Earthquake Detection and Alerting System

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***Abstract** - This paper offers a brief summary of my group's Earthquake Detection and Alerting System project. As Earthquakes pose a serious threat to human life.They are caused by seismic waves, which are caused by a sudden release of energy in the Earth's crust. Earthquakes can be so powerful that they can throw people around and kill whole cities. Earthquakes, as we all know, are a natural occurrence that cannot be prevented.However, if we do not take appropriate action to tackle it, it can be extremely dangerous. Furthermore, seismometers can be used to track earthquakes, but they are very expensive. As a result, there should be a mechanism in place that can detect an earthquake without the use of a seismometer and warn the DMT and residents.*

Key Words: **DMT, Seismometer, Earthquake, Alert, IoT, Safety, Accelerometer**

1. INTRODUCTION

Despite many advances in science and technology, natural laws cannot be ignored. Nature has compelled scientists to consider or foresee certain natural disasters. Earthquake is one of the most destructive natural events, posing a significant danger to areas near active faults on land or offshore subduction zones. Earthquakes occur when a significant volume of energy is emitted unexpectedly from the earth's crust. The earth produces destructive seismic waves as a result of this force. Shear waves, longitudinal waves, and surface waves have all been discovered to be seismic waves .P-wave and S-wave are the terms for longitudinal and shear waves, respectively. The surface wave is the most destructive of all waves in nature, but it travels at a slower speed than the other waves. The vibration path and forward motion of the P-wave was found to be identical, making it the fastest wave in existence. The destructive force of the P-wave, on the other hand, is found to be low. Earthquakes pose a significant threat to human lives as a result of urbanisation. Many research projects for earthquake prediction are still ongoing. As a result, our system focuses on earthquake detection and alerting the emergency response team, as well as providing a safe route for residents.

1.1. LITERATURE SURVEY

In a paper by Sanjib kalita and J.N. Borole, the authors used ATmega328p as a micro controller, accelerometer ADXL335 and XBeeS2 for wireless connectivity. Here, The earthquake shock is detected using an accelerometer by looking at the ADXL335's X, Y, and Z axes[1].

A system made by Pradeep Khatwa , Gurav Ingle , Rameshwar Shinde uses similar concept of detecting the earthquake using a microcontroller. But they also used GSM modem for wireless mobile communication[2].

N.K.Wargatiwar, A.S. Barbade, A.P. Shingade, and A.N.Shire wrote a paper that was used to monitor the wireless earthquake warning design using MEMS accelerometer. The vibration travels through the earth's crust. "Earthquake warning researched in this paper was based on the powerful motion observation theory adopted MEMS accelerometer and wireless transmitting technology, was more advanced and realistic device" to solve earthquake disaster caused by building structure[4].

The system designed by Wenxiang Jiang, Haiying Yu, Li & Lei Huang uses robust algorithm for the automatic earthquake detector. "A strong-motion seismograph records real-time acceleration data and detects earthquakes. To sniff events, this event detector compares the short-term average (STA) and long-term average (LTA) with a threshold value (THR).The algorithm is robust enough to operate in situations where there is a lot of noise, such as an earthquake, lightning, falling weight, or traffic. The results of the paper show that the algorithm could be used to support high-speed trains, nuclear power plants, and special factories that cannot tolerate false triggers. This algorithm is simple enough to be used in low-power computers like embedded systems[5]."

Burak Ozbey, Ozgur Kurc, Hilmi Volkan Demir, Vakur B. Erturk, and Ayhan Altintas engineered wireless monitoring of a standard reinforced concrete beam that is seen in a simply assisted beam experiment in their paper. "The passive nested split-ring resonator (NSRR) probes are attached on the reinforcing bars (rebar's) within the beam, and the probes are interrogated from outside the beam by an antenna. The results of the experiment show that the wireless sensing device can detect plastic deformation strain/displacement. After earthquakes, the data obtained by the machine can be seen[6]."

1.2. PROBLEM DEFINITION

How might we solve the lack of safety measures taken by the residents which leads to injury, health issues and loss of life."

2. PROPOSED SYSTEM

The proposed system is based on safety measures for the people who are living in earthquake prone area or region. Our system will work on earthquake vibrations collected by accelerometer and alert the people nearby region. Also notify through mobile application by notification and providing safety route to escape from earthquake region. It will also send the alert messages to the DMT and nearby hospital for rescue. This system have a mobile application which give people faster interaction and escape route from the area. After conducting various interviews with the stakeholders related to the topic, we have proposed a problem statement i.e "How might we solve the lack of safety measures taken by the residents which leads to injury, health issues and loss of life" Looking at this problem statement, the main objective of our proposed system is to solve these lack of safety measures taken by the residents.

