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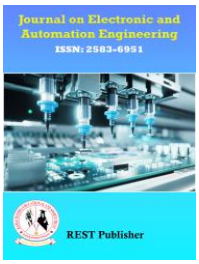

An Efficient High-Performance GSM-Based Earthquake and Cyclone Alert System by using ARDUINO

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Abstract: *The earthquake and cyclone are dangerous natural disasters that are unpredictable, which causes damage to lives and property. It happens all of a sudden, but we can alert from it. In this modern world, many modern technologies can easily analyze the small vibrations and knock so that we can take the necessary precautions. The usage of accelerometer ADXL335 paves the way to sense the earthquake vibrations and cyclone seismic waves in all three axes. This project setup includes the LoRa and GSM module in addition to the accelerometer. Hence, it acts as a perfect shield because it gives a warning, vibration graph on the computer and spread the warning via messages. Every year thousands of people die because of earthquake occurs in a dangerous place or during a defenseless sleep. Here's a GSM-based seismic alert system that could warn before an earthquake strikes. Earthquakes strike without warning. The resulting damage can be minimized and lives can be saved if people living in the earthquake-prone area are already prepared to survive the strike. This requires a warning before strong ground motion from the earthquake arrival. Such a warning system is possible because of energy wave released at the epicenter of the earth quake travels slower than light. The warning signal from the earthquake epicenter can be transmitted to different places using satellite communication network, fiber-optics network, pager service, Cell phone services or a combination of these. The satellite-based network is ideal when an alert system has to cover a large country like India. For earthquake-prone states like Gujarat, a seismic alert system using the global system for mobile communication network spread throughout the state is proposed here. This system does not try to find the epicenter or fault line caused by the earthquake. It simply monitors the earth vibrations and generates alert signal when the level of earth vibrations crosses a threshold. The Earth consists of the crust and outer mantle layer, thus the outer mantle layer consists of seven humongous plates and many timid ones that fit together like puzzle pieces. When these pieces slip over or move unsequentially, huge energy is released as an earthquake. Earthquakes that happen at undersea results in the form of mighty cyclones. These tectonic shifts also result in the creation of volcanoes, mountains and also play a role in the redrawing coastlines. According to the sources, there are over 5,00,000 earthquakes in which 1,00,000 of them were felt in a year. When the magnitude of the earthquake reaches 7 or greater, it results in a major catastrophe. These natural calamity setbacks. The nation several years back by crushing the nation's economy and destroys the lives of people without any prior warning. This stresses the importance of this project.*

Keywords: *seismic waves, reporting of cyclones and earthquakes, LORA module, accelerometer sensor, GSM module.*

1. INTRODUCTION

The Earth's outer structure consists of the crust and the upper mantle, which together form the lithosphere. This layer is divided into seven massive tectonic plates and numerous smaller ones that interlock like puzzle pieces. When these plates shift or move unexpectedly, immense energy is released, causing earthquakes. Underwater earthquakes can generate powerful cyclones, while tectonic movements also contribute to the formation of volcanoes, mountains, and even changes in coastlines. According to sources, over 500,000 earthquakes occur annually, with approximately 100,000 of them being strong enough to be felt. Earthquakes with a magnitude of 7.0 or higher often result in widespread devastation. These natural disasters can cripple economies and destroy countless lives without warning, emphasizing the urgency and significance of this project.

2. BLOCK DIAGRAM

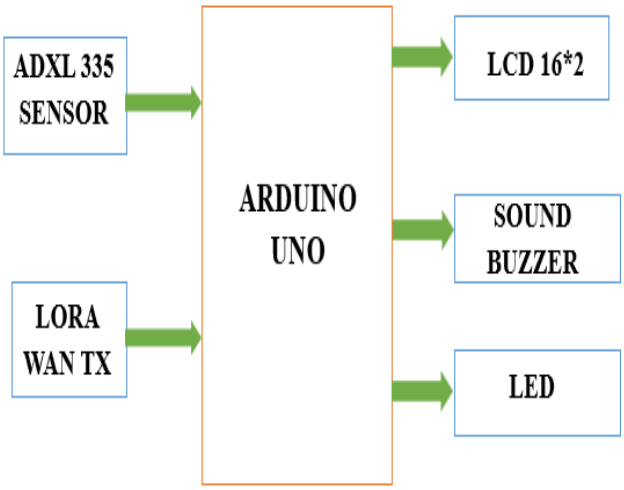

FIGURE 1. Transmitter

FIGURE 2. Receiver

3. HARDWARE COMPONENTS

ARDUINOUNO:

Arduino is an open-source electronic platform that combines easy-to-use hardware and software. It can receive inputs and generate outputs, such as activating a motor or blinking an LED. These actions are executed by programming a microcontroller using the Arduino programming language and the Arduino Integrated Development Environment (IDE) [1]. The Arduino operates at a voltage of 5V, as shown in Figure 3. It has 2KB of RAM, 32KB of flash memory for storing programs, and 1KB of EEPROM for storing parameters. The microcontroller runs at a clock speed of 16 MHz. The board features 14 digital I/O pins and 6 analog input pins, making it versatile for various applications. Arduino can be powered via a USB connection or an external power source, such as an AC-DC adapter or battery. The external power supply can range from 6V to 20V.

