# Development of wireless earthquake alarm system for early warning

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***Abstract*: The aim of this project is to design the system that can detect P-wave before the first S-wave spike. Typically, P-wave travel 1.68 to 1.75 times faster than S-wave. Our proposed designed device consists of a pendulum type earthquake detection device which is interconnected with fault point finder, wireless alarm, GSM kit and automatic turn off system. when P- wave strike the pendulum, it activates relay and send the pulse to stimulate the wireless alarm which can be install at any place as it detects the P-waves and can save human lives as they will be aware of how to deal with this situation.**

## 1. INTRODUCTION

### 1.1Earthquake

An earthquake (also known as a quake, tremor, or temblor) is the perceptible shaking of the Earth's surface caused by a sudden release of energy in the Earth's crust, which generates seismic waves. Earthquakes can be powerful enough to fling people around and destroy entire cities.

The moment magnitude scale is the most commonly used scale for reporting earthquakes larger than approximately 5 on a global scale. The majority of earthquakes smaller than magnitude 5 reported by national seismological observatories are measured primarily on the local magnitude scale, also known as the Richter scale. Earthquakes are mostly imperceptible or weak, and magnitudes 7 and higher can cause significant damage depending on their depth, larger areas. h. The largest earthquakes in recorded history have had magnitudes slightly greater than 9, though there is no upper limit to the magnitude that can occur. The modified Mercalli scale is used to assess the intensity of shaking. All else being equal, the deeper an earthquake, the more structural damage it causes. On Earth's surface, Earthquakes cause shaking and, in some cases, displacement of the ground. When the epicenter of a large earthquake If the earthquake occurs offshore, the seabed may be displaced enough to cause a tsunami. Earthquakes can also cause landslides and, on rare occasions, volcanic activity.

About 50,000 earthquakes large enough to be noticed without the aid of instruments occur annually over the entire Earth. Of these, approximately 100 are of sufficient size to produce substantial damage if their centers are near areas of habitation. Very great earthquakes occur on average about once per year. Over the centuries they have been responsible for millions of deaths and an incalculable amount of damage to property.

Primary wave (p-wave) is 1.68 to 1.75 times faster than Swave, whose rotation is about 3.5 km/s. Therefore, there is typically 1 second separation between every 8-kilometer traveled. Earthquake early warning system can utilize Pwave as source of information of earthquake. The Electromagnetic waves which is faster than P- wave and much faster than S-wave sending of early warning message is possible. The movement of primary wave power on the earth is the cycle of forward and backward shaking in a x axis and y-axis plane, spreading in similar direction of the seismic wave. The movement of wave on the earth is the reason of the pushing (compression) and pulling (dilation)of earth elements in its path and it can pass from any type of soil structure such as solid and liquid. There are three kinds of waves Primary waves, secondary waves and in the last surface. P-wave is faster than other seismic waves.

S-wave or secondary wave also called as shear wave due to the movement of up-and-down at the right angle of earth surface. It is dissimilar with P-wave because of the movement, it can move only in solid unlike the P-wave which can also travel in liquid. Due to the movement of shear wave the element of earth causes propagate in all direction.

### 1.2 Types of Earthquake Fault

A fault is a fracture or zone of fractures between two blocks of rock. Faults allow the blocks to move relative to each other. This movement may occur rapidly, in the form of an earthquake – or may occur slowly, in the form of creep. Faults may range in length from a few millimeters to thousands of kilometers. Most faults produce repeated displacements over geologic time. During an earthquake, the rock on one side of the fault suddenly slips with respect to the other. The fault surface can be horizontal or vertical or some arbitrary angle in between.

Normal, reverse (thrust), and strike-slip faults are the three main types of faults that can cause an interpolate earthquake. Normal and reverse faulting are examples of dip-slip, in which the displacement along the fault is in the direction of the dip and movement on them has a vertical component. Normal faults are most common in areas where the crust is being extended in the form of a divergent boundary. Reverse faults form where the crust is being shortened. As an example, consider a convergent boundary. Strike-slip faults are steep structures in which the fault's two sides slip horizontally beyond each other; transform boundaries are a type of strike-slip fault. Many earthquakes are triggered by movement on faults with both dip-slip and strike slip components; which is also known as Oblique slip.

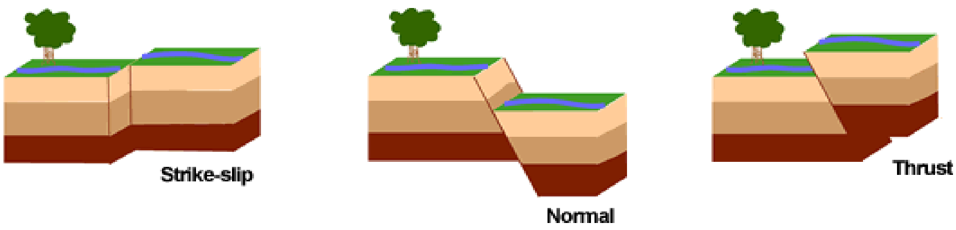



**Fig 1. Earthquake Fault Types**

### 1.3Effects of Earthquake

**A. Ground Shaking and Structural Failure**

Ground shaking is the vibration of the ground during an earthquake. The shaking triggers other hazards such as liquefaction and landslides. Most earthquake damage results from the seismic waves passing beneath buildings, roads, and other structures.

**B. Surface Rupture and Ground Displacement.**

The primary earthquake hazard is surface rupture. It can be caused by vertical or horizontal movement on either side of a ruptured fault. Ground displacement, which can affect large land areas, can produce severe damage to structures, roads, railways and pipelines.

**C. Landslides**

Earthquakes can trigger landslides and mudslides, especially in areas with water-soaked soils. Landslides may result in falling rocks and debris that collide with people, trees, animals, buildings and vehicles. They also can block roads and disrupt utility lines.

**D. Liquefaction**

The shaking from an earthquake can turn loose soil into a liquid during an earthquake. Liquefaction can undermine the foundations and supports of buildings, bridges, pipelines, and roads, causing them to sink into the ground, collapse or dissolve.

**E. Tsunami.**

An earthquake generated within the Pacific Ocean floor will generate a tsunami, which is actually a series of very long waves. Large tsunamis which travel to the ocean floor to the surface are dangerous to human health, property, and infrastructure. Long lasting effects of tsunami destruction can be felt beyond the coastline

## 2. REVIEW OF LITERATURE

### 2.1 Historical data

A large number of earthquakes are felt all over the globe every year. The small ones are
unnoticed while the large ones are felt over thousands of kilometers. Earthquakes have damaged and destroyed human lives since time. It is therefore important to design low-cost
earthquake alarm system which can be used by the people in their home to save their lives at
the time of earthquake.

