EARTHQUAKE ALERTS THROUGH MEMS ACCELEROMETER AND GSM NETWORK

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Abstract- **The main aim of the project is to provide alerts about Earthquake before it comes by using the MEMS & GSM technologies. The MEMS Sensors, having the X and Y coordinates which are used for sensing the movements in all directions, are used to find out the disturbance in all directions. While MEMS observe the movements, it sends a request to a PIC microcontroller. The microcontroller will automatically send a message to the authority through GSM network and displays in the Display.**

Index Terms- **GSM network, embedded system, MEMS, PIC.**

I.INTRODUCTION

Earthquakes [1] which are a natural calamity phenomenon, challenges the lives of thousands of people every year, making it as an inevitable process. The June 16, 1819 Gujarat earthquake [2] with a magnitude of 8.2 caused more than 1543 deaths. The April 1905 Kangra earthquake in Himachal Pradesh earthquake with a magnitude of 7.8 caused more than 20,000 deaths. The 1934 Nepal–Bihar earthquake with 8.7 magnitudes caused more than 8100 deaths. The December 26, 2004 Sumatra Earthquake and Indian Ocean Tsunami demonstrated the menace of a 9.3 magnitude causing 283,106 deaths. The 2011 Sikkim earthquake with scale 6.9 caused more than 118 deaths in the north-east India. Nevertheless history is observant of many deathly earthquakes that terrified the survival of many lives.

The upcoming demands are a challenge and thus the reason for increase in automated [3] systems. With the present scenario of technological improvement, most of the systems are automated with few of them requiring manual supervision [4]. This calls for the use of automated systems in every possible field. The field of electronics show prominent improvement in the performance with the use of automated systems.

As the technology improves, a demand rises for a warning system [5] that will alert every one of these deathly measures, though it can't be prevented. The MEMS Sensors detects movements or disturbances in all directions. While MEMS [8][9] observe the movements, it sends a request to a PIC microcontroller. The microcontroller block plays a major role in this work. The PIC 16F877A, a 40-pin IC, microcontroller chip is used in this project work and is the heart of the project. This Microcontroller will automatically send a message to the authority through GSM [10] network about the disturbances detection and displays in the Display unit.

II.PROPOSED SYSTEM

Embedded System is a combination of hardware and software used to achieve a single specific task. An embedded system is a microcontroller based, software driven, reliable, real-time control system, autonomous, or human or network interactive, operating on diverse physical variables and in diverse environments. This system is used to integrate the various modules.
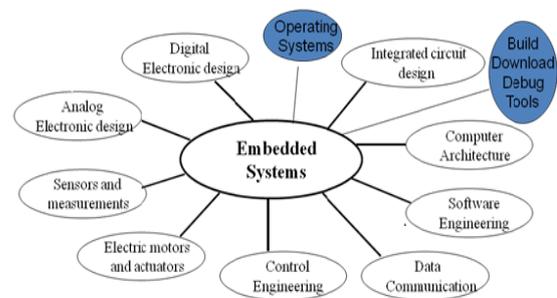

Figure 1. Embedded system design calls on many disciplines

The block diagram interfacing the various modules is shown in figure 2.
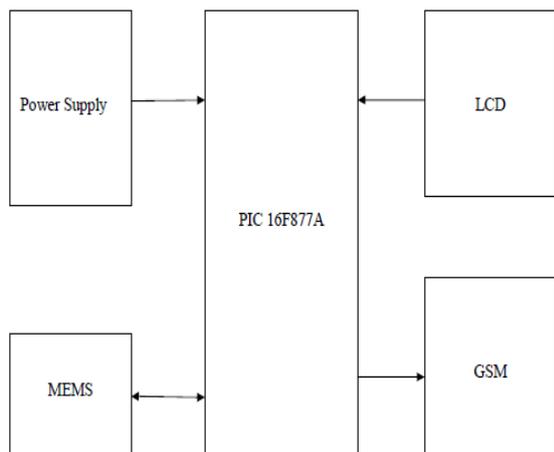
Figure 2. Block Diagram

The major components of this project are micro controller, MEMS and, GSM Module. And power supply unit is given to the device and the Display unit to Display.