FIGURE 3. Arduino UNO

ADXL 335 SENSOR:

Accelerometers are used to measure acceleration. The acceleration is defined as the rate of change of the velocity of an object. They are used to sense static or dynamic forces. The former one includes gravity, while the other one Includes vibrations and movements [2]. Their usage ranges from vehicle acceleration to seismic activity. There are many types of accelerometers, namely:

- Piezo electric accelerometer
- Quantum (Rubidium atom cloud, laser-cooled)
- Resonance
- Seat pad accelerometers
- Shear mode accelerometer
- Strain gauge
- Surface acoustic wave (SAW)
- Surface micro machined capacitive (MEMS)

It can measure the acceleration in three-dimensional axes. Accelerometers consist of capacitive plates, some of them are interconnected to a timid spring that will be in motion when the force acts on it[3]. Hence, the capacitance among them changes which paves the way to find the acceleration. It will give us the output in three forms such as analog, digital and pulse width modulation as well. It is alow-power device. The required current will be in micro or milli-amp range and supply voltage of 5 volts or less.

Pin Description of accelerometer:

X-OUT, Y-OUT, Z-OUT: These pins provide associate degree Analog output of x, y and z directions respectively.
ST Pin: This is used for the sensitivity of the device.
GND: It denotes the ground.

LED: A Light-Emitting Diode (LED) is a semiconductor device that emits light when an electric current passes through it. The light emission occurs due to the recombination of electrons, which releases energy in the form of photons. The color of the emitted light depends on the amount of energy released during this process. LEDs offer several advantages. They produce light in a specific color without the need for color filters, making them more efficient. Additionally, LEDs are compact in size, energy-efficient, and have a long lifespan compared to traditional lighting technologies.

LORAWAN: LoRa (Long Range) is a wireless communication technology primarily used for long-range transmission with minimal power consumption. It has a significant impact on the Internet of Things (IoT) sector, offering reliable connectivity for remote IoT and Machine-to-Machine (M2M) applications. LoRa is particularly effective due to its radio interface design, which allows it to receive extremely weak signals, enabling long-distance communication [4].

Lora's modulation and radio interface are specifically optimized to support the type of low-power, long-range communication required for remote IoT nodes. Although initially developed by Semtech, its open standard has enabled widespread adoption by various companies, leading to increased engagement, a broader range of products, and overall growth in usage key Features of LoRa Technology.

Range: Approximately15–20 km

Components of LoRa Technology:
LoRa PHY / RF Interface: The physical layer (PHY) plays a crucial role in transmitting and receiving signals between endpoints. It defines key aspects such as frequencies, modulation formats, power levels, and signal processing between transmitters and receivers.
LoRa Protocol Stack: In addition to the physical layer, the LoRa Alliance has developed an open protocol stack that facilitates seamless communication. The availability of an open-source protocol has helped in expanding LoRa's adoption by various companies, making it a cost-effective and easy-to-deploy solution for connecting IoT devices.
LoRa Specification (LORAWAN): L0RAWAN is the network architecture that includes system design, backhaul connectivity, servers, and application layers [6]. It allows LoRa-enabled devices to operate over long distances while maintaining efficient power usage.

4. APPLICATIONS AND ADVANTAGES

LoRa technology is widely used in both indoor and outdoor environments due to its long-range and low-power capabilities. It enables easy deployment of new nodes, ensuring scalable network expansion with minimal effort.

- Smart agriculture
- Industrial automation
- Smart cities
- Environmental monitoring
- Asset tracking

With its strong communication range and energy efficiency, LoRa is well-positioned as a key technology for IoT applications.

5. SOFTWARE

Arduino IDE: Arduino IDE permits the user to perform real-time operations by writing and uploading the codes in ceitis open-source that makes easy to use. It is available for a wide range of operating systems such as MAC, Windows, and Linux. It accepts Java Platform as well. It is gifted with many in built functions that help in debugging and to compile in the environment. It also holds others alient features as we can easily share any details with others. We are not restricted in changing the schematics when required. It also has guidelines for installation for beginners. Battery Life: More than 10 years Low Power Consumption Highly Scalable for IoT Networks

Processing: Processing is easy to use since it is open-source. It helps building the graphical interpretation of the result. It mainly designed for the student community who were not programmers, to create a visual context. It uses java along with the computer program for graphs which paves the way for Simplified execution and compilation. It additionally permits users to form their categories at intervals the Applet sketch. This enables complicated knowledge sorts that will embrace any variety of arguments.