2.1. WORKFLOW

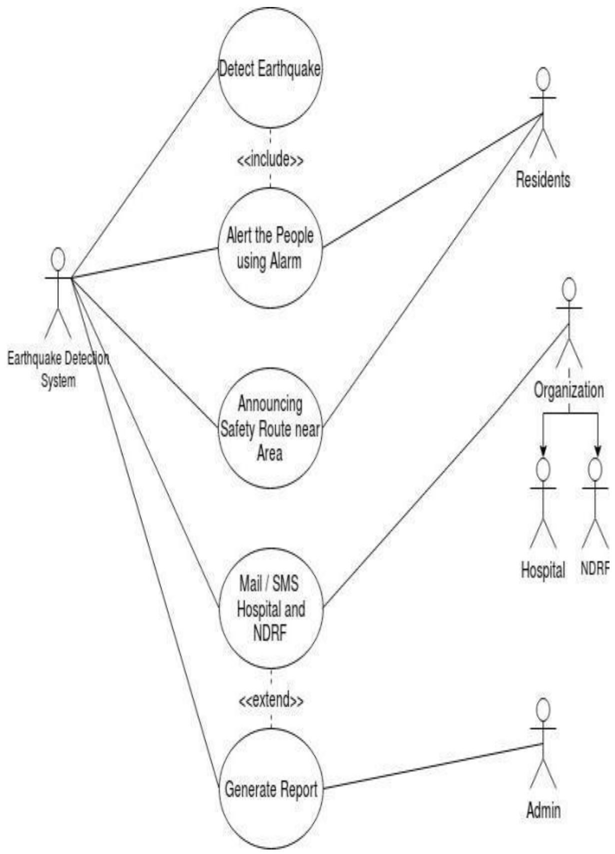

Fig. 2.1.1: workflow of proposed system

2.2. IMPLEMENTATION METHODS

After doing some customer and market research, that is, by taking interviews of the stakeholders like residents, builders, engineers etc. which are related to our project, we found out that there was a lack of knowledge about safety path in residents that where to go when earthquake occurs. Some residents were unaware about what safety measures they should take to avoid the loss of their lives. They were also not connected to any disaster management teams directly if any earthquake occurs. Also, ambulances are less in number and they are informed little late, so they come late.

COLLECTION OF REQUIRED COMPONENTS:

Firstly, try to find out the components which are required to complete this system and purchase them. We require components like Arduino, accelerometer, LED light, ESP8266.

CONNECT THE COMPONENTS:

We need to firstly connect all the hardware requirements to the microcontroller; in our case it's Arduino UNO. Connections should be done properly as shown in the circuit diagram.

CONNECT THE SYSTEM TO THINGSPEAK SERVER:

We need a server so that we can monitor data remotely and also we can use that data to show the residents after creating an app. So we have used ThingSpeak server. To use it, we firstly need to have an account on the thingspeak website. After creating account we will create one channel with three fields to monitor data from X,Y and Z axes of ADXL335. Now we can use created channel's API in our code and also in our mobile application as well.

CREATING WEBHOOK ON IFTTT:

For sending an email, create respective webhook on IFTTT website and use its url to make http request with the help of ThingSpeak.

CREATE AN MOBILE APP:

Create a mobile app using MIT app inventor for alerting the residents by providing the safety direction so that they can take a safer path.

WRITE AND RUN THE PROGRAM:

Write the code correctly in Arduino IDE and upload it in Arduino Uno. Now you are done, the system will start detecting the earthquake, sending the data to server, sending email to DMT's if earthquake occurs and alerting the people on the mobile app by providing safety path.

DESIGN DETAILS:

A. ARDUINO UNO:

The Arduino Uno is a microcontroller board based on the ATmega328P microcontroller.It has 14 digital input/output pins (six of which can be used as PWM outputs), as well as 6 analog input/output pins. A USB link, a power jack, an ICSP header, and a reset button are among the features. It comes with everything you'll need to get started with the microcontroller; simply plug it into a device with a USB cable or power it with an AC-to-DC adapter or battery.

