



Development and Fabrication of Earthquake Alarming System

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ABSTRACT: The proposed system involves the development and fabrication of an earthquake alarm and to display the nearest muster station to evacuate the person/ human to avoid injuries and fatalities. In the developed system accelerometer ADXL335 is implemented to sense the vibrations of earthquake created by S-waves and the send the analog signal to the programmed controller using Arduino Uno. The controller coding is so developed that it stimulates the other circuitry when the output of accelerometer reaches the threshold value of 5.4 magnitude level of Richter scale. The proposed system is installed in the Electrical Engineering department of Dr. B. R. Ambedkar Institute of Technology, Port Blair, Andaman & Nicobar Islands. The developed and installed system is tested by creating virtual vibrations using vibration platform on which accelerometer is mounted. The test results are found satisfactorily when the vibrations reach the threshold magnitude level by producing warning alarm and display the nearest muster station.

KEYWORDS: Vibration sensor, Earthquake detector, Warning alarm, Accelerometer, Panel Board Display

I. INTRODUCTION

Earthquakes, storm overflows, rains, snow, etc. are a natural disaster. The outbreak of this disaster is falling on some part of the world. There are many animals who are victims of this disaster. The loss of life and property resulting from it is only estimated. This is because its effects are unlimited and uncertain. As a result, it is difficult to say with certainty about it. Therefore, nature is unpredictable.

Scientists have given many reasons for earthquakes. Two of them are mainly due to tectonic causes and non-reversible causes. Accordingly, earthquakes occur due to the pressure of the Earth, that is, the temperature is much lower and more at a much deeper depth within the Earth. As a result, the pressure on its inner layers is very high and it is low. Where the pressure is high, it sometimes increases a lot. Sometimes it gets so much that the inner rock of the earth starts to break due to the movement of the movement. Its effect starts on the upper rocks. As a result, the rocks begin to slide. During the process of moving, earthquakes occur.

An earthquake is an inevitable and unpredictable natural phenomenon that often causes damage to lives and property. Humans can't fight with it but can stay alert and aware using the technology that can protect and alert the society. On the occurrence, earthquake produces seismic waves that travels through the earth surface causes underground explosion, volcanic eruptions and man-made explosions.

Seismic waves are mainly two types: body and surface waves. Former travels through earth surface and later travels along earth surface. Body wave are further classified as P-wave and S-wave and surface waves are classified as Love and Rayleigh waves.

P-waves are longitudinal waves that cause very little damages, where S-wave is more dangerous and slower and cause a ground shake back and forth perpendicular to the direction of the wave is traveling.

Earthquake scientists say that no such instrument has been developed so far that it is known that earthquakes are going to happen in such and such areas. At the time of the earthquake, only its capacity can be measured on the 'Richter Scale'. Scientists have built seismic houses. The government should formulate an effective policy to initiate the process of construction of 'earthquake-resistant' houses in earthquake-proof areas of India.

In this work, an attempt has made to develop and fabricate an alarming system to detect earthquake and other seismic activities. The propose system examines the magnitude level of earthquake vibrations and activates the audible alarm when it exceeds the threshold value. The threshold value is set at magnitude level of moderate category of earthquake.

II. LITERATURE REVIEW

Vineetha et.al.[1], suggested that the Accelerometer module is based on the popular ADXL335 three-Axis Analog Accelerometer IC, which reads X, Y and Z Acceleration as analog voltages. By measuring the amount of acceleration due to gravity, an accelerometer can figure out the angle it is tilted at with respect to the earth. TejasTurakhia and

Dharmesh C Prajapati et.al.[2], suggested an instrumentation system for the detection of the variation which consist of a sensor which in coupled to an embedded system to enable precise detection of variation in physical parameters. This helps us to interface it with the microcontroller through the related software & send an alarm in the parameters exceed beyond certain threshold.Saddam et.al.[3], proposed a system which detects the vibration in earth and sounds an alarm. In this he uses accelerometer ADXL335 to detect the pre- earthquake vibration. The accelerometer is highly sensitive to vibration along with all the 3 axes.Veenu Grover&Amansharma et.al.[4], design a model to predict earthquake. In this accelerometer ADXL335 has been used in combination with Arduino Uno (Atmega 328) the ADXL335 sense the vibration from all the directions X, Y & Z. The ADXL335 is a low power, complete 3 Axis accelerometer with signal conditioned voltage o/p & can measure static & dynamic acceleration. Programming for the controller is carried out using the software Arduino.Pushan Kumar Dutta et.al.[5], proposed a study involves design & development for the earthquake alarm detection circuit based on electronic devices only which will helpful for the determination of high frequency variations which will trigger on impulse when S wave is detected by the earthquake sensor.