**TABLE 2.1 EARTHQUAKE DATA 2000-2003**

| Time | LATITUDE | LONGITUDE | MAGNITUDE | RMS | PLACE |
|---|---|---|---|---|---|
| 2000-01-18 | 32.66 | 71.122 | 4.5mb | 0.7 | PAKISTAN |
| 2000-01-26 | 27.566 | 92.492 | 4.3mb | 0.93 | ARUNCHAL PARDESH |
| 2000-08-09 | 34.52 | 71.033 | 4.6mb | 1.12 | AFGHANISTAN |
| 2000-12-24 | 23.971 | 69.763 | 4.6mb | 1.34 | GUJARAT |
| 2001-02-04 | 33.205 | 75.805 | 4.7mb | 1.31 | KASHMIR |
| 2001-05-03 | 27.63 | 90.47 | 4.1mb | 1.22 | BHUTAN |
| 2001-08-27 | 36.578 | 70.44 | 4.4mb | 1.11 | HNDUKUSH |
| 2001-12-18 | 29.612 | 81.78 | 4.9mb | 0.75 | NEPAL |
| 2002-03-04 | 35.908 | 90.566 | 4.3mb | 1.06 | CHINA |
| 2002-07-25 | 29.971 | 87.843 | 3.9mb | 0.52 | XINZANG |
| 2003-08-06 | 29.94 | 93.642 | 4.5mb | 0.66 | MYANMAR |

**TABLE 2.2 EARTHQUAKE DATA 2004-2017**

| TABLE | LATITUDE | LONGITUDE | MAGNITUDE | RMS | PLACE |
|---|---|---|---|---|---|
| 2004-11-16 | 5.317 | 94.028 | 4.3mb | 0.68 | INDONESIA |
| 2005-07-07 | 8.858 | 94.291 | 4.7mb | 0.86 | Nicobar Island |
| 2006-03-25 | 26.788 | 92.242 | 4.8mb | 0.63 | ASSAM |
| 2007-02-16 | 15.208 | 93.749 | 4.3mb | 1.45 | BAY OF BENGAL |
| 2008-01-04 | 36.54 | 71.33 | 3.8mb | 0.99 | EASTERN KASHMIR |
| 2009-10-28 | 23.65 | 69.843 | 4.4mb | 0.82 | GUJRAT |
| 2010-11-09 | 25.23 | 73.649 | 4.6mb | 1.13 | RAJISTHAN |
| 2011-12-28 | 34.141 | 69.476 | 4.1mb | 0.85 | CENTRAL AFGHANISTAN |
| 2012-01-01 | 23.472 | 91.834 | 4.6mb | 0.63 | TRIPURA |
| 2013-12-31 | 21.6226 | 94.0575 | 4.6mb | 0.71 | BURMA |
| 2014-01-04 | 36.6578 | 71.0772 | 4.1mb | 1.2 | AFGHANISTAN |
| 2015-02-04 | 32.866 | 83.4305 | 5.1mb | 0.73 | CHINA |
| 2016-06-11 | 25.7858 | 95.2245 | 4.5mb | 0.69 | INDIA |
| 2017-08-30 | 36.6023 | 70.8242 | 4.1mb | 0.58 | AFGHANISTAN |

**TABLE 2.3 MAJOR EARTHQUAKE**

| LOCATION | YEAR | TOTAL DEATH TOLL | EARTHQUAKE MAGNITUDE |
|---|---|---|---|
| Shaanxi, China | 1556 | 830,000 | 8 |
| Port-au-Prince, Haiti | 2010 | 316,00 | **7** |
| Antakya, Turkey | 115 | 260,000 | 7.5 |
| Antakya, Turkey | 525 | 250,000 | 7 |
| Sumatra, Indonesia | 2004 | 227,899 | 9.1 |
| PAKISTAN | 2005 | 80,361 | 7.6 |
| SICHUAN, CHINA | 2008 | 87,587 | 7.9 |
| IRAN | 2003 | 26,271 | 6.6 |
| INDIA | 2001 | 20,085 | 7.7 |
| NEPAL | 2015 | 8964 | 7.8 |
| JAPAN | 2011 | 17,178 | 9.0 |
| CHILE | 2010 | 525 | 8.8 |
| UNITED STATES | 2020 | 0 | 7.8 |
| UNITED STATES | 2020 | 0 | 8.6 |
| MEXICO | 2022 | 2 | 7.6 |
| PAPUA NEW GENEVA | 2022 | 12 | 7.6 |

## 2.2 Aim and Objectives

The primary aim of this project if to detect Earthquake and provide an early warning through mobile text messaging, prior to damaging ground shake of earthquake. This system can reduce the number of causalities and the cost in the earthquake affected areas. The GSM connectivity will be used to send the alert warning messages through SMS, to all by near base stations. The wireless alarm facility can also be incorporated into the system to warn the people which can be at any place. An automatic turn off system is also aimed, to turn off all the possible connections and open safety door in buildings, houses, offices etc. An additional key features using fault point finder is also included, to detect the direction from which side the earthquake is coming. The earthquake early warning system can be installed in various different facilities and locations including but not limited to Factories and mills, Industries, Houses, Offices, Fire brigade's headquarters and Hospitals.

## 2.3 Time Estimation and Analyzing of Earthquake

Most people caught in earthquakes have a feeling of helplessness. Especially if they have never experienced a quake before, they have no idea how long it is going to last or what will happen next. Every second counts to save the human life, therefore, initially a technical analysis is done regarding these types of disasters, determining how much time will be given to warn the people and save people, if the earthquake system is installed. First the 2001 and 2005 horrible earthquakes are analyzed, which occurred in India and Pakistan, in which heavy losses were incurred. The epicenter (origin) of earthquake which occurred in 2001 in Chobari, was at the 9 km Southwest (SW) of GujratCity. It is necessary to keep in mind, that those areas which are situated near the epicenter are the most affected areas of earthquake. As already discussed, the P-wave is information carrier wave and it is about 3 times faster than S-waves, which is energy carrier or also knows as the Destructive wave. There is about one second separation between P-wave and S-wave, over a distance of every 8 kilometers per traveling path. In 2005, the earthquake epicenter was 100 km from NE of Islamabad, so there is a typically 13 seconds gap between P-wave and S-wave over 100 km travel. Another earthquake which occurred in 2008, its epicenter was at away 600 km South-West (SW) of Islamabad. If the time estimation is done as previously, then it is determined that there was about 60 seconds of window between the first P-wave and actual destructive S-wave, and thus these 60 seconds could have been utilized to warn people and get them out of buildings and in open areas saving their lives. Suppose you have the 13 seconds to save your life, thinks what you can do. You can move away from the large objects which may be in your house such as large shelves, mirrors large pieces of furniture topple over. If you are outside not in ho.me you can move away from trees, signboard or from the large hanging objects or when you are driving you can stop the car to prevent any vehicle accident.

## 2.4 Related Works

**Hiro Kanamori**, a Japanese seismologist researcher stated that "Recent advances in seismic sensor technology, data acquisition systems, digital communications, and computer hardware and software make it possible to build reliable real-time earthquake information systems. In the long term these systems also provide basic data for mitigation strategies such as improved building codes."

During an earthquake, one side of the fault moves suddenly with respect to the other. This process radiates energy as seismic waves, and generates heat due to friction and other non-linear processes. The study of the recent deep Bolivian earthquake suggests that only 4 % of the total strain energy was released as seismic waves, and most of the energy was converted to heat. The total amount of heat energy released is 1 to 10 times more than that released during the major volcanic eruptions such as the 1980 Mt St Helens eruption. This result suggested that melting can be an important mechanism for promoting seismic slip, especially for deep-focus earthquakes.

With the advent of modern broad-band seismic networks we can study seismic wave radiation in detail, from which we can understand how an earthquake nucleates, ruptures, and stops. The goal is to understand the deterministic as well as "complex" aspect of earthquake physics.

