

Earthquake Detection System

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ABSTRACT : Real-time identification of earthquakes is very important. It may save valuable lives. In this project, an earthquake detection system is developed. The system consists of two parts: a mobile application for notifying or monitoring the earthquake and an embedded framework (physical device) for detecting earthquakes. The system required to place the physical device on the earth's surface for sensing the vibration pattern during earthquakes. The device developed will use a WIFI module (ESP8266 development board) that transfers earthquake (vibration) data from the sensor MPU6050 to the LCD screen. The purpose of this project is to make the precedent of an easy-to-use earthquake detector hatch that can easily and safely be installed in any household for little cost while giving accurate details as well as the potential for scalability and upgrades. It also shows the potential of IoT devices such as the ESP8266, which is used in this project.

I. INTRODUCTION

Earthquakes are among the most devastating natural disasters that can occur on Earth. They can cause widespread destruction and loss of life, making it critical to detect them as quickly and accurately as possible. Earthquake detection systems are designed to do just that, using a range of sensors and algorithms to detect seismic activity and provide advance warning of potential earthquakes.

Recent incidents such as the earthquake in Haiti in August 2021 and the earthquake in Mexico in September 2021 have once again highlighted the urgent need for effective earthquake detection systems. These earthquakes resulted in significant loss of life and damage to infrastructure, emphasizing the importance of early detection and warning.

The importance of earthquake detection systems cannot be overstated. Early detection can provide a crucial time for people to evacuate buildings and take other safety measures, reducing the risk of injury and loss of life. It can also help emergency responders prepare for potential earthquakes and minimize damage to infrastructure and property.

This research paper aims to provide an overview of earthquake detection systems, including the different types of systems, their advantages and disadvantages, and the technical details of their design and implementation. The paper will also present the results of a study on a specific earthquake detection system, analyzing its performance and limitations. Finally, the paper will conclude with recommendations for future research and improvements to earthquake detection systems.

Overall, this research paper highlights the significance of earthquake detection systems in mitigating the impact of earthquakes and improving public safety, especially in light of recent incidents.

II. LITERATURE REVIEW

- [1] UrEDAS, the Earthquake Warning System: Today and Tomorrow Yutaka Nakamura, Jun Saita (1988): UrEDAS, Urgent Earthquake Detection and Alarm System, is the first real-time Pwave alarm system in practical use in the world. It is able to process digitized waveforms step by step without storing the waveform data. As the amount of processing does not differ whether or not an earthquake occurs, system failure due to overload will not occur. Here, the present condition of the P-wave early detection system UrEDAS is viewed under working conditions and the results of test observations where faults exist are also reported. Then a new real-time data processing system for the new generation will be considered.
- [2] RTQUAKE, A Real-Time Earthquake Detection System Integrated with SEISAN by T. Utheim, J. Havskov, M. Ozyazicioglu, J. Rodriguez, and E. Talavera (2014): RTQUAKE consists of a series of independent

modules written in C using OpenGL and GD (Boutell) for graphics. The trigger-recording module RTDET is the core module. The user can choose to run the RTDET module only, which is sufficient for the detection and recording of the events. RTDET receives data from one or more SeedLink servers. Triggering can be done with selected channels using standard short-term average/long-term average (STA/LTA) triggering on filtered traces, and a standard network detector is used to declare an event. The network detector will declare an event when a certain number of triggers are present within a given time window, the array propagation window (APW). The network detector includes the option of delayed triggering in the case of delayed data from the acquisition systems in the network. The delay can be up to one hour. This will of course is not a good solution for alarm systems, but delayed signals from different stations will be processed in a delayed time window, and event data saved if it arrives within the delayed time. The corresponding waveform file with user-selected channels (MiniSeed format) is then extracted from the SeisComp archive (several if reading from more than one SeedLink server) and stored in a SEISAN database together with the corresponding trigger times, and the data is immediately ready for further manual or automatic processing.

