

# Earthquake Early Warning System (EEWS)

\*Saba S D<sup>1</sup>, Manasa S N, Shruthi B T<sup>3</sup>, Sneha vardhi<sup>4</sup>

<sup>1,2,3,4</sup>Sambhram Institute of Technology

M S palya, Jalahalli East, Vidyaranyapura, Bengaluru, Karnataka 560091

<sup>1,2,3,4</sup>Undergraduate Students

**Abstract-** Earth is made up of many layers like Core, Mantle, Inner and Outer crust. Due to deformation of faults in Earth's crust, Earthquakes occurs. It is very important to shift Mankind living near faults to other safe places. By keeping "The Exact Position" in consideration, Earthquake Early Warning System using Arm and GPS" has been developed which can locate the exact position of the Earthquake before it occurs based on the sensing of vibration by a vibration piezosensor. GPS is placed near the sensing area which will keep track of positions. Allow power Microprocessor is used as a server and a system to guide signals to other systems. By considering the statement, "Earthquake occurs along with heavy storms," An air pressure sensing system is been developed along with the vibration sensing system to measure the pressure of air and warn people if air pressure is beyond a threshold value. The system will also be able to send warning messages to nearby emergency service authorities to take necessary precautions before any damage occurs.

**Keywords-** Earthquake waves, Focus point, GPS,

Strom sensing, vibration sensor.

## I. INTRODUCTION

If a stone is thrown in a pond of still water, series of waves are produced on the surface of water. These waves spread in all directions from the point where the stone strikes the water. Similarly sudden disturbances in the earth's crust may produce vibration in the crust which travels in all directions from point of disturbances. Earthquake is sudden violent shake of ground as a result of movements within the Earth's crust. The movements occur along faults, which are thin zones of crushed rock separating blocks of crust. Faults can be microscopic or can be elaborated to hundreds or thousands of kilometers. When the blocks suddenly move with respect to other along a fault, the energy is released in the form of waves, that radiates

up through the crust of the earth's surface causing the ground shake. Basically earthquake waves are distinguished based on the travel medium as body and surface waves. Body waves are the waves which travel towards the Earth's surface. Body waves usually travel interior of the Earth from focus center towards surface of the Earth. Body waves are distinguished based on the velocity as P-waves and S-waves. P-waves or primary waves are longitudinal waves which can travel through rock, liquid and air and are the fastest moving seismic waves. S-waves or secondary waves are transverse waves which travel through rocks but not liquid or air. These waves have velocity 1.7 slower than P-waves. Surface waves are the seismic waves which travel along the earth surface. These are slowest travelling waves. The difference between velocities of P and S wave helps to find epicenter which is the exact point on the Earth surface where the Earthquake originated. Focus point is said to be the point inside the earth's surface from where Earthquake is originated. The effects of Earthquake vary upon magnitude and intensity. Earthquake effects could be Ground motion, Landslides, Ground displacement, Liquefaction and Tsunami's. Earthquakes are the result of sudden release of energy in the Earth's crust that creates seismic waves. Seismic waves are recorded by seismometer. Velocity of seismic waves depends on the ability of a strained body to recover its shape after deformation, as from a vibration or compression and mass per unit volume of the medium.

There are many devastating Earthquakes. One of the recent major Earthquake is 2015 Nepal Earthquake which killed more than 8000 people and injured over 1200 people. The earthquake triggered an avalanche on Mount Everest, killing 21 people and making the day as the deadliest day on the mountain in history. The earthquake triggered another huge avalanche in the Langtang valley, Where 250 people were reported missing. According to United Nations

University for Environment and human security and feature in the 2013 world risk report published by the Alliance Development works, there are totally 128 countries across the world in risk of earthquake hazards. Many Earthquake warning systems are developed to warn people in prior an earthquake occurs. But many systems are failed to produce results based on finding the exact position of earthquake. Finding Exact position helps to know the velocity of waves at that area and time duration of the shaking of the Earth. Many earthquake warning systems are also failed to predict hot storms which occur along with the earthquake which helps the earthquake waves to increase their velocity and cause more Geological damage. GPS is the best way to track locations in real-time by using the help of satellites and locating coordinates for each and every minute. Early warning system can use GPS to locate the position of the earthquake. To solve the problem related to storms, a specially designed storm indicator interfaced with system is used to indicate people when the storm speed is increased more than a Threshold. GSM system can be used to send alert messages to the authorities like nearby hospitals, fire stations and Electricity boards etc., to take precautions to save people.

## II. PRINCIPLE OF OPERATION

Early Earthquake Warning System (EEWS) shown in Figure-1 consist of Vibration Sensor of 0.2g sensitivity, Storm sensing system, system controller, GPS module and GSM module.

