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Microcontroller Based Earthquake Indicator and Measurement System

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***Abstract*—**"Prevention is better than cure". This statement goes perfect with the events whose probability of occurrence is highly possible. Earthquake is one of such disaster that comes as an evil fate and sweeps away precious human lives and civilization, it is that unpredictable phenomenon whose occurrence cannot be avoided, but at least we can take measures to minimize the adverse effect of its consequences. The main objective of this research paper is to design a circuit which will acts as an earthquake indicator and prevents further damage. Arduino microcontroller and a highly-sensitive ADXL335 accelerometer are used to accomplish the circuit.

***Keywords*—**Earthquake, Microcontroller, ADXL335 accelerometer

I. INTRODUCTION

The device "Microcontroller based Earthquake indicator and measurement system" can sense vibrations and knocks along the three physical dimensions or axes, which make it more sensitive. Once it identifies vibration, it is applied with acceleration and ADXL335 produces an analogue voltage equivalent to acceleration imposed on it by the vibration. The device "Microcontroller based Earthquake indicator and measurement system" supplies three outputs along three axes- X-, Y- and Z- axes.

An accelerometer is an electromechanical device that will measure acceleration force. It shows acceleration, only due to cause of gravity i.e. g- force. It measures acceleration in g-unit.

Features of ADXL335 module

- The ADXL335 gives complete 3-axis acceleration measurement.
- This module measures acceleration within range ±3 g in the x, y and z axis.
- The output signals of this module are analog voltages that are proportional to the acceleration.
- It contains a polysilicon surface-micro machined sensor and signal conditioning circuitry.

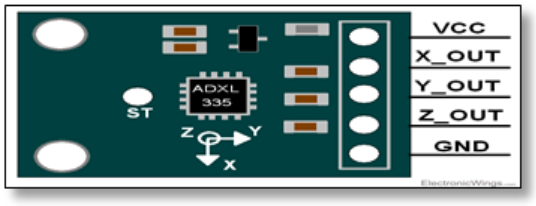

Figure 1. ADXL335 module

The structure of accelerometer consist fixed plates and moving plates (mass).Acceleration deflects the moving mass and unbalances the differential capacitor which results in a sensor output voltage amplitude which is proportional to the acceleration. Phase-sensitive demodulation techniques are then used to determine the magnitude and direction of the acceleration. The functions of different pin are given below.

VCC: Power supply pin i.e. connect 5V here.
X_OUT: X axis analog output.
Y_OUT: Y axis analog output.
Z_OUT: Z axis analog output.
GND: Ground pin i.e. connect ground here.

II. LITERATURE SURVEY

There are various devices for the measurement of earthquakes like SEISMOGRAPH and RICHTER SCALE that provides the magnitudes based on certain calculations and calibrations. Arduino-UNO used along with Accelerometer provides 3-axial displacements (static or dynamic).Here is a detailed study about the components used along with their specifications.

ARDUINO UNO: The Arduino-UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts.

ADXL335: The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 g. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration. The user selects the bandwidth of the accelerometer using the CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis. The ADXL335 is available in a small, low profile, 4 mm × 4 mm × 1.45 mm, 16-lead, plastic lead frame chip scale package (LFCSP_LQ).ADXL335 accelerometer provides analog voltage at the output X, Y, Z pins; which is proportional to the acceleration in respective directions i.e. X, Y, Z.

III. METHODOLOGY

In this research work accelerometer ADXL335 has been interfaced with Arduino to design a "Microcontroller based Earthquake indicator and measurement system". The Accelerometer accepts analog signals as input via the Arduino-UNO analog pins. Angle of inclination or tilt is calculated by using X, Y, Z's value. Roll Pitch and Yaw angles can be calculated with respect to X, Y and Z axis. So the10-bit ADC value is converted into g unit. As per ADXL335 datasheet maximum voltage level at 0g is 1.65V and sensitivity scale factor of 330mV/g.

Software Requirement: Arduino IDE

Hardware Requirement:

- Arduino-UNO
- Accelerometer ADXL335
- Breadboard
- Jumper wires
- Buzzer
- 16 * 2 LCD

Pin Diagram

Table1. Arduino Connection With ADXL335

Arduino Pin	ADXL335 Pin
5V	5V
GND	GND
A0	X
A1	Y
A2	Z

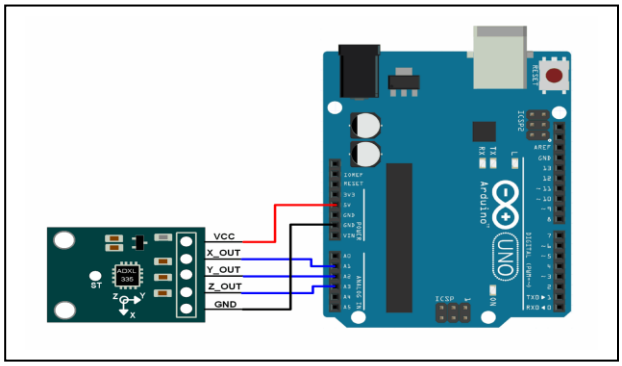

Figure 2. Pin diagram

Working Principle: Working of this Earthquake Detector is simple. As mentioned earlier, Accelerometer is used for detecting earthquake vibrations along any of the three axes so that whenever vibrations occur accelerometer senses that vibrations and convert them into equivalent ADC value. Then these ADC values are read by Arduino and shown over the 16x2 LCD or Serial Monitor. First we need to calibrate the Accelerometer by taking the samples of surrounding vibrations whenever Arduino Powers up. Then we need to subtract those sample values from the actual readings to get the real readings. This calibration is needed so that it will not show alerts with respect to its normal surrounding vibrations. After finding real readings, Arduino compares these values with predefined max and min values. If Arduino finds any changes values are more then or less then the pre-defined values of any axis in both direction (negative and positive) then Arduino trigger the buzzer and shows the status of alert over the 16x2 LCD and a LED also turned on as well. We can adjust the sensitivity of Earthquake detector by changing the Predefined values in Arduino code.

Circuit Diagram

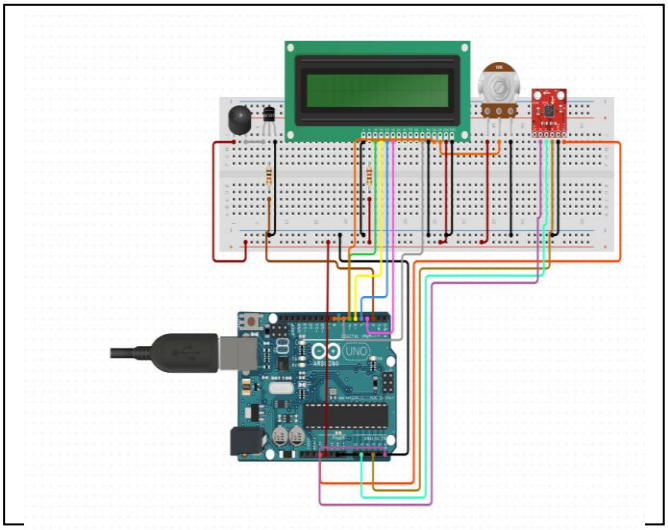

Figure 3. Circuit diagram

Circuit Explanation: In this research work, Arduino is used to reads accelerometer's analog voltage and convert them into the digital values. Arduino also drives the buzzer, LED, 16x2 LCD and calculate and compare values and take appropriate action.

Next part is Accelerometer which detects vibration of earth and generates analog voltages in 3 axes (X, Y, and Z). LCD is used for showing X, Y and Z axis's change in values and also showing alert message over it. This LCD is attached to Arduino in 4-bit mode. RS, GND, and EN pins are directly connected to 9, GND and 8 pins of Arduino and rest of 4 data pins of LCD namely D4, D5, D6 and D7 are directly connected to digital pin 7, 6, 5 and 4 of Arduino. The buzzer is connected to pin 12 of Arduino through an NPN BC547 transistor. A 10k pot is also used for controlling the brightness of the LCD.

IV. RESULTS AND DISCUSSION

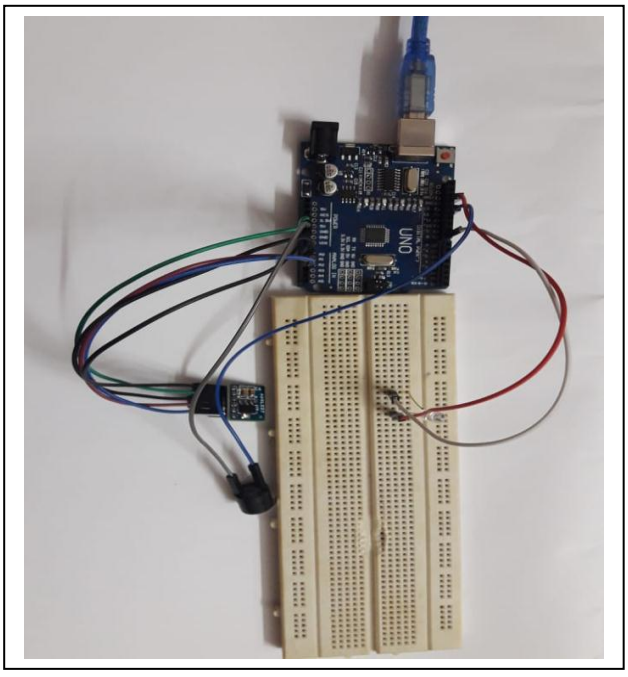

Figure 4. Working Circuit diagram

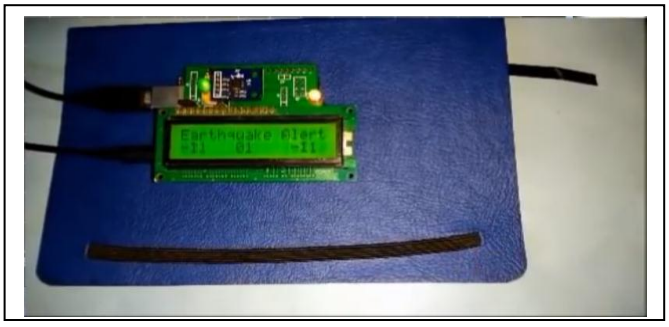

Figure 5. Display of Earthquake alart

V. CONCLUSION AND FUTURE SCOPE

Since an Accelerometer uses 3 axis measurement of rotation, it can be used to detect very minute amount of earthquake and can also be used as a seismograph or a richter scale. It can be implemented more to calibrate all three axial values into one so as to detect a single value as showed on a richter scale.

VI. ANALYSIS AND DISCUSSION

The device "Microcontroller based Earthquake indicator and measurement system" is highly sensitive and so it must be carefully fabricated. We can also set this device within a protective hard enclosure and then fix it in any place of the industry or home. Further the device "Microcontroller based Earthquake indicator and measurement system" can also be operated in terms of acceleration. Firstly, determine resultant acceleration by using formula of square root of $X_2+Y_2+Z_2$ where X, Y and Z are corresponding co-ordinates outputs obtained from ADXL335.

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