- [3] UrEDAS, URGENT EARTHQUAKE DETECTION AND ALARM SYSTEM, NOW AND FUTURE Yutaka NAKAMURA (2004): UrEDAS, Urgent Earthquake Detection, and Alarm System, can realize the real-time early earthquake detection and alarm system in the world. There is a local government that has realized a tsunami warning system using real-time estimated earthquake parameters as magnitude and location, distributed by UrEDAS. On 26th May 2003, the Miyagiken-Oki Earthquake occurred. It was so large that a maximum acceleration of about 600 Gal was observed along the Shinkansen line and 23 columns of the rigid frame viaducts (RC) were severely cracked. This earthquake occurred during the business hours of the Shinkansen. As expected, coastline “Compact UrEDAS” along the Shinkansen took out the early P-wave alarm before the destructive earthquake motion and the validity of this system was proved for the first time.
- [4] EARS (Earthquake Alert and Report System): a Real-Time Decision Support System for Earthquake Crisis Management Marco Avvenuti, Stefano Cresci, Andrea Marchetti, Carlo Meletti, Maurizio (2014): Social sensing is based on the idea that communities or groups of people can provide a set of information similar to those obtainable from a sensor network. Emergency management is a candidate field of application for social sensing. In this work, they have described the design, implementation, and deployment of a decision support system for the detection and damage assessment of earthquakes in Italy. Their system exploits the messages shared in real-time on Twitter, one of the most popular social networks in the world. Data mining and natural language processing techniques are employed to select meaningful and comprehensive sets of tweets. They then applied a burst detection algorithm in order to promptly identify outbreaking seismic events. Detected events are automatically broadcasted by this system via a dedicated Twitter account and by email notifications. In addition, they have mined the content of the messages associated with an event to discover knowledge of its consequences. Finally, they compared their results with official data provided by the National Institute of Geophysics and Volcanology (INGV), the authority responsible for monitoring seismic events in Italy. The INGV network detects shaking levels produced by the earthquake, but can only model the damage scenario by using empirical relationships. This scenario can be greatly improved with direct information site by site. Results show that the system has a great ability to detect events of a certain magnitude, with relatively low occurrences of false positives. Earthquake detection mostly occurs within seconds of the event and far earlier than the notifications shared by INGV or by other official channels.

III. METHODS AND TOOLS USED

The earthquake detection system utilized several hardware components, including an ESP8266 microcontroller, an MPU 6050 sensor, a Node MCU WiFi module, and an OLED display. The ESP8266 first initialized the MPU 6050 sensor and then checked the sleep mode and clock signal from the module before starting to read the values. The system declared maximum and minimum values and checked if the value was greater or smaller than the desired values. If the values were abnormal, the system triggered the buzzer, LED, and displayed the message "Earthquake" on the OLED display.

The ESP8266 microcontroller had a dual-core 32-bit LX6 microprocessor with a clock speed of 160 or 240 MHz, 320 KiB RAM, and 448 KiB ROM. The microcontroller also had a built-in ultra-low power co-processor and wireless connectivity features such as Wi-Fi 802.11 and Bluetooth v4.2 BR/EDR and BLE. In addition, it had 34 programmable GPIOs, an SDIO/SPI slave controller, and an Ethernet MAC interface with dedicated DMA, among other features.

The MPU 6050 sensor had a built-in 16-bit AD converter and 16-bit data output. The sensor was designed to operate at a voltage of 3-5V DC and communicated using the I2C/IIC protocol. The gyro range of the MPU 6050 was ± 250 , 500, 1000, or 2000 °/s, while the accelerometer range was ± 2 , ± 4 , ± 8 , or ± 16 g.