**DAN WANG AND YIQING NI** in 2012 researched about the Earthquake early warning system (EEW) is of huge interest as the general public is less and less willing to accept that earthquake damage to lives and properties is a fate to bear. Carrying high social and commercial value, high speed railway lines stand at the weakness point for the public to endure such fate if earthquake happens. There are many earthquakes early warning systems. The key of the EEW is an accurate and timely report of earthquake warning under such constraints as geographical and geological prediction limitation, communication constraints, fault tolerance; to name but a few.

Wireless sensor network (WSN) is used in many domains due to its advantage in cost, simple maintenance, robustness, etc. There are calls to use WSN for EEW in recent years. In this paper, we first present a modular designed WSN framework for EEW. In this framework, we study two bottlenecks of applying WSN to EEW. First, we study the locations that the sensors should be placed (or the sensor density), so as to achieve a timely warning report and system efficiency. We observe that wireless communication is faster than the destructive S-wave of the earthquake. Therefore, a trade-off can be made so that the number of the sensors to be deployed or maintained can be significantly reduced. Intrinsically, the faster P-wave of the earthquake should first hit at least one sensor which can gather, compute and transmit this information to the damage prone point, before the S-wave arrives. Second, we study a deadline driven strategy for WSN to reduce false alarms. In this case, the WSN of EEW and the WSN of the railway line health monitoring system will work together. Since the sensors of the railway line health monitoring system of the railway lines are densely deployed, there will be a great number of reports generated. An early aggregation of the information is needed to localize and evaluate the earthquake range and impact. False alarms should be filtered out.
These problems are intrinsic and cannot be improved by engineering advances. A joint foundational understanding of the communication limitation, complexity reduction of the computing systems, and earthquake knowledge is required. We believe that this work can serve as a first step before the development of a practical EEW system.

**G Gunawan, B B Nasution1, M Zarlis, Mar liana Sari, AR Lubi1 and Solikhun 2010:** Disaster mitigation is very important in order to reduce the number of victims of both life and material. Alertness in disaster mitigation is urgently needed in every area in all countries of the world, especially in Indonesia. Embedded device technology specifically designed and programmed to detect disasters such as earthquakes, tsunamis, floods and landslides, storms and hurricanes. The sensors are used according to the type of disaster will be detected. The system will be built this serves as an early warning system that will provide early warning against floods and landslides were predicted would happen. The system can detect floods and landslides in accordance with a sensor mounted on a disaster-prone location. Device technology development mitigation sensors embedded as floods and landslides integrate hardware and software and Internet networks. Hardware in the form of microchip controllers and software applications of information and communication technology-based internet of things. Microcontroller programmed so that it can control the data with computational algorithms can predict natural disasters will occur. With the development of technology these devices could be detected early disaster. For Embedded system could be produced more cheaply with a local content of 60%. This support government programs in the field of technological independence. Microcontroller programmed so that it can control the data with computational algorithms can predict natural disasters will occur. With the development of technology these devices could be detected early disaster. For Embedded system could be produced more cheaply with a local content of 60%. This support government programs in the field of technological independence. Microcontroller programmed so that it can control the data with computational algorithms can predict natural disasters will occur. With the development of technology these devices could be detected early disaster. For Embedded system could be produced more cheaply with a local content of 60%. This support government programs in the field of technological independence.

**Sanjib Kalita, J.N. Borole, Dr. K.P.Rane 2014**: Wireless Earthquake Alarm System using ATmega328p, ADXL335 and Bee S2 presented research paper on it in International Journal of Engineering Trends and Technology. In this paper an idea of low-cost earthquake alarm system using ATmega328p, ADXL335 and Bee S2 has been discussed.

**Sudarvizhi and Jayasutha 2015**: Earthquake Early Warning System presented this paper and paper epically focused on earthquake early Warning (EEW) system provides advance information of the estimated seismic intensities and expected arrival time of principal motion. These estimations can be obtained by prompt analysis of the focus and magnitude of the earthquake using wave form data observed by seismographs near the epicentre. However, conventional EEW system cannot offer satisfactory alarms for high-speed railway systems. Therefore, it is necessary to develop an EEW for high-speed railways (HREEW). One of the key issues in designing an HR-EEW system is how to offer timely alarms to trains under certain constrains, such as budget limitation and geological restriction. We propose HR-EEW systems based on wireless sensor networks (WSNs). In this proposal, we take a close look at deploying wireless sensor nodes in HR-EEW systems. We target at solving the minimum cost deployment problem while guaranteeing that any earthquake in a seismic district can be timely reported by k sensors.

**Alphonsa A, Ravi G. 2016:** Earthquake early warning system by IOT using Wireless sensor networks. In this paper, we propose an earthquake early warning system by means of an IOTin WSN. The sensors are placed in the surface of the earth. When an earthquake occurs, both compression P wave and transverse S wave radiates outward the epicenter of the earth. The P wave, which travels fastest, trips the sensors, placed in the landscape. It causes early alert signals to be transfer ahead, giving humans and automated electronic system a warning to take precautionary actions. So that before the damage begins with the arrival of the slower but stronger S waves, the public are warned earlier. The signal from each sensor which senses the P wave and which has Zigbee transmitter transfers the alert signal to the gateway. The gateway which has the Zigbee receiver and acts as an IOT transfers the warning to smart phones. Thus, early alert message is received by the people in terms of location, time and other parameters. Eventually, many of the human lives can be saved. The software used here is LABVIEW were the three-angle axis of the sensor can be sensed and detected when the sensors are interfaced with this software.

**Zaryab Qazi, Mubashir Malik, Waseem Javaid Soomro 2018:** Earthquake Monitoring & Early Warnings System presented paper in University of Sindh Journal of Information and Communication Technology (USJICT) The aim of this project is to design the system that can detect P-wave before the first S-wave spike. Typically, P-wave travel 1.68 to 1.75 times faster than S-wave. Our proposed designed device consists of a pendulum type earthquake detection device which is interconnected with fault point finder, wireless alarm, GSM kit and automatic turn off system. when P- wave strike the pendulum, it activates relay and send the pulse to stimulate the wireless alarm which can be install at any place as it detects the P-waves and can save human lives as they will be aware of how to deal with this situation.

**R. C. Prasad1, Rupali Mahajan, Dr. Rashmi Priyadarshini 2019:** Earthquake Early Warning System (EEWS) presented paper in International Research Journal of Engineering and Technology (IRJET) To reduce these losses earthquake early warning system is must. With the advancement of technology particularly in the field of seismic sensors, embedded technology, wireless networks, IoT and cloud computing, it is possible to develop low-cost advance earthquake monitoring and warning system using Wireless Sensor Network (WSN). The ability to anticipate and predict the earthquake through scientific means will give the time needed to escape and survive.

**Chu-Chieh Jay Lin (2019):** developed a concept of Structural Response with On-Site Earthquake Early Warning System Using Neural Networks. The real-time strong motion signals recorded the characteristics of the sensed earthquake and “accelerograms” were learned. The neural networks provide a seismic profile of the arrival ground motion instantaneously after the shaking is felt at the sensors by analyzing the three components of the earthquake signals. By producing informative warnings, the neural network-based methodology has shown its potential to increase significantly the application of earthquake early warning system (EEWS) on hazard mitigation.