6. WORKING

This setup is user-friendly and efficient. The accelerometer sensor used in this system is highly sensitive, allowing it to detect seismic activity and even minute vibrations. It measures vibrations in three dimensions. Due to variations in sensor readings, an average of multiple data points is considered for accuracy. When the calculated value exceeds the predefined threshold, a primary alert is displayed on an LCD screen [7][8][9]. The LoRa module facilitates wireless communication by enabling transmission and reception of data. Depending on the configuration, the LoRa module can function as either a transmitter or a receiver. The GSM module is responsible for sending final alerts to users via SMS, ensuring timely warnings.

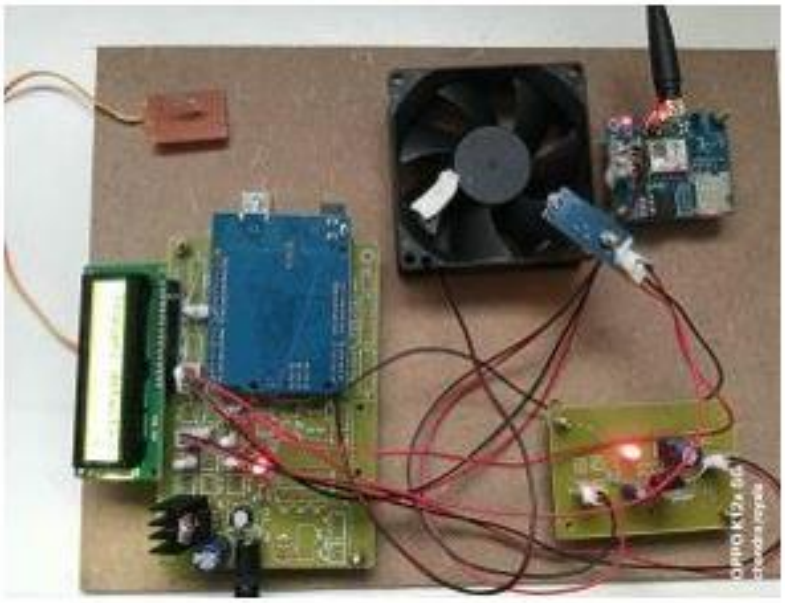

FIGURE 4. Project setup for earthquake and cyclone detection

This system is highly reliable and efficient, as it enables direct communication with users without intermediaries, as illustrated in Figures 4 and 5 [10]. By leveraging LoRa and GSM technology, this setup ensures a fast, long-range, and real-time alert system for seismic monitoring.

FIGURE 5. output of the earthquake and cyclone detection.

7. RESULT AND DISCUSSION

This project has many options to add further modifications and to update the project to a whole new level. We can develop it into a mobile application. By this, we can widespread the news of the threat. In this paper, the LoRa module provides a viable solution to warn the people. With the cooperation of the government, we can implement this project on a large scale. Due to this, we can save the lives of people and government properties as well.