The microcontroller used is PIC16F877A. The microcontroller is supplied with a power supply of +5Volts. MEMS [10] is interfaced to the PIC microcontroller, which acts as the input to the controller. The control unit where the system is installed, has a LCD display interfaced with the controller to indicate the intensity of the earthquake. Further, the microcontroller is connected with a GSM module through which messages will be sent to the registered users. As soon as some vibration occurs, the MEMS sense it and depending on the intensity of the vibrations, signals are sent to the controller. The signals are converted by the ADC and the values are calculated which is displayed on the LCD screen. The same is sent to the users through GSM [11] to alert them of the danger.

PIC MICROCONTROLLER:

The heart of this project is PIC16F877A microcontroller. The enhancing features of PIC are 16bit timer, 10-bit ADC, USART, SPI, I2C, 256 bytes of EEPROM memory, and 8kbytes of flash program memory, with speed of program execution that is about 1 microsecond or 10 MIPS (10 Million Instructions per second), etc. However, as compared to other microcontrollers, it is fast and very easy to program in C language because of huge support that can be obtained from the manufacturer (Microchip Corporation) for programming. The special IDE offered by the manufacturer, known as MPLAB IDE is used for code generation purpose. Another feature is that there are several cheap programming tools to dump

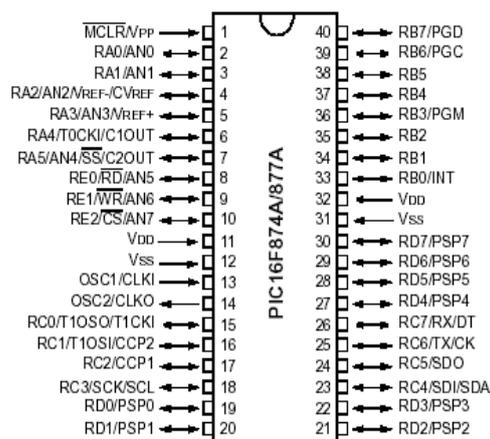the coding into the controller, for example: ProPIC, PIC Flash, ProMATE, and ProUniversal.