**Venita Babu (2021):** discussed the vibration sensor like accelerometer, gyroscope helps to provide attentive signal to registered authority with the help of GSM module. IOT approach is done to fasten the information about the system and helps to analyses the results in a more effective way. ESP wi-fi module act as a gateway to transmit the data to Thing Speak cloud server. By using G4-61, an analog sensor and aid in detecting pre-earthquake quivering using ESP8260 and Cayenne app software. Cayenne yields an SMS to alert people.

**T.Nagaosa, Daichi (2021):** proposed a system where server in earthquake early warning system was constructed and mobile with android OS act as a seismometer about transmission of acceleration data. With this system, decision of acceptable values of threshold is analyzed which aids in the detection of given earthquakes.

**Raj Prasanna, Chanthujan Chandrakumar, Rasika Nandana 2022:** Saving Precious Seconds”—A Novel Approach to Implementing a Low-Cost Earthquake Early Warning System with Node-Level Detection and Alert Generation presented this paper and this paper presents findings from ongoing research that explores the ability to use MicroElectromechanical Systems (MEMS)-based technologies and various digital communication protocols for earthquake early warning (EEW). The paper proposes a step-by-step guide to developing a unique EEW network architecture driven by a Software-Defined Wide Area Network (SD-WAN)-based hole-punching technology consisting of MEMS-based, low-cost accelerometers hosted by the general public.

## 3. MATERIALS AND METHODS

### 3.1Materials Used

The most significant objective of this paper is to warned people about cataclysm in particular area and alert them by means of innovative technology IOT. Then comprised system consists of MEMS Sensor, vibration sensor, Arduino uno and Node MCU as a gateway. Arduino Uno equipped with 8-bit RISC processor ,16 MHz CLK speed and 32-Kb for storing codeSRAM2Kb, EEPROM-1 kB, is wield the whole software with the help of Node MCU. MEMS sensor helps in measuring linear motion, movement, shock, or vibration but without a fixed reference. Thing Speak is IOT cloud platform use for sending sensor data to the cloud. The earthquake early warning system, includes ADXL335 accelerometer. This accelerometer has 3-axis capacitive accelerometer and is also consist of magnetometer, gyroscope which helps to find any kind of vibration due to earthquake. In this project, the following tools and techniques are used to develop and construct the earthquake early alarm system**.**

- AT89C51 MICROCONTROLLER
- GLOBAL SYSTEM FOR MOBILE (GSM)

- MOBILE
- FAULT POINT FINDER
- VISUAL INDICATOR
- WIRELESS ALARM
- AUTOMATIC TURN OFF SYSTEM
- EMBEDDED ASEMBLY AND C LANGUAGE
- PROTEOUS STIMULATOR
- SERIAL PORT COMMUNICATION
- R232 PROTOCOL
- POWER SUPPLY
- COMPUTER
- P-WAVER

### 3.2AT89C51 Microcontroller

AT89C51 is a CMOS 8-bit microcontroller of high performance but low power. Further, it has an erasable and flashes programmable (4K bytes).

In this project AT89C51 microcontroller is used. The microcontroller has a major role, as it is the brain of the system. Here the use of microcontroller is to connect the four individual systems with the microcontroller to work simultaneously. The microcontroller is used to communicate with all four devices, pin number from 21 to 24 is used for visual direction meter and pin number 27 to 28 is used for wireless alarm and automatic turn off system. Pin number 10 to 11 is reserved for max 232 for interface purpose and pin number 1 to 4 is used for pendulum pulse receiver and pin number 5 is used for system reset. Pin number from 18- 19 11.059 MHz oscillator connected and pin number 20 went ground and pin number 40 is connected to 5-volt power supply.

The features and specifications of at89c51 comprise the following;

- First, it has six interrupt sources and a 128 × 8-bit internal RAM.
- Then, its fully static operation via the external oscillator ranges from 0Hz to 24MHz.
- Thirdly, it is compatible with MCS-51™ products.
- Despite lacking comparators, DAC and in-built ADC module, and data EEPROM, it has an internal oscillator.
- It has a 4Kb flash memory.
- It also has power-down and low-power idle modes.
- The 40-pinned at89c51 has an operating voltage of 2V to 5.5V and an operating temperature ranging from -55°C to 125°C.
- Besides having a three-level program memory lock, it also has a programmable serial channel. Additionally, it has two 16-bit timers/counters and 32-programmable I/O lines.
- Lastly, it can endure 1000 write/erase cycles during 4K bytes of in-system reprogrammable flash memory endurance.

