buzzer sounds and the red LED turns on.
5	2.1 - 3.0	Active	Significant vibration, buzzer sounds and red LED on.
6	> 3.0	Active	Strong vibration, buzzer sounds and red LED on.

Based on the tests that have been carried out, it can be seen in Table 1 that the designed earthquake detection system functions well. Each test is in accordance with the commands carried out on the device. The test results show that when conditions are without vibration, the magnitude value is less than 1.5, the buzzer is not active, in contrast to the results of the last test, where in conditions of tilt and vibration, the system produces a value of more than 1.5 which is where the number causes the buzzer to turn on, this indicates that the system can detect changes in angle and vibration significantly.

Figure 7. Telegram display on previous research results.

Based on previous research data [3], as in Figure 7 using sw420, a telegram notification was obtained with the notification content indicating that there was a vibration. In this study, the author added an MPU6050 sensor to detect tilt or gyroscope, where the results obtained data as in Table 1. Where the test results are more complete because there is information on speed magnitude, earthquake warnings with LEDs and buzzers on the Blynk application.

Results

The results of the tool test show that the MPU6050 and SW420 sensors work effectively in detecting vibrations and tilts that occur during an earthquake. Meanwhile, to process data received from this sensor and send information quickly, a microcontroller is used that can connect the system to the internet, one of which is ESP32. ESP32 has the ability to connect to a Wi-Fi or Bluetooth network, so that data received from the sensor can be sent to other platforms directly. [13]. The earthquake detection system was built using the MPU6050 sensor, ESP32 microcontroller, and Blynk platform. After all devices are integrated, the data obtained from these sensors is then sent to the ESP32 microcontroller via I2C LCD communication and then sent to the Blynk platform via a Wi-Fi connection, allowing data to be viewed in real-time via the Blynk mobile application [14]. This system is also equipped with an alarm that provides a warning to the user if a vibration is detected by the sensor, as evidenced by Table 1. The results of testing this tool show that the combination of these two sensors can significantly increase the accuracy of earthquake detection compared to using only one sensor. With the integration of IoT technology that allows real-time monitoring and early warning [15], this tool is expected to be implemented to support disaster mitigation and provide further benefits in accelerating the response to earthquakes.

5. CONCLUSIONS

This research has succeeded in developing an earthquake detector using the MPU6050 sensor to detect tilt, the SW420 sensor as a vibration detector and ESP32 as a microcontroller to process the data. The tool in this research is also integrated with the Blynk application which allows users to monitor in real time via smartphone. Based on the results of testing the earthquake detection system using the MPU6050 and ESP32 sensors with the integration of the Blynk platform, it can be concluded that it has functioned well according to its main function. This system is able to detect vibrations and changes in tilt accurately. By utilizing Internet of Things (IoT) technology, this system not only detects earthquakes closely, but also remotely. In addition, this system is also an innovative step that can increase earthquake preparedness, especially in areas prone to earthquakes. With this system, it is hoped that the community can be better prepared to face the possibility of an earthquake.

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