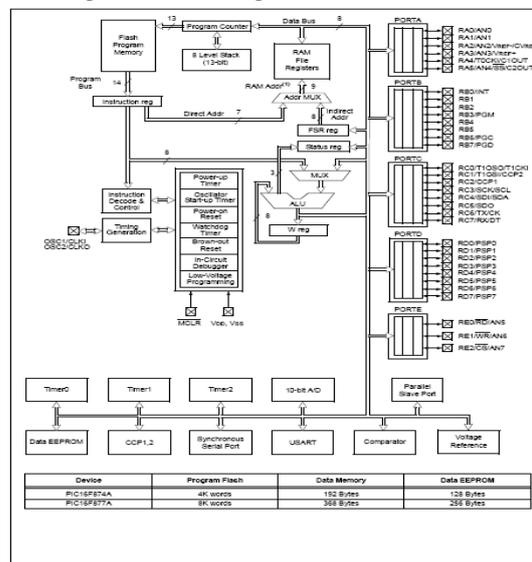**Figure 3: Pin diagram of PIC16F877A**

Figure 4. Functional block diagram of PIC 16F877A

A computer-on-a-chip is a variation of a microprocessor which combines the processor core (CPU), some memory, and I/O (input/output) lines, all on one chip. The computer-on-a-chip is called the microcomputer whose proper meaning is a computer using a (number of) microprocessor(s) as its CPUs, while the concept of the microcomputer is known to be a microcontroller. There is a set of digital logic circuits integrated on a single silicon chip in a microcontroller. This chip is used to accomplish certain tasks. The operation is shown in figure 5.
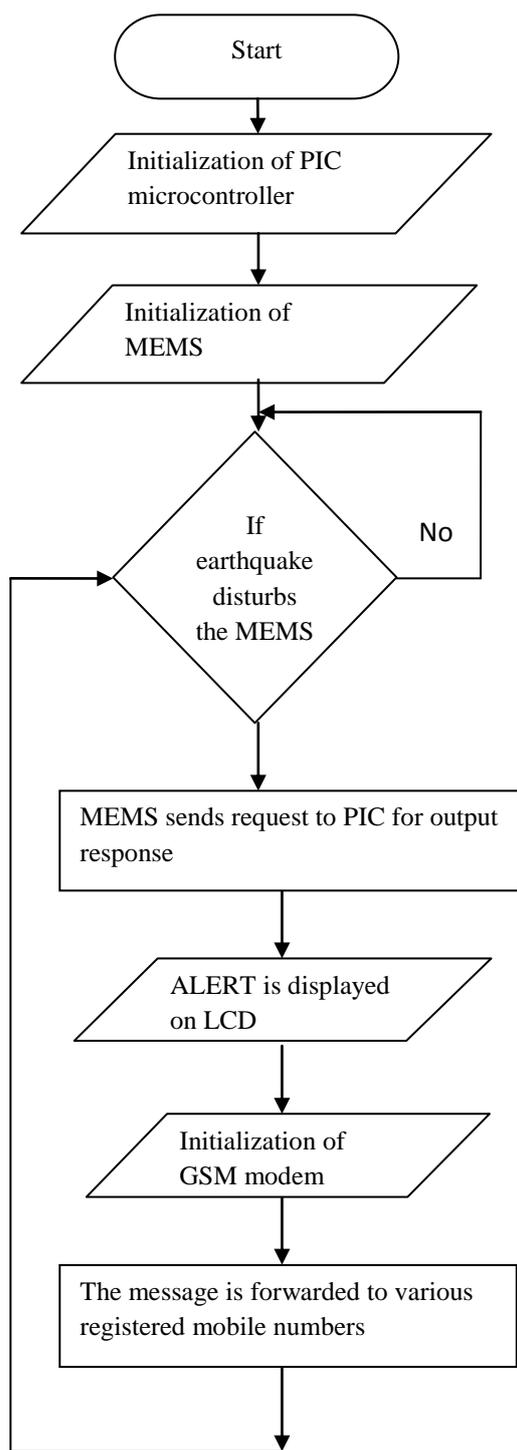
Start

Initialization of PIC microcontroller

Initialization of MEMS

If earthquake disturbs the MEMS — No

MEMS sends request to PIC for output response

ALERT is displayed on LCD

Initialization of GSM modem

The message is forwarded to various registered mobile numbers

Figure 5. Flowchart

The working principle of the project is to finding the Alerts before the Earthquake affects or damages. Firstly, we can find the MEMS Movements [8] and in case there is any alert, the details of the movements can be given to the controller by using the MEMS technology through GSM which will further send messages to the mobile phone [12].
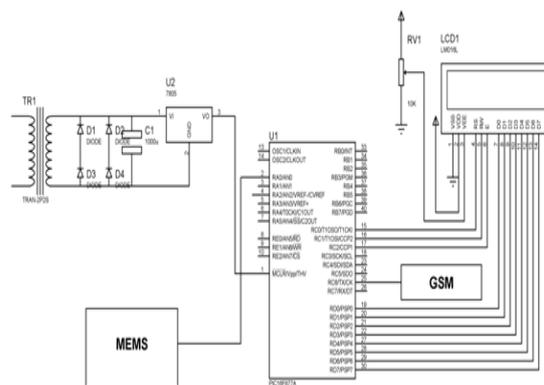

Figure 6.Circuit Diagram GSM (Global System for Mobile communication)
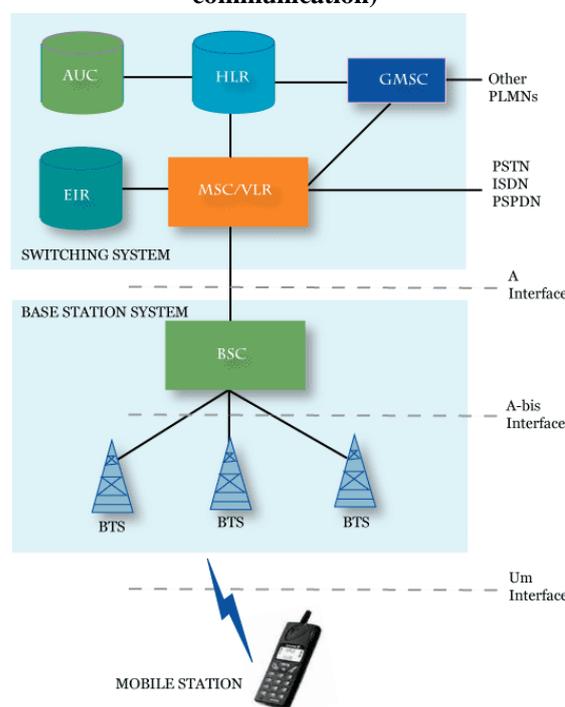

Figure 7. GSM Network

GSM provides recommendations, not requirements. The GSM specifications define the functions and interface requirements in detail but do not address the hardware. The reason behind this is to limit the designers as much as possible but still to make it possible for the operators to buy equipment from different suppliers. The GSM network is divided into three major systems: the switching system (SS), the base station system (BSS), and the operation and support system (OSS). The operations [11][12] and maintenance centre (OMC) is connected to all the equipments in the switching system and to the BSC. The implementation of OMC is called the operation and support system (OSS). The OSS is the functional entity from which the network operator monitors

and controls the system. The purpose of OSS is to offer the customer cost-effective support for centralized, regional and local operational and maintenance activities that are required for a GSM network. An important function of OSS is to provide a network overview and support the maintenance activities of different operation and maintenance organizations.

MEMS:

Micro-Electro-Mechanical System (MEMS) is the integration of mechanical electronic components on a common silicon substrate through micro fabrication technology. MEMS uses a technology where number of components are integrated that sense and control environmental parameters. While the electronics are fabricated using integrated circuit (IC) process sequences (e.g., CMOS, Bipolar, or BICMOS processes), the micromechanical components are fabricated using compatible "micromachining" processes that selectively etch away parts of the silicon wafer or add new structural layers to form the mechanical and electromechanical devices. MEMS sensors are power efficient and more sensitive to input parameters compared to other sensors.
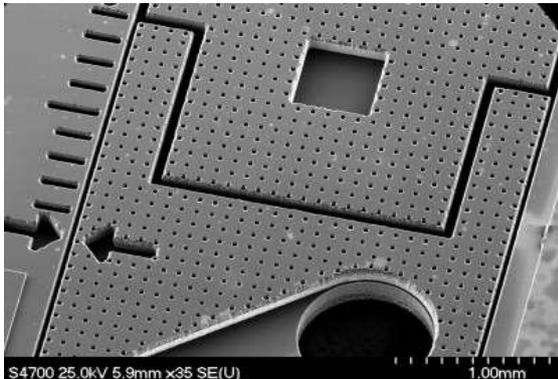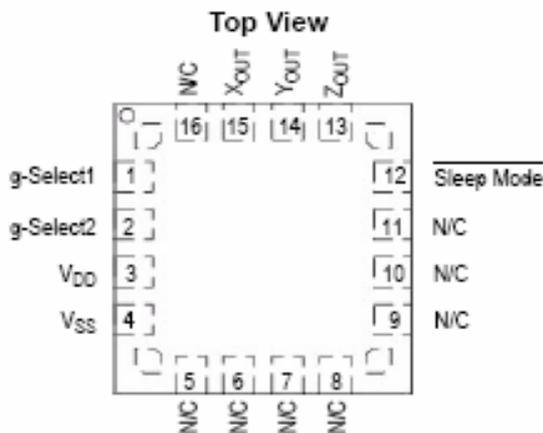

Figure 8. MEMS

Figure 9. PIN diagram for MEMS

Table 1 shows the pin configuration of MEMS accelerometer used in the project.

Table 1. PIN description for MEMS

Pin no.	Pin Name	Description
1	g-Select1	Logic input pin to select g level
2	g-Select2	Logic input pin to select g level
3	V_{DD}	Power Supply
4	V_{SS}	Power Supply Ground
5-7	N/C	No internal connection, leave unconnected
8-11	N/C	Unused for factory trim, leave unconnected
12	Sleep mode	Logic input pin to enable product or Sleep mode
13	Z_{OUT}	Z direction output voltage
14	Y_{OUT}	Y direction output voltage
15	X_{OUT}	X direction output voltage
16	N/C	No internal connection, leave unconnected

LCD Display:

Liquid crystal display (LCD) has material which combines the properties of both liquid and crystals. They have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an order form similar to a crystal.

Figure 10. 16x2 LCD Display

More microcontroller devices are using 'smart LCD' displays to output visual information. The following discussion covers the connection of a Hitachi LCD display to a PIC microcontroller. LCD displays designed around Hitachi's LCD HD44780 module, are inexpensive, easy to use, and it is even possible to produce a readout using the 8 x 80 pixels of the display. Hitachi LCD displays have a standard ASCII set of characters plus Japanese, Greek and mathematical symbols.