8. FLOWDIAGRAM

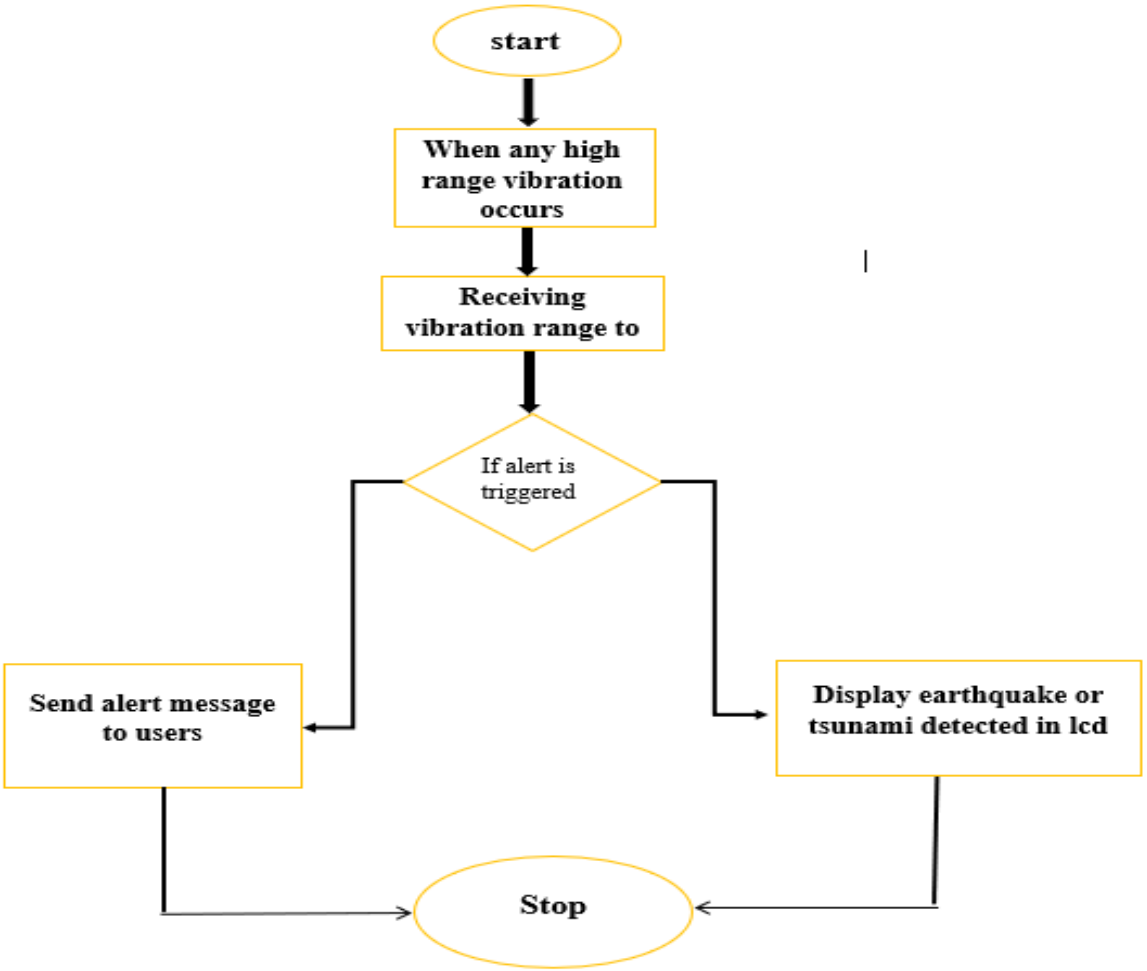

FIGURE 6. Flow Diagram

As per the figure 6 the flow diagram helps to understand the concept easily. The below flow diagram depicts the function of transmission and receiver respectively. In this operation, accelerometers read the seismic waves continuously and transmit the data to the receiver. If the data goes beyond the threshold range, it will alert the people via LCD, LED, and buzzer or text messages based on the setup.

9. CONCLUSION

To summarize, we have introduced this product with the goal of reducing destruction caused by earthquakes and cyclones by providing timely alerts to people. It is cost-effective and priced affordably so that it is accessible to everyone. We have proposed a novel approach for the automated detection and classification of seismic activities in a single step using an Arduino-based earthquake and cyclone detection system. Our system offers practical benefits in most cases, helping to protect lives and resources during such disasters. We have proposed a novel approach for the automated detection and classification of seismic activities in a single step using an Arduino-based earthquake and cyclone detection system. Our system offers practical benefits in most cases, helping to protect lives and resources during such disasters.

REFERENCES

[1]. Charland, and Priest. 1995. Inventory of Critical and Essential Facilities in the Earthquake or Cyclone Hazards in the coastal areas.
[2]. Cox, D.C Bulletin of the Seismological Society of EastAmerica53 (6):1191-1209.
[3]. Heaton, T.H., and Hartzell. 1987.Earthquakehazardsinthesubduction zone. Science 236(4798):162-168.

[4]. Atwater, 1987. Evidence for great earthquakes along the outer coast of North AmericaScience236 (4804):942-944.
[5]. Balaban, V. 2006. Psychological assessment in disasters and emergencies. Disasters 30(2):178-198.
[6]. The geologic setting, field survey, and modeling. Paradiploid Geophysics 154(3-4):513-540.
[7]. Blaustein Carver, G. 2008. Paleo seismicity and nature of the neotectonics of the subduction zone: An overview. Geophysical Monograph 179:43-63.
[8]. Intergovernmental Oceanographic Commission. 2008. A Pacific-wide Cyclone Warning and Communication Exercise Pacific, United Nations Educational, Scientific and Cultural Organization.
[9]. Johnson, D., and P. Borgelt. 2005. Measuring cyclone preparedness incoastal areas, United States. NaturalHazards35 (1):173-184.10
[10]. Jarvenpaa,S.L, andD.E.Leidner. 1999.Communicion in virtual teams. Organization Science 10(6):791-815.
[11]. Gregg,C.E.,B. Houghton, D. Paton,D. Swanson, andD.Johnston. 2004. Community preparedness for lava flows from volcanoes. Bulletin of Volcanology 66(6):531-540.