III. BLOCK DIAGRAM OF A PROPOSED SYSTEM

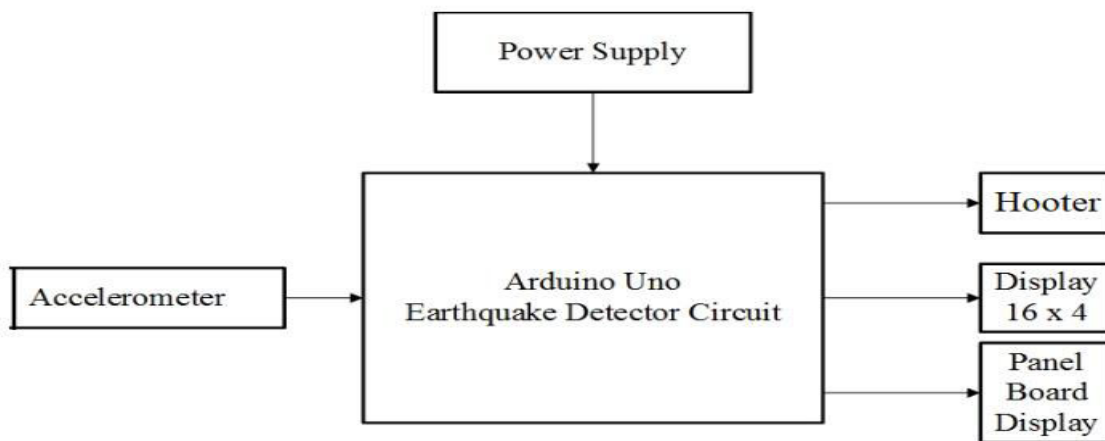


Figure.1: Functional Block Diagram of a System

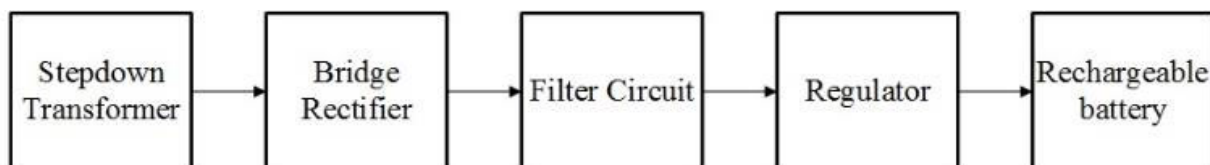


Figure.2: Functional Block Diagram of a Power Supply

Block Diagram Description:

Accelerometer ADXL335:

An accelerometer is an electronic sensor device that measures force, shock, vibration and acceleration. In this work, accelerometer ADXL335 has been used and is highly sensitive to knocks and vibrations. ADXL335 transducer converts an analogue voltage signal to equivalent imposed acceleration. It has three outputs X, Y and Z axis. The outputs of an accelerometer send a signal to the Arduino Uno ADC pins.

Arduino Uno:

The Arduino UNO is a microcontroller board based on the AT mega328 operates on external powersupply or via USB connection. The external power can be provided through an AC-DC adapter or through a battery.The board can operate on an external supply of 6-20 Volts. If the supply is less than 5Volts, the board may be unstableIf using more than 12Volts the voltage regulator may over heat and damage the board. Therefore, the recommended range is 7-12 volts. It has 14 input/ output digital pins, out of which 6 provide PWM output. It also comprises of 6analog pins (i.e. from A0-A5), 6 power pins, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP (In-Circuit Serial Programming), TX/RX LEDs, “TEST” LED 13 and reset button.

Hooter:

Earthquake alarming system produces a sound to warn the human on ground shaking during the earthquake. For this, a hooter is chosen which operates on 12V, 1200mA supply with power rating of 20Watts & 123db sound.

LCD Display:

In this work, LCD display is used to display the threshold adjustment and making the system user friendly. A 16 x 2 LCD is connected in 4-wire mode with Arduino pins contrast control and backlight enabled.

Panel Board Display (PBD):

PBD is an indication which activates and indicates the humans during evacuation of building to reach the safest nearest muster station. The PBD is prepared using red lights used for decoration which are cheaply and easily available. The prepared PBD is installed in the premises of Electrical Engineering department and the nearest muster station is PDME ground. This is an indication for the faculty of the department to evacuate and gather at PDME ground which is an open area.