**FIG 2 AT89C51 Microcontroller**

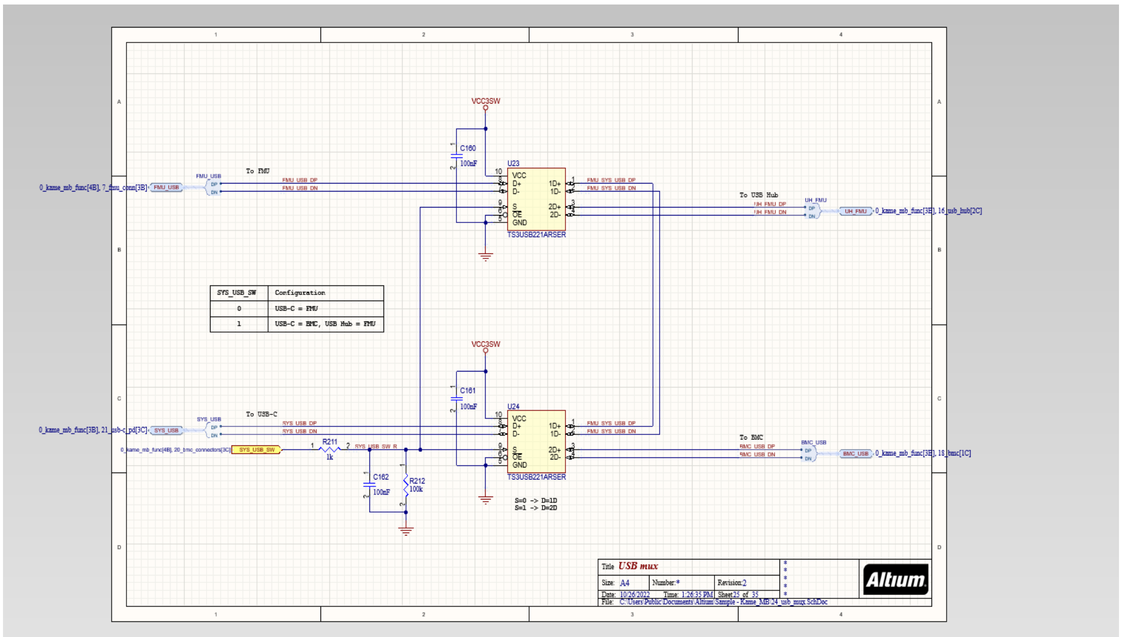



**Fig 3 Circuit Diagram of AT89C51 Microcontroller**

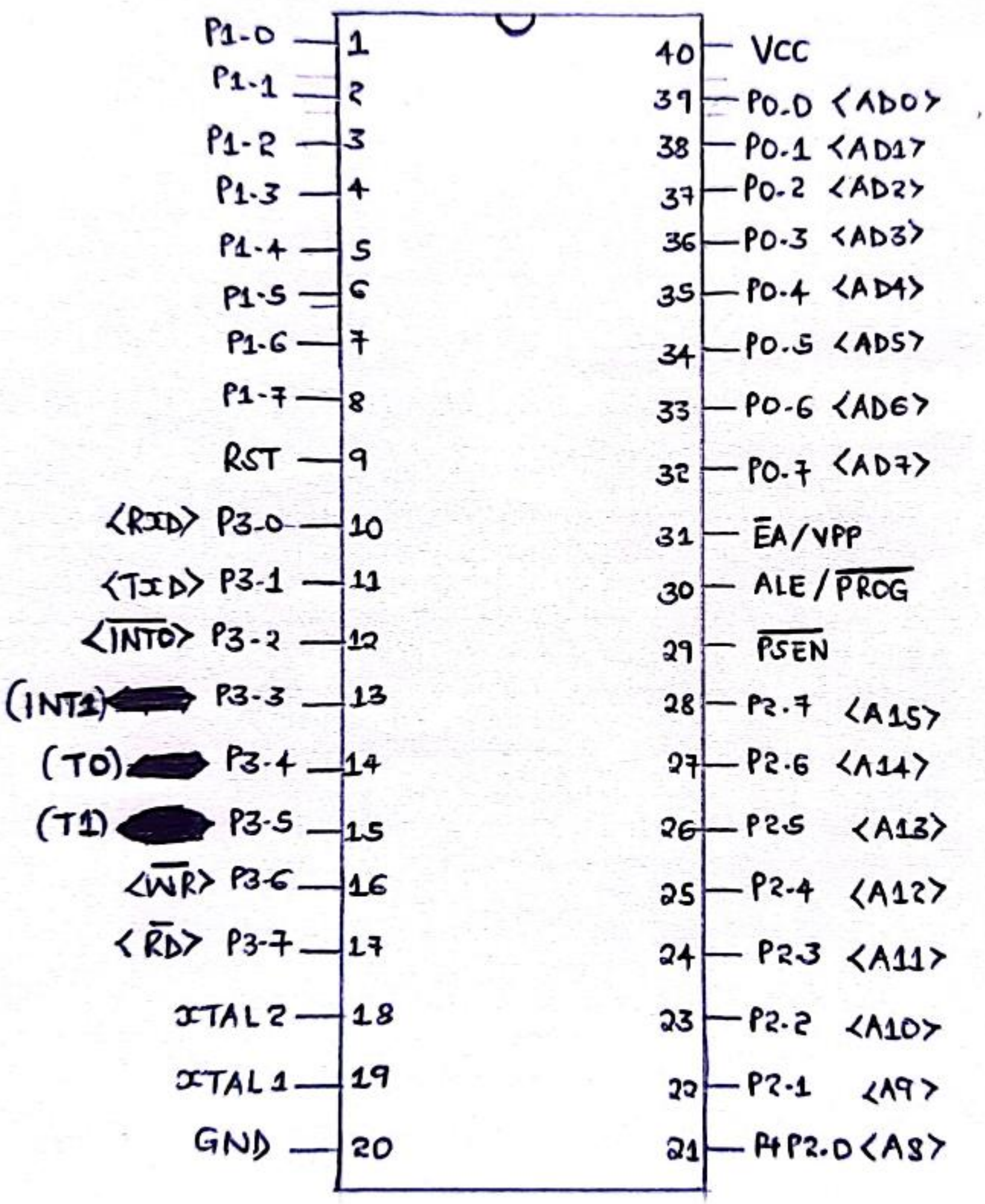



**Fig 4 AT89C51 Pinout**

### 3.3Global System for Mobile (GSM):

GSM (Global System for Mobile communication) is a digital mobile network that is widely used by mobile phone users in Europe and other parts of the world. GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies: TDMA, GSM and code-division multiple access (CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 megahertz (MHz) or 1,800 MHz frequency band.

GSM, together with other technologies, is part of the evolution of wireless mobile telecommunications that includes High-Speed Circuit-Switched Data (HSCSD), General Packet Radio Service (GPRS), Enhanced Data GSM Environment (EDGE) and Universal Mobile Telecommunications Service (UMTS).

**3.4Fault Point Finder:**

A fault code diagnostic system that puts the power of knowledge at your fingertips Faultfinder diagnoses faults, suggests remedies & locates parts to help in analyzing the earthquake.

**3.5Visual Indicator:**

Visual indicators are one such example. A visual indicator is a "marker" that helps users quickly locate an item that has an important distinctive attribute within a list of otherwise similar objects. Visual indicator help in detecting the direction of earthquake

**3.6Wireless Alarm:**

We can divide building alarm systems into two main categories, such as a wired and wireless alarm system. Wired alarm systems are old conventional systems that utilize existing telephone and electric lines for connecting all alarm system parts. Adding extra elements or moving equipment is highly complex in wired alarm systems. In contrast, the wireless counterparts are the latest in security equipment. Wireless alarms are known for lower costs of installation, easy upgrades, and comprehensive protection. A wireless home alarm system consists of various detectors, cameras, sensors, and alarms. There is a control panel that connects all these through radio signals.

**3.7Automatic Turn off system ( P Waver) :**

P-Waver is based in Taiwan, an island located along the 'Ring of Fire' in the Western Pacific that experiences over 18,000 earthquakes annually. Started in 2010, Pei- Yang Lin and his team have used big data and AI technology to create an Earthquake Early Warning (EEW) model that, after successful on-site lab validation, has been installed and used by the government, institutions, and international SI Partners. P-Waver's services also cover structural safety monitoring systems, earthquake disaster prevention consulting, and smart security solutions delivered via IOT devices or control systems for buildings and homes. As a member of the Taiwan Tech Arena (TTA) program, P-Waver is working toward preventing seismic hazards across a market area spanning two billion people and three billion businesses.

**3.8Embedded Assembly and C language**

```
#include<iostream>

using namespace std;

       int main()

{

   float magnitude;

   std::cout<<"Enter the magnitude of the earthquake :"<<endl;

   std::cin>>magnitude

  if(magnitude>=0 && magnitude<=4)

   std::cout<<"MINOR"<<endl;

   else if(magnitude>4 && magnitude<=5)

   std::cout<<"LIGHT"<<endl;

   else if(magnitude>5 && magnitude<=6)

   std::cout<<"MODERATE"<<endl;

   else if(magnitude>6 && magnitude<=7)

   std::cout<<"STRONG"<<endl;

   else if(magnitude>7 && magnitude<=8)

   std::cout<<"MAJOR"<<endl;

   else if(magnitude>8)

   std::cout<<"GREAT"<<endl;

   else
```

```
    std::cout<<"Magnitude cannot be negative."<<endl;



    return 0;

}
```

**3.9Proetus Stimulator:**

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

**3.10Serial Port Communication:**

On computers, a serial port is a serial communication interface through which information transfers in or out sequentially one bit at a time.[1] This is in contrast to a parallel port, which communicates multiple bits simultaneously in parallel. Throughout most of the history of personal computers, data has been transferred through serial ports to devices such as modems, terminals, various peripherals, and directly between computers.