The Node MCU WiFi module had a 2.4 GHz Wi-Fi (802.11 b/g/n) supporting WPA/WPA2 and had 16 general-purpose input/output (GPIO) pins. The module also supported the I²C serial communication protocol, 10-bit ADC, SPI serial communication protocol, and I²S interfaces with DMA. The module had UART on dedicated pins, and a transmit-only UART could be enabled on GPIO2. The module also supported pulse-width modulation (PWM).

The OLED display utilized an SSD1306 OLED driver IC and had a resolution of 128 x 64. The display had a visual angle of greater than 160° and displayed an area color of white. The display was compatible with both 3.3V and 5V I/O levels, and only two I/O ports were needed to control it. The display was fully compatible with Arduino and had a working temperature range of -30°C to 70°C. The display interface used the I2C protocol.

The software requirements for the earthquake detection system included Proteus, Arduino IDE, and NodeMCU, while the programming language used was C and C++. The device specifications for the system included an operating voltage range of 2.2 to 3.6V, an operating current of over 240mA, a temperature range of -40°C to 125°C, and a built-in 802.11 b/g/n Wi-Fi.

Overall, the earthquake detection system is a simple yet effective solution for detecting and alerting people in the event of an earthquake. It combines low-cost hardware components with open-source software to create a system that is easy to build and customize. With the widespread availability of the hardware components and the ease of programming the system, it is an accessible solution for anyone interested in building an earthquake detection system.

The following libraries are used in the code: Adafruit Mpu6050, Adafruit Bus IO, and Adafruit Unified Sensor. These are the libraries that the MPU6050 sensor uses in the Arduino IDE environment. SSD1306 This is the library that the OLED display uses in the Arduino IDE environment.

The ESP8266 sends sensor readings periodically as events to the browser. When the client receives those events, we want to place the readings on the corresponding HTML elements. The gyroscope readings are a String in JSON. Once an event is instantiated, we can start listening for messages from the server. When new gyroscope readings are available, the ESP8266 sends an event to the client and we need to listen to it. For the cube 3D movement, we use a renderer based on the gyro rotation, with our accelerometer being the cube itself. For the accelerometer and temperature reading, HTML is used to display the data on the HTML page using the said EventListener above. We also need to declare the reset button, which we also need to create a function. After everything is done, we insert our network credentials from the WI-FI router in the code. After the code is run, we will connect

and receive an IP from the subnet of the router, on which the web server will be hosted. Note that to access the server from a browser, we need to connect with a device connected to the same WI-FI and check if the IP address received by said device is also from the same subnet.