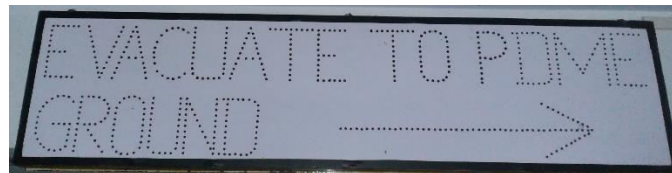


Figure.3: Installed Panel Board Display

Vibration Platform:

During earthquake, seismic waves travel along the Earth’s surface. The propagation velocity of seismic waves depends on density and elasticity of the medium as well as the type of wave. The vibration platform is made up of wooden board. It consists of two wooden board, one is the base which is hooked along the wall and on the upper board accelerometer is mounted.

During earthquake, the top most floor of a building is more sensitive to the vibration as in compare to the ground floor, so vibration platform is hooked at height of 2.5 meter from the floor.



Figure.4: Pictorial view of Vibration Platform

IV. SYSTEM OPERATION

The developed and fabricated earthquake detection system operates on 9 Volts DC power supply or through a battery. A rechargeable battery with charging circuit is incorporated as during major earthquake condition, the Service connection power gets disconnected. At that condition the system will operate through battery. The circuit diagram for proposed system is shown in the figure.5.

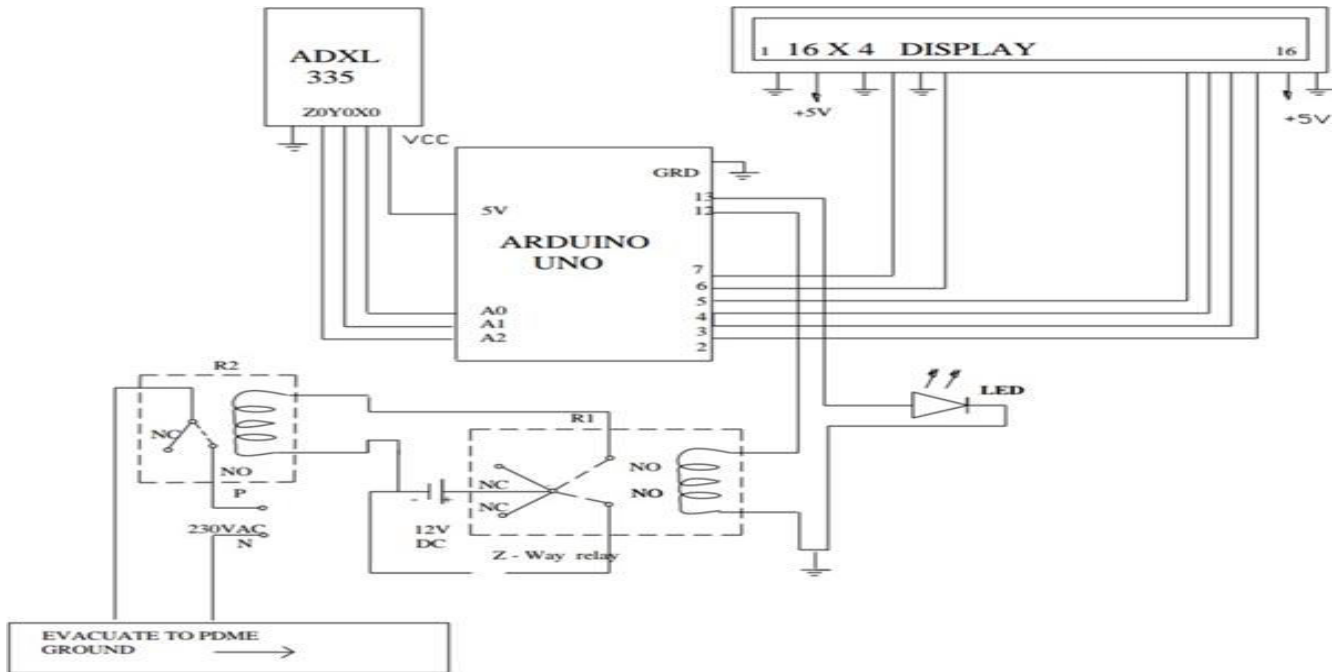


Figure.5: Circuit diagram for Earthquake detector

Working: The developed system uses Arduino Uno board connected with Accelerometer ADXL335 module. The output pins of accelerometer X, Y & Z axis are connected with the pins of Arduino Uno analogue pin A0, A1 & A2 respectively. ADXL335, pin-1 is connected to 5V and pin-5 is grounded.

When the earthquake vibrations are such that it crosses the threshold, value assigned in the programming of Arduino Uno, a high signal from the Arduino sends to the two relays to operate. One relay is utilized to operate the alarm circuit which produces alarming sound to evacuate the persons and other relay is used to operate the PBD, indicates to move towards nearest muster station.