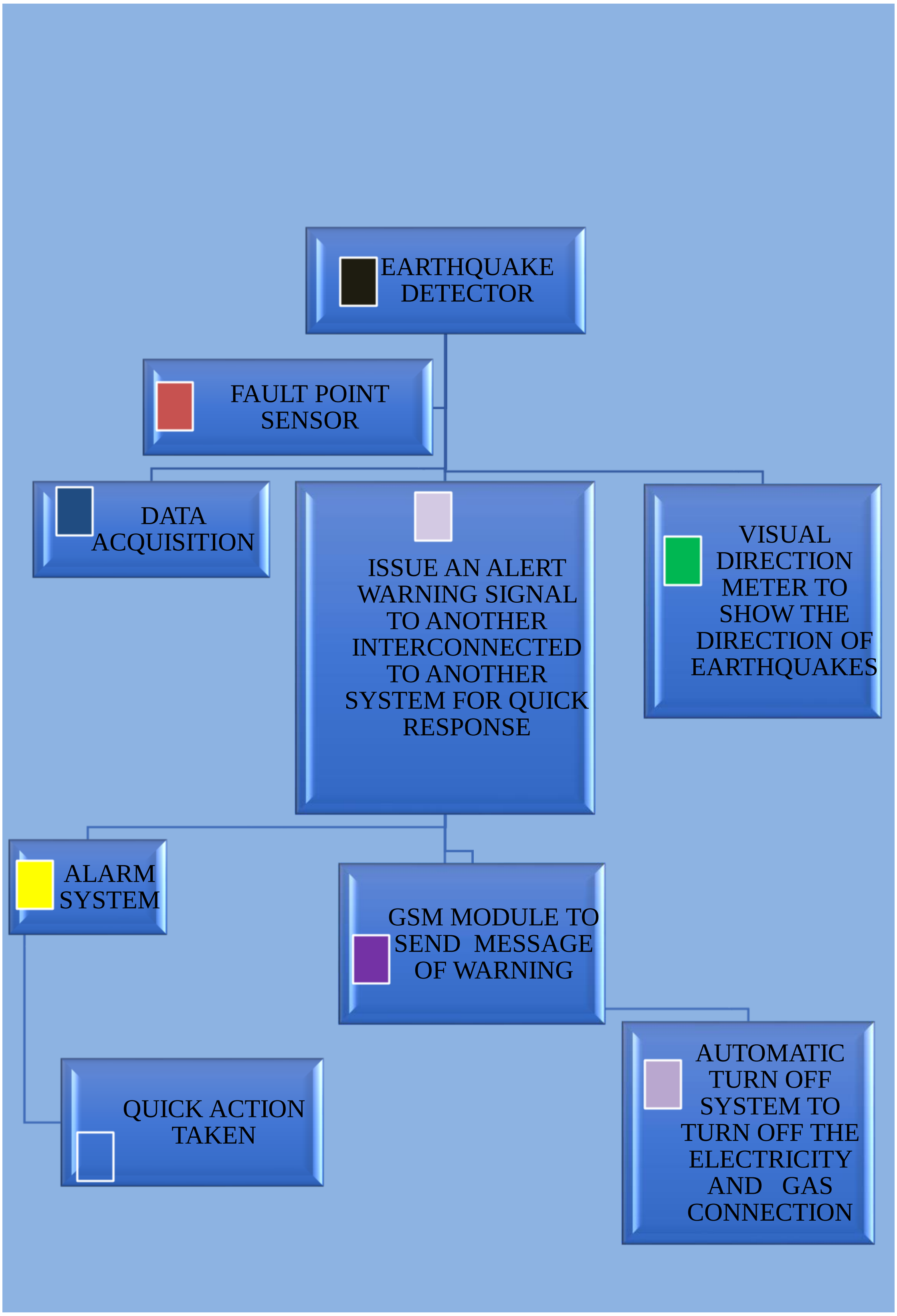
**3.11RS 232 Protocol:**

Despite the "RS" standing for "Recommended Standard", the specifications of RS-232 are relatively flexible and have been repeatedly updated over the past several decades. For example, the protocol can use either a 25-pin or 9-pin D sub connector. Because of this, two devices using the same standard may not be immediately compatible because they have different physical connectors.

RS-232 communicates data one bit at a time (in series), unlike a parallel interface that sends multiple bits simultaneously. The key benefit of this is that serial communication is less complicated and requires fewer wires.

In modern personal computers, USB has displaced RS-232 from most of its peripheral interface roles.

**3.12Structure of the System:**




**3.13System Work Flow:**

In this project four systems are developed and interconnect with Pendulum form earthquake detector shown in Figure (3) to build up a system called GSM based early warning wireless earthquake alarm system. A free swing sensitive pendulum is fitted inside a cylindrical shape tube, to detect the earthquake vibration. When seismic wave collides with pendulum it sideways from its resting equilibrium positioning cylindrical shape because of energy stored in it and it oscillate like a Foucault pendulum. The four-pulse receiver is connecting in bottom side of cylindrical body in all four directions east, west, north, south respectively. When it collides with any pulse receiver data acquisition process become complete and the receiving pulse send to all four systems which is interconnect with earthquake detector to do perform task. After recognizing the seismic wave direction, it will send information to visual Indicator, the function of visual indicator is it visually shows the warning from which point seismic wave is coming either from the east or the west. The automatic turns off system has a very key role in modern system in which every single device is automatic. When the P-wave strikes with pendulum it sends the pulse to the base station, trigging an alarm to automatically turn off the system. In the late 1954 automatic turn off system is installed in Japanese railway station to stop or slow down the train. It can be used in atomic reactor plant, industries and where the people working with heavy machinery, especially where casualties may be occurring. The GSM has a very important role here in order to warn the people. In modern world, where a mobile has become every person's need and every individual has an access to it. The alert warning massage can be sent to people and it can save the human life as they will get early warning of earthquake and will be aware of how to deal with this situation. Wireless alarm system is a technique to warn the people through wirelessly which can be install everywhere such as room, office, building or as per need when earthquake alarm system detects the P-wave it sends the signal to wireless alarm to start the alarm and it is a very useful method and quick warn technique that may save life.