IV.FIGURES

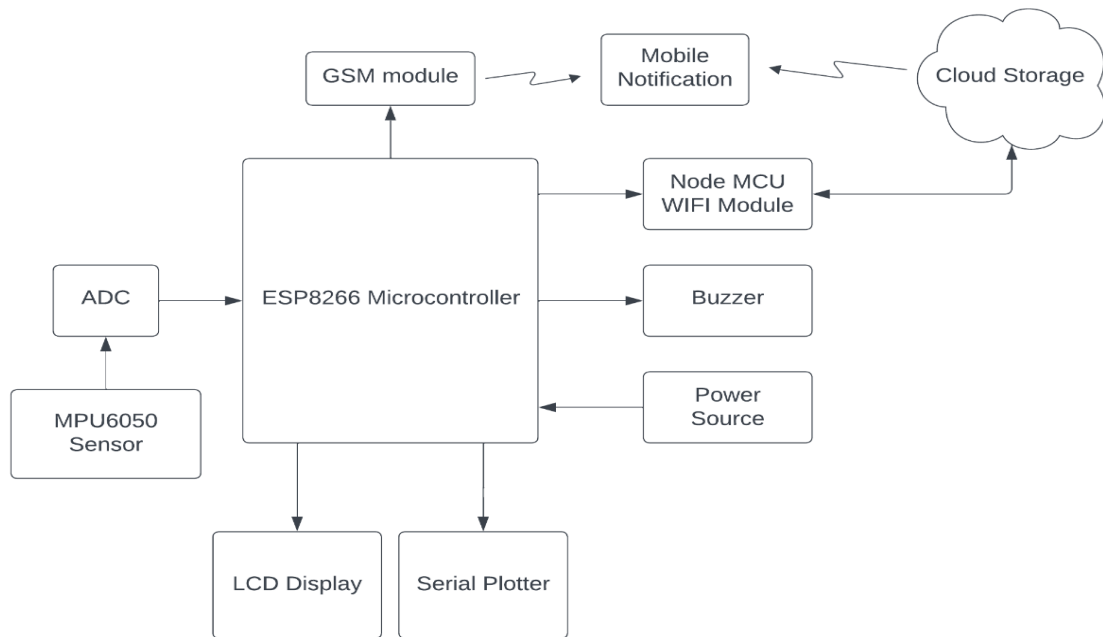


Fig. 1 Block Diagram

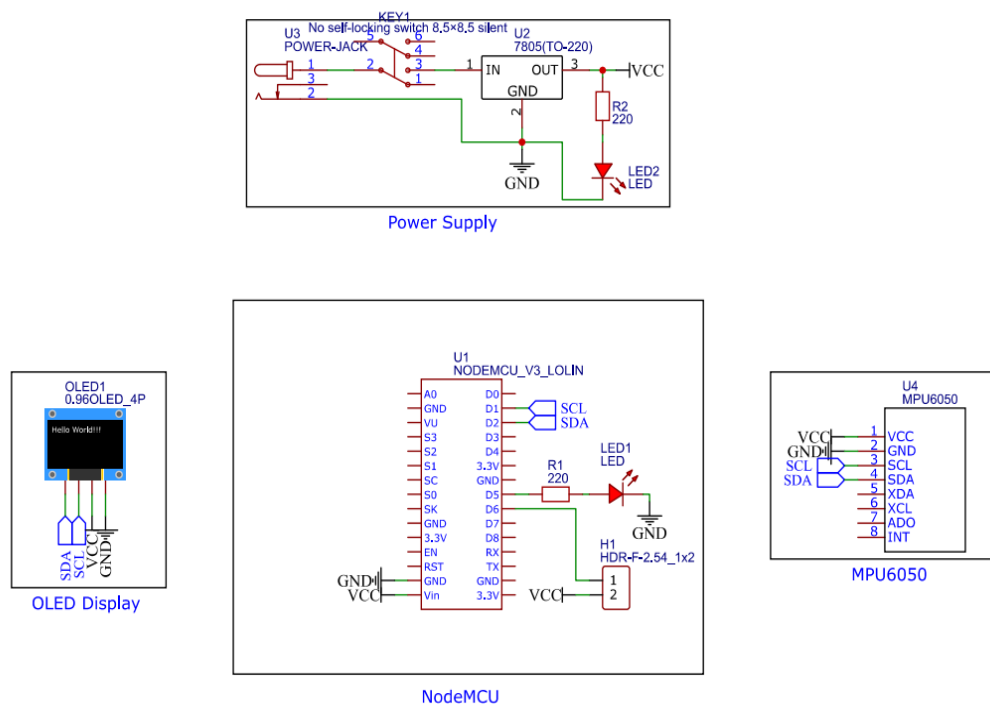


Fig. 2 Circuit Diagram

V.RESULT

MPU6050 sensor is designed to give a digital output of vibrations and movement is received when a certain amount of vibrations/movement is provided to it. When the EARTHQUAKE DETECTION SYSTEM is working, the ESP8266 microcontroller reads the reading provided by the MPU6050 sensor and provides a digital output. This digital output is connected to OLED which displays the intensity of the earthquake i.e., the number of vibrations formed. And when the reading goes above a certain range, the buzzer goes off. Input provided to the system will include video input, image, or voice notes, this input language can be in English or sign two words at the same time. Depending on the need, give the output in the desired language or output type, whether audio or text. We will be able to collect up to ten words at a time to form a text message and read it. The project's end result is an interface that allows people with disabilities to especially easily communicate with people with disabilities.

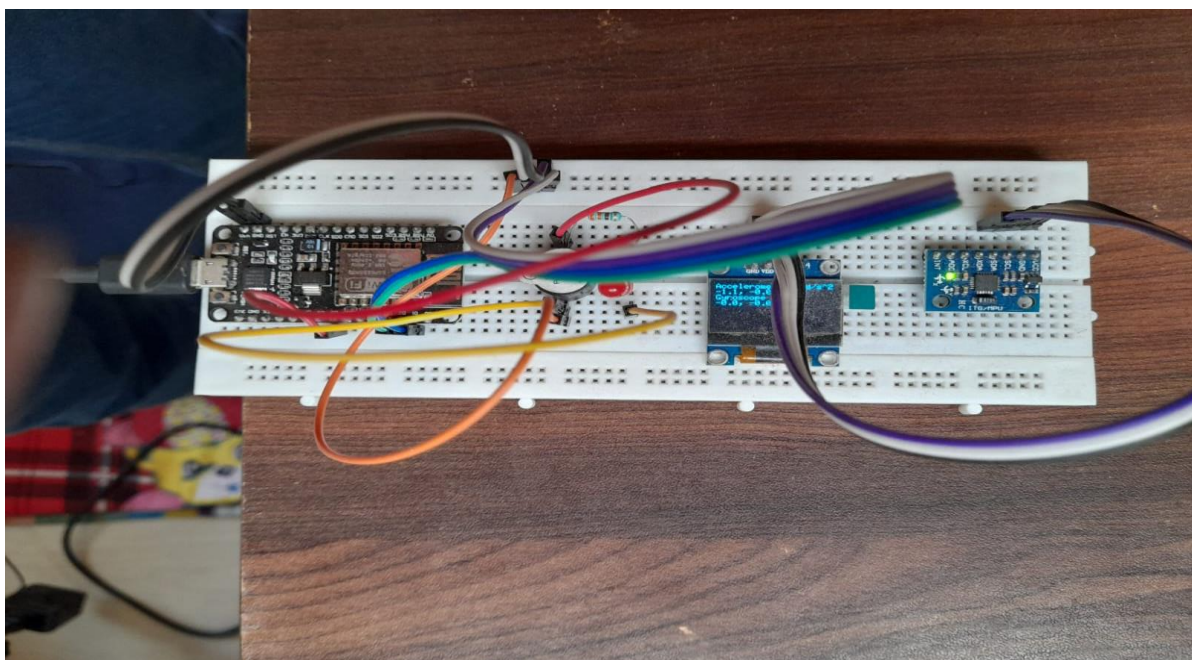


Fig 2. Earthquake Detection System

VI.CONCLUSION

Earthquake detectors are called seismometer which is basically used to detect and measure motions of the ground caused due to seismic waves from an earthquake. Earthquake detector basically helps to alarm human beings about an upcoming earthquake so that we can take some precautionary action to prevent both human lives and extensive damage to property. Thus, to sum up, we have introduced this project with a view to reducing the destruction caused by an earthquake, by alerting the people. It is economical and its price is quoted in such a way that it is affordable and convenient.

VII.ACKNOWLEDGEMENTS

This project and the research that accompanies it would not have been possible without the exceptional support of our instructor, Dr. M. B. Mali. He was always there to push us a little bit to get the job done on time and on time. He always gave us the freedom to do our thesis and the opportunity to work under her guidance. We greatly appreciate the help of Dr. M. B. Mali, HOD, Faculty of Electronics and Telecommunications, and all staff have allowed us to continue our project work in the required university laboratories and use the necessary tools for the project. judgment. We would like to express our sincere gratitude to the Principal, Dr. S. D. Lokhande for his invaluable support and trust in us.

VIII. REFERENCES

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