V. SOFTWARE AND HARDWARE IMPLEMENTATION

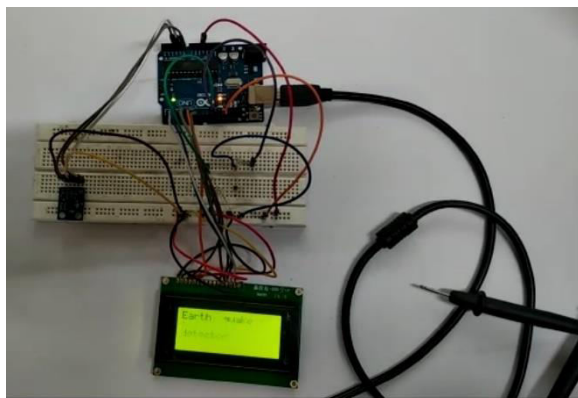


Figure.6: Proposed model during deactivated-condition

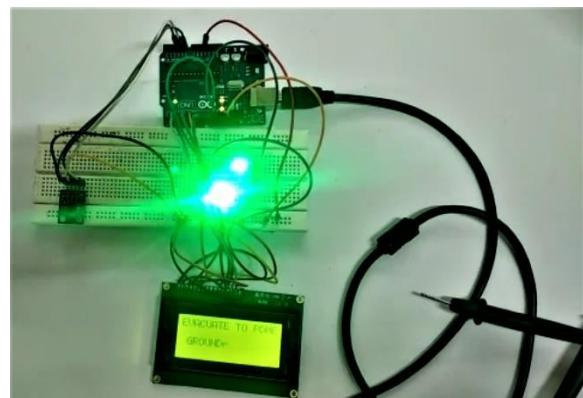


Figure.7: Proposed model during activated-condition.

The program codes are developed as to activate the system when the earthquake vibrations are crossing the threshold value of '5.4' magnitude level of a Richter scale provided in the Table below.



S. No.	Magnitude Level	Earthquake Effect
1.	2.5 or less	Usually not felt, but can be recorded by seismograph.
2.	2.5 to 5.4	Often felt, but only causes minor damage.
3.	5.4 to 6.0	Slight damage to buildings and other structures.
4.	6.0 to 6.9	May cause a lot of damage in very populated areas.
5.	6.9 to 7.9	Major earthquake. Serious damage.
6.	8.0 or greater	Great earthquake. Can totally destroy communities near the epicenter.

Table-1: Magnitude level of earthquake & its effects.

Primarily, the hardware components are mounted on the bread board and tested by providing the vibration to accelerometer as shown in the fig: 6 & 7.

After the completion of first stage, the components are mounted and fabricated on the PCB board and the complete system is developed.

Test & Results:

The testing of the proposed system was carried out using a develop shock simulator platform on which accelerometer ADXL335 module is fabricated.

The proposed earthquake detector system showed an excellent performance and provides satisfactory results on the creation of vibration for the period of testing. The cost of the proposed system is Rs.4900/- including the two PBD installed in the vicinity.

The test was carried out several times and the results were the almost same for all the cases. The accelerometer sensor is so calibrated and adjusted that it senses the vibrations quickly.

Activation of the system is provided for 10 min after the vibrations are detected and reactivated after 2 mins to alarm and indicate to avoid any accidents during the hazardous condition of the earthquake.

The results are summarized below, are as follows:

S.No.	Test Condition	LED	Hooter	PBD
1	No vibration	Off	Off	Off
2	Low level vibration i.e.> 5.4 mag. level	Off	Off	Off
3	High level vibration i.e. < 5.4 mag. Level	Glow	Sound	Display

Table-2: Test results

VI. CONCLUSION

An economical earthquake detector system was developed, fabricated, and installed in the premises of the Electrical Engineering department of Dr. B.R. Ambedkar Institute of Technology, Port Blair, A & N Islands to provide the security requirement, which is presented in this paper. The test results are obtained by creating a vibration on the simulator platform. The test results are very the effective and efficient operation of the prototype by detecting low and high vibrations and alert the user by providing an audible alarm and visible indication signals. The cost of the proposed system is economical with reliable real-time operation.

VII. FUTURE SCOPE

In Future by using GSM module with this system, we can alert the people by sending message to the registered user’s number during earthquake. At present, the installed hooter is not sufficient to cover the entire campus, so further more hooters and separate speakers for A/C rooms can be installed, using adequate circuitry connect with the installed earthquake detector circuit.



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