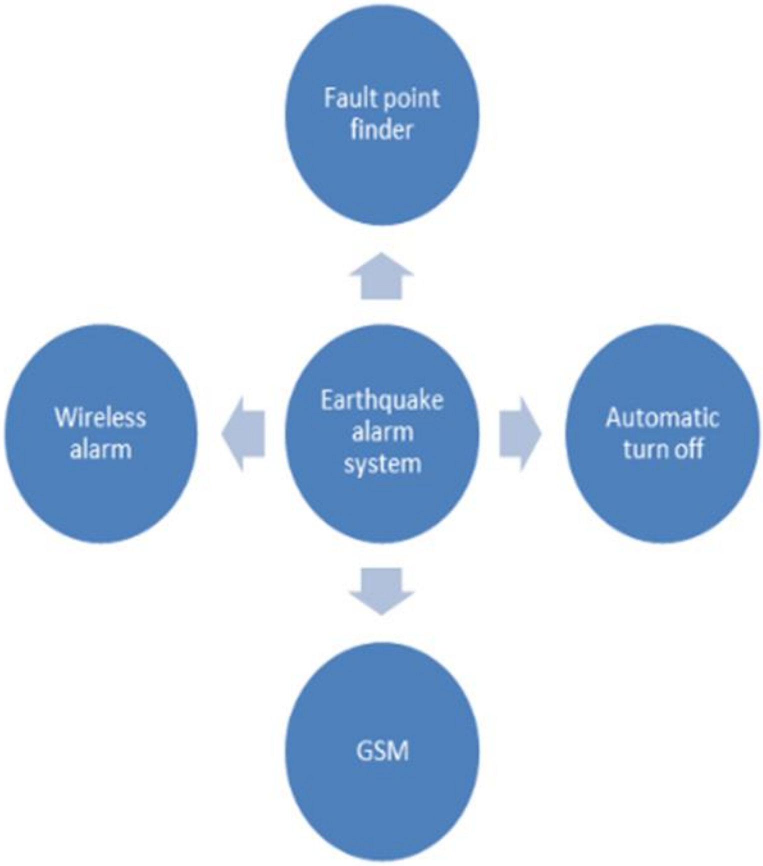



**Fig 5 Earthquake Alarm system connected with another system**

### 3.14Construction

Designing of this project is possible by using of AT89c51 microcontroller. The microcontroller has a central role in this project to design a GSM based early warning earthquake alarm system. The earthquake alarm system is interconnecting with four another system, this made possible by the use of microcontroller to work simultaneously. The circuit diagram of the system is shown in Figure 4,5 &6. A free swing sensitive pendulum fitted in cylindrical shape to detect the earthquake vibration as shown in figure 7. When seismic wave collides with pendulum it sideways from its resting equilibrium position in cylindrical shape because of energy stored in it and it oscillate. The four-pulse receiver is connecting in bottom side of cylindrical body in all four directions east, west, north, south respectively. When it collides with any pulse receiver data acquisition process become start and the receiving pulse send to all four systems which is interconnect with earthquake detector to do perform task. R. The microcontroller as receive the pulse from the pulse receiver it sends the warning pulse at the same time to four another system which is interconnect with earthquake system. When GSM kit receive the signal it sends the warning alert message to all mobile number which is stored in database of GSM, and may save the life by performing he early warning service. On the other hand, wireless alarm system which can be install at any place start alarm as it receives the alarm signal and by this action people can be aware that earthquake is coming and it may save the life as they will aware that how to deal with this situation. The automatic turns off system has a very important role in modern life where every signal device or system is automatic. As it receives the warning signal it quickly turns off the all-possible domestic connection such as it turns off the electricity and gas for preventing any short circuit or fire burning due to leakage and open safety/ emergency door and in industry level it can turn off the machinery or any system to prevent any damages and start alarm to move away worker from heavy machinery may reduce the casualties. In the end visual direction indicator is used to visually show the direction that from which point earthquake is coming either from the east or west. This all system working quickly at the same time as it is receiving the pulse and performing early warning operation through the rapid action has a role of saving the human life is made possible by the use of microcontroller.

### 3.15Software Used

This chapter consists of information about software which is used in this project. There are many electronic software which is used for designing and simulating the electronic circuit. GSM based early warning earthquake alarm system has a very important role to save the life in natural disaster. To design a efficient earthquake alarm circuit it is very important to design a circuit correctly that's why we are using some of following software to accomplishing the GSM based early warning earthquake alarm system. We used mutisim software to check circuit through simulation. Micro Vision Keil is used to convert the C language program into the HEX file and burned it into microcontroller IC. Express schematic is used to draw the diagram of the circuit and visual basic used for GSM interfacing purpose and for making the earthquake monitoring application.

## 4. RESULT AND DISCUSSION

In this Project, one of the most key problems occurs in real time prediction of earthquake system is tried to solve. This thesis proposed a new view point to add communication resources and others previous research in order to make a one new efficient system to warn the people in real time. By analyzing of previous earthquake record we reached at this point that life losses can be minimize if the authentic earthquake information reached from the identified institution to the people before the earth quake destruction, then early warning concept fulfill. The proposed system methodology gives big contribution to making an efficient system with the usage of GSM for broadcasting the early warning message and wireless alarm for start alarm as it receive the signal and automatic turn off system for turn any system to prevent any damages during working The working of a system is made possible by the using of AT89C51 microcontroller which is the heart of the system and gives instruction to all the connected system for work simultaneously and to give the whole package of earthquake detector and people warn system.

### 4.1Extraction with Embedded C Language

```
#include<iostream>

using namespace std;

    int main()

{

  float magnitude;

  std::cout<<"Enter the magnitude of the earthquake :"<<endl;

  std::cin>>magnitude

 if(magnitude>=0 && magnitude<=4)

  std::cout<<"MINOR"<<endl;

  else if(magnitude>4 && magnitude<=5)

  std::cout<<"LIGHT"<<endl;

  else if(magnitude>5 && magnitude<=6)

  std::cout<<"MODERATE"<<endl;

  else if(magnitude>6 && magnitude<=7)

  std::cout<<"STRONG"<<endl;

  else if(magnitude>7 && magnitude<=8)

  std::cout<<"MAJOR"<<endl;

  else if(magnitude>8)

  std::cout<<"GREAT"<<endl;

  else

  std::cout<<"Magnitude cannot be negative."<<endl;
```

```
    return 0;

}
```

**OUTPUT -**
**Enter the magnitude of the earthquake:**
**3.6**
**MINOR**

**Enter the magnitude of the earthquake:**
**12**
**GREAT**

**Enter the magnitude of the earthquake:**
**-2**
**Magnitude cannot be negative.**

The c++ embedded language worked and produced the output in accordance with the wave of the earthquake as shown in the written programme above when the data was transmitted into binary format from the data acquisition system.