When there is a quake, it is sensed by the vibration sensor, and the signals are given to System control unit. The function of system control unit is to store the signals and trigger GPS as soon as the signal seems to vary largely beyond the Threshold i.e., more than or equal to 0.2g. The function of GPS module is to locate the exact position and sends the latitude and longitude information to Control unit for every particular time instances. When there is a signal variation more than the threshold, control system interrupts the GPS and store that locations which the GPS has tracked and then gives the warning information through GSM to nearby authorities like fire station, electricity board, and nearby hospitals whose numbers are stored in the control unit.

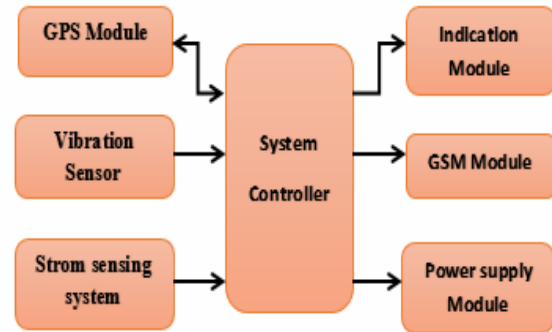


Figure-1 Early Earthquake Warning System (EEWS)

The storm sensing module in the system senses the air pressure and passes the signals to system controller. When the storms beyond threshold are detected, System Controller again interrupts the GPS to find the locations and sends messages through GSM to the authorities.

## III. HARDWARE IMPLEMENTATION

### i. Vibration sensing module

Vibration sensing module uses a piezoelectric sensor to sense the quake waves before they reach the ground and convert them to electrical signals. Piezoelectric sensors are best transducers which turn force, or mechanical stress into electrical charge. An example of piezoelectric transducers is they are used both as speakers (voltage to mechanical) and microphones (mechanical to electrical). Piezoelectric measuring systems are active electrical systems. The crystals produce an electrical output only when they experience a change in load.

As the output of the vibration sensor will not be in a stable state, a specially designed, Monostable multivibrator using a 555 timer is used to produce a stable output. The current through monostable multivibrator depends on the signal falling on the sensor.

### ii. GPS Module

The Global Positioning system (GPS) is a satellite based navigation system made up of a network of 24 satellites.

GPS module is placed near vibration sensor module to track the exact location in terms of latitude and longitude irrespective of weather conditions. When continuous tracking of GPS is

interrupted by system controller the particular location information is sent to the system controller.

### iii. Storm Sensing system

Storm sensing system has a Pressure sensor to sense the pressure of the wind and an Analog to Digital converter to convert the analog values to digital. Circuit is designed such that, as soon as the wind pressure increases more than certain Threshold, signals are sensed through controller and warnings will be sent to respective authorities via GSM and indication module.

### iv. System Controller

ARM 7 (LPC 2148) is used as system controller. ARM controller is popularly known for its low power consumption and high speed response. ARM stands for Acorn RISC machine. It is an instruction set architecture based on Reduced Instruction set computing. Lpc2148 is widely used IC in ARM 7 family. It has two UARTs (6C550), which is very much used for interfacing serial communication devices like GPS and GSM. It also uses a minimum voltage of 3.3V. It has up to 45 general purpose I/O pins where each pin has tolerance of 5V. Its CPU

System Controller in Earth quake Early warning system is used to store information signals and direct them to particular inputs according to the instructions provided to the controller. System Controller sends a interrupt to GPS as soon as it receives the signal from Multivibrator. After it receives the location information from GPS, it warns to respective authorities through GSM and Indication module.

### v. GSM Module

Global System for Mobile communication is a telephony system which uses time division multiple accesses. Earthquake early warning system is build using SIM 900 GSM Module which is a Quad band cellphone and works on 850/900/1800/1900MHz and which can be used for both accessing the Internet and for oral communication like SMS. The module is managed by an AMR926EJ-S processor, which controls phone communication. The module is supplied with continuous energy (between 3.4 and 4.5 V) and absorbs a maximum of 0.8 A during transmission.

GSM send messages to respective authorities as soon as it receives the command signal form control

unit. The authorities may be like fire stations, hospitals and electricity board etc.

### vi. Power supply module

For the entire system to work, there must be the supply of electric energy. So, a specially designed power supply module is used for powering up the entire system. Since 230V is very high energy and it damages the entire system, power supply module is designed such that, a regulated power of 12V and 5V is extracted at the output of the module.

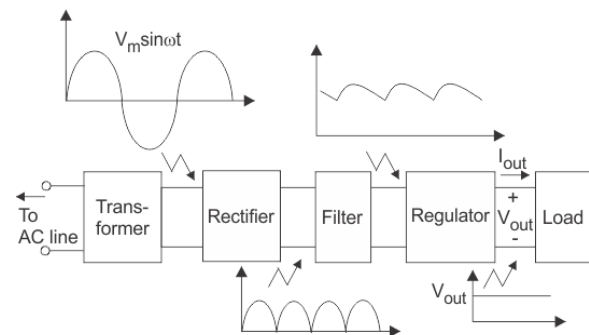


Figure-2 Regulated Power supply

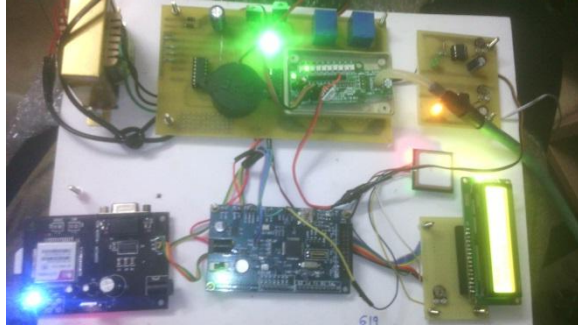
Power supply design shown above uses a step-down transformer for stepping down the voltage. Almost all the electronic devices needs dc supply for its operation so, a Full-Wave center tapped rectifier is used to convert AC to DC voltage. The rectified voltage from rectifier is Pulsating voltage having very high ripple content. Hence a capacitor filter is used. As the voltage starts increasing, capacitor charges till the waveform reaches its peak value. When the instantaneous voltage values starts decreasing, capacitor starts discharging slowly through the load. The output voltages and currents change when there is change in ac main. Hence, the output must be regulated. 7812 and 7805 IC's are used in the circuit to regulate the voltage to +12 and +5 volts.

### vii. Indication Module

Indication module consists of circuits for providing alerts regarding earthquake when there is any warning signal from control system to these units. This indication circuit may be used to alert people and shift them to safety places. Indication module contains circuits like a LCD display to display the warning message and latitude and longitude position of quake, a alarm or buzzer to buzz until the messages are sent and GSM system to

send messages to the authorities like electricity board, nearby fire stations and hospitals.

#### IV. EXPERIMENTAL SETUP



A piezo electric vibration sensor is used to sense the vibration and convert them to electrical signal as shown in the figure. The sensor is connected to a monostable multivibrator for making a stable electric signal. A 555 timer IC is used to set the time delay for multivibrator to maintain its state. Output of the multivibrator is given to a micro controller to store the signal and interrupt the GPS. GPS sends the latitude and longitude coordinates which are outputted to the authorities using LCD display, buzzer and GSM module as shown in the figure. Since current form microcontroller is sufficient to drive the LCD, a driver circuit using relay and buffer is used to driver the LCD output. The output of the microcontroller just acts as on-off signal to driver. Regulator power supply is used to power up the whole circuit.

#### V. RESULTS AND ANALYSIS

First, designed regulated power supply is checked for input and output voltages and corresponding values are noted down. The table below shows input and output values of each and every component used in the circuit.

Component	Vin	Vout
Transformer	230V	13.1V
Diode D1	13.1	18.34
Diode D2	13.1	18.34
Capacitor C1	18.34	18.35
Capacitor C2	18.34	18.35
IC 7812	18.37	11.95
IC 7805	11.95	4.93
Resistor	4.98	2.98
LED	2.98	1.95

Table-1 Voltage values for Power supply circuit

From the Table-1 it is observed that transformer is stepping down the input to 13.1 volts. 12V and 5V are extracted by IC 7812 and 7805. LED is used to indicate whether the signal is passing. The voltages for buffer driver circuit are shown in the table below.

Component	Vin	Vout
Buffer	5.01	4.67
Signaling Diode	4.67	4.07
Driver IC	4.07	0.73
Relay	11.89	0.73

Table-2 Voltage for Buffer Relay circuit

#### VI. CONCLUSION

Earthquake Early Warning System is demonstrated for with the measurement of input and output voltage values. By converting the vibration to electrical signal using vibration sensor, suitable warnings are produced. By using GPS and GSM, system efficiency of information delivery in case of disaster is increased and the exact location can be found.

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#### BIOGRAPHY



**Saba S Dis** persuing B.Engg.degree in Electronics and communication Engineering in Sambhram Institute of Technology. She is presently working on the final year project “THE EARTHQUAKE EARLY WARNING SYSTEM USING ARM AND GPS TO LOCATE EXACT POSITION”.



**Sneha Vardhiis** persuing B.Engg.degree in Electronics and communication Engineering in Sambhram Institute of Technology. She is presently working on the final year project “THE EARTHQUAKE EARLY WARNING SYSTEM USING ARM AND GPS TO LOCATE EXACT POSITION”.



**Manasa S Nis** persuing B.Engg.degree in Electronics and communication Engineering in Sambhram Institute of Technology. She is presently working on the final year project “THE EARTHQUAKE EARLY WARNING SYSTEM USING ARM AND GPS TO LOCATE EXACT POSITION”.



**Shruthi B T** is persuing B.Engg.degree in Electronics and communication Engineering in Sambhram Institute of Technology. She is presently working on the final year project “THE EARTHQUAKE EARLY WARNING SYSTEM USING ARM AND GPS TO LOCATE EXACT POSITION”.