B. WIFI MODULE ESP 8266:

The ESP8266 is a low-cost Wi-Fi microchip that includes a complete TCP/IP stack as well as a microcontroller.This small module allows microcontrollers to bind to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands.Since the ESP8266's maximum voltage is 3.6V, it has an onboard 3.3V regulator to ensure that the IC receives a stable and reliable voltage. That means the ESP8266's I/O pins are also 3.3V, and any 5V signals going into the IC must be Logic Level Controlled.

FEATURES INCLUDE:

Processor: Tensilica Xtensa Diamond Standard 106 Micro-based L106 32-bit RISC microprocessor core running at 80 MHz.
Memory:
32 KiB instruction RAM
32 KiB instruction cache RAM
80 KiB user-data RAM
16 KiB ETS system-data RAM

C. ADXL335 3-AXIS ACCELEROMETER:

The famous ADXL335 three-axis analog accelerometer IC is used in this Accelerometer module, which reads the X, Y, and Z acceleration as analog voltages. An accelerometer will determine the angle it is inclined at with respect to the earth by calculating the amount of acceleration caused by gravity.

The accelerometer will determine how quickly and in which direction the system is going by detecting the amount of dynamic acceleration. You can make a number of fun projects with these two assets, including musical instruments (imagine playing and making the tilt attached to the distortion level or pitch-bend) and a velocity monitor for your car (or your kids' car).The accelerometer connects to an Arduino Microcontroller through three analog input pins, and it can also be used with other microcontrollers like the PIC or AVR.

The basic connections needed for most accelerometers' operation are power and communication lines. Accelerometers with an analog interface show accelerations as voltage levels change. These values fluctuate between ground and supply voltage levels in most cases. This value can then be read using an ADC on a microcontroller. These are less costly than digital accelerometers in general.

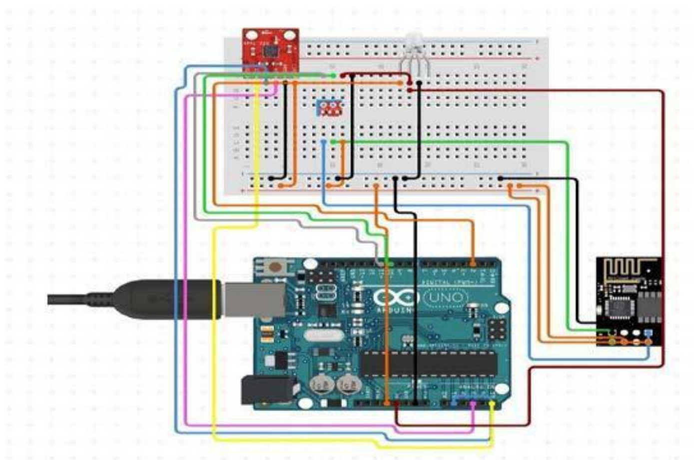

Fig 2.2.1: Circuit Diagram

2.3. RESULT AND DISCUSSION

Before Earthquake Detection:

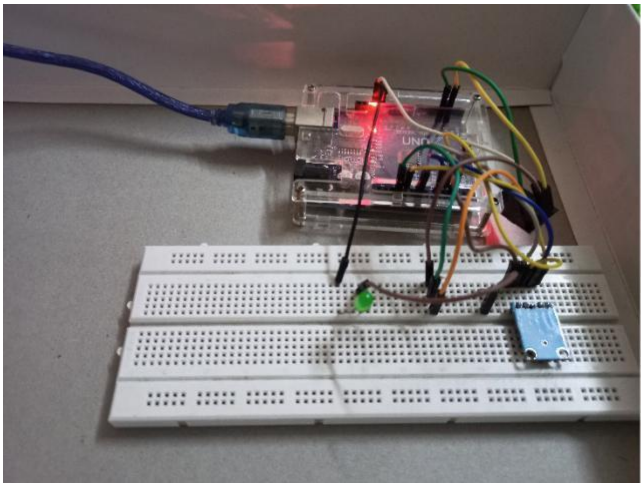

Fig 2.3.1: Led off

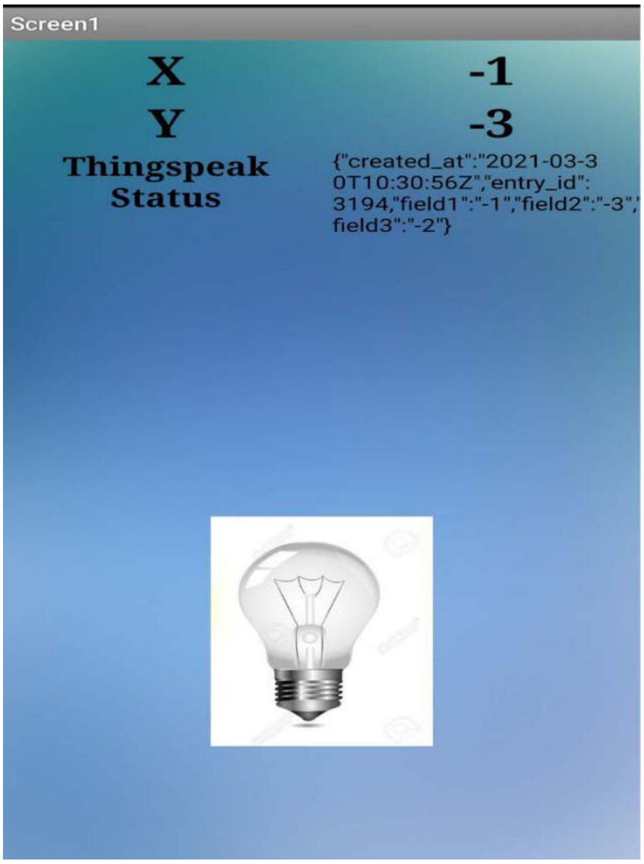

Fig 2.3.2: No Safety Path

After Earthquake Detection:

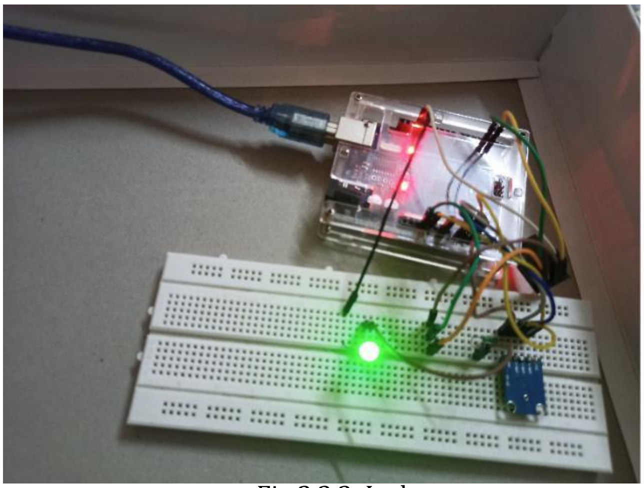

Fig 2.3.3: Led on

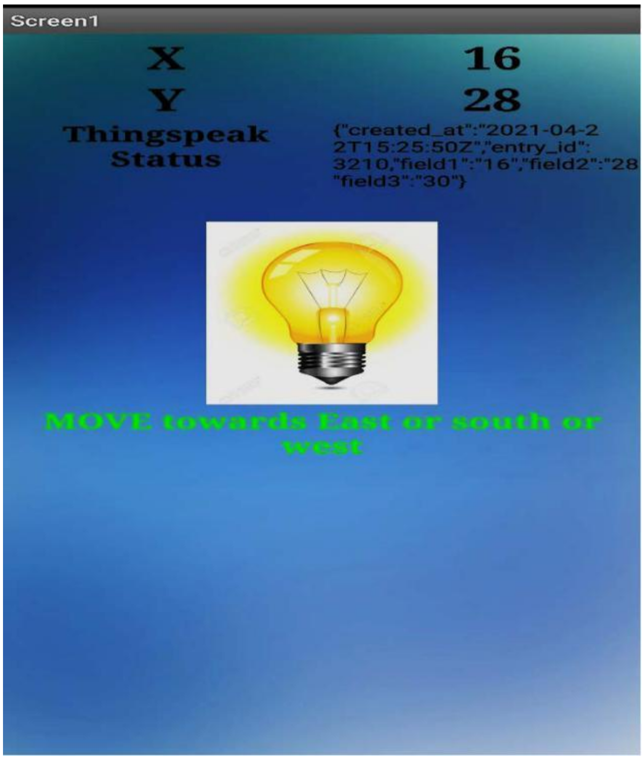

Fig 2.3.4:Safety Path

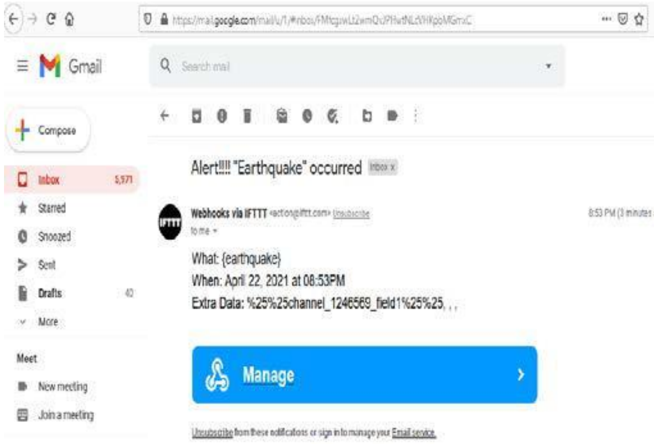

Fig 2.3.5: Email Received

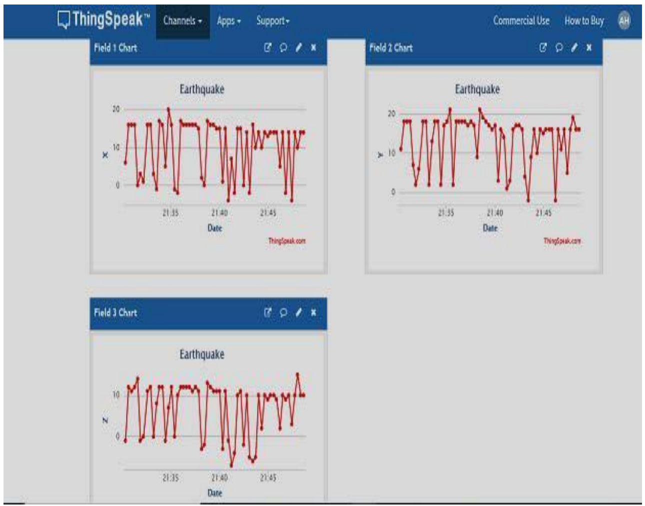

Fig 2.3.6: Thingspeak Monitoring

3. CONCLUSION

There are many researches carried out on early warning system of earthquake, but none of the system is perfect. Escaping from earthquake is the main challenge when it occurs. At that time, providing the best escaping route is very important.

The proposed system focuses on more efficient way to detect the earthquake with alerting DMT and providing safety measures to residents.

REFERENCES

1. Sanjib kalita, J.N Borole and Dr. K.P Rane (June 2014) "Wireless earthquake alarm system using Atmega328p ADXL335 and XBee S2"

2. Prof. Pradeep khatwa, Gaurav ingle, Rameshwar Shinde, Ajay Sane (Feb 2018) "Earthquake alarm system based on advanced wireless GSM modem"

3. Allen (1978) "Automatic Earthquake Recognition and Timing from Single Trace". Bulletin of Seismic Society of America.

4. N.K.Wargantiwar , A.S.Barbade (January 2017) "Wireless Earthquake Alarm Design based on MEMS Accelerometer"

5. Wenxiang Jiang , Haiying yu , lei huang (March 2015) "A Robust Algorithm For Earthquake Detector"

6. Burak Ozbey, Ozgur Kurc, Hilmi Volkan Demir, Vakur B. Erturk, and Ayhan Altintas (August 2017) "Wireless Monitoring of a Structural Beam for Post-Earthquake Damage Assessment"

7. Poslad S, Middleton S.E., Chaves F., Ran Tao Necmioglu O and Bugel U (June 2015) "A Semantic IOT Early Warning System for Natural Environment Crisis Management"

8. Fischer J, Kühnlenz F, Ahrens K, Eveslage I(April 2009) "Model-based Development of Self-organizing Earthquake Early Warning Systems"

9. Yih-Min Wu; Kanamori, H. (June 2008) "Development of an Earthquake Early Warning System Using Real – Time Strong Motion Signals"

10. Richard M. Allen, Paolo Gasparini, Osamu Kamigaichi and Maren Bose (September 2013) " The Status of Earthquake Early Warning around the World: An Introductory Overview"

11. Sanjib Kalita, J.N.Borole (Feb 2016) "Application of MEMS Accelerometer To Consumer Electronics"

12. Adam Pascale (July 2009) "Using Micro-Electro Mechanical Systems(MEMS) accelerometers for Earthquake monitoring"