**4.2Extraction with R232 Protocol**

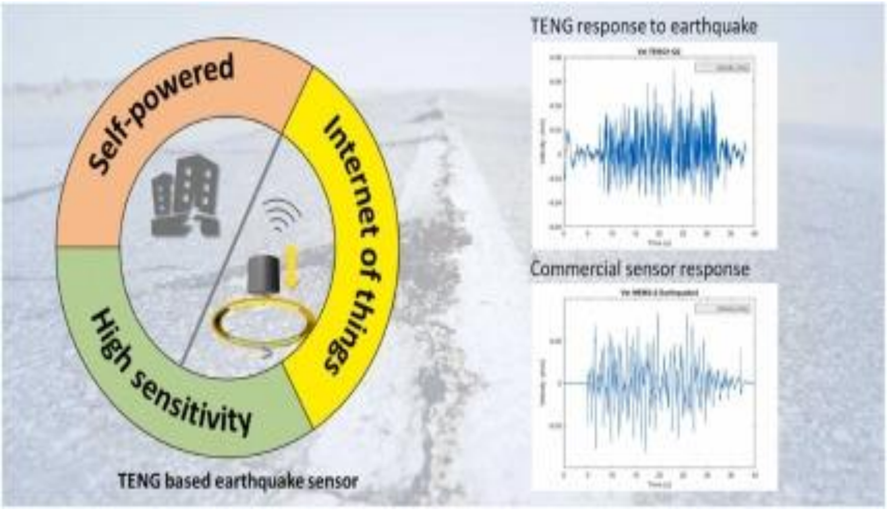



**Fig. 6 TENG RESPONSE TO EARTHQUAKE**

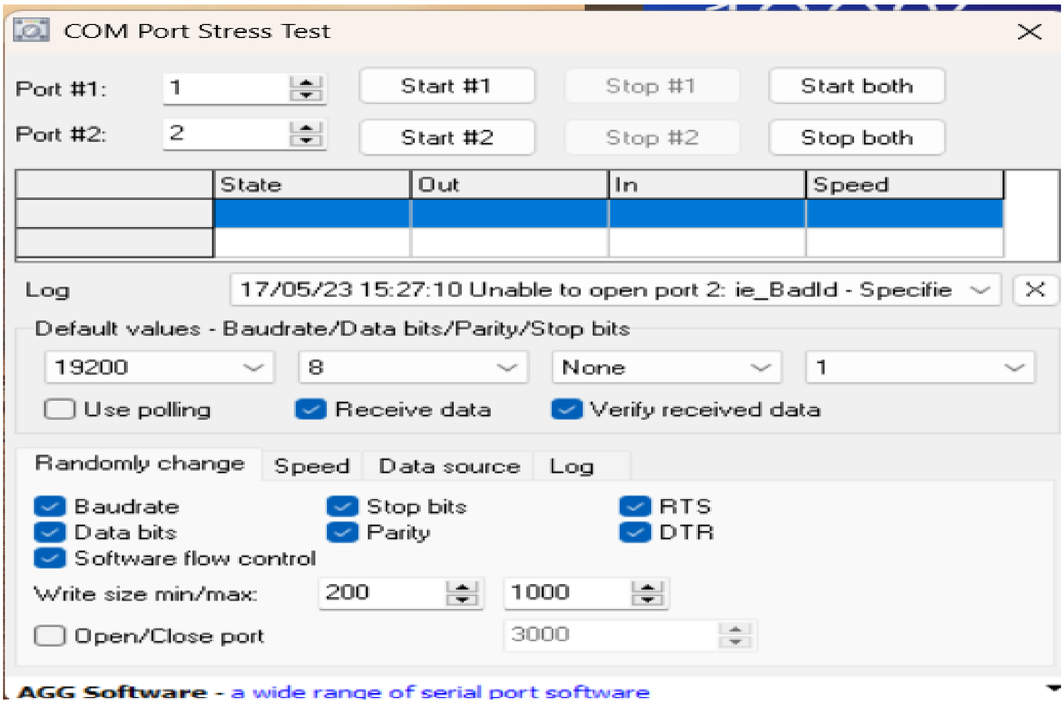



**Fig. 7 R232 Port Test**

The extraction was finished when the GSM data was gathered, so the R232 protocol is now operational and executes the signal and response in accordance with the earthquake, as shown in figs. 4 and 5.

### 4.3Extraction From GSM MODULE

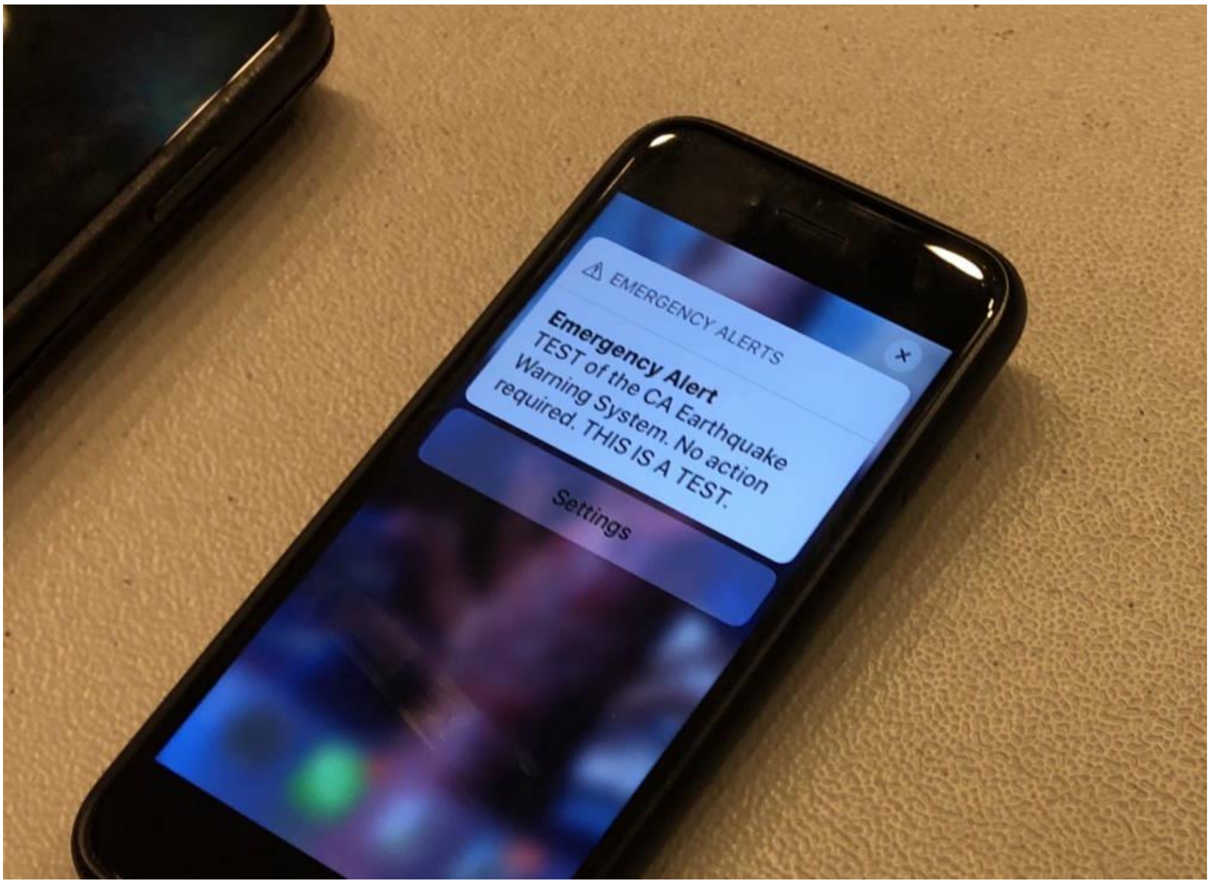



**Fig 8 GSM Signals for Earthquake**

In the early warning system, the GSM is essential. As illustrated in Fig. 6, after receiving the information from the visual direction indicator, the GSM programmed prepares a signal in the form of an SMS to notify people of an earthquake and allow them time to take safety precautions.

## 5. CONCLUSION

In this study, Real time prediction and alarm system to warn the people has been accomplished. The main key problem to warn the people in real time mode is tried to solve. Using the GSM system, an early warning message sent as the earthquake detector detects the earthquake sound wave and generate the pulse to auto turn off system that would turn off the gas or electricity connection and send the pulse to alarm system to warn the people using voice audible alarm. By analyzing the previous earthquakes, we reached at this point that casualties can be minimize if the people get earthquake coming authentic information in real time to take action before the coming of destructive sound wave. The proposed system has a key role to make the useful earthquake system to warn the people in real time and send the message to the people as it receives the earthquake initial sound wave and people can take action before the coming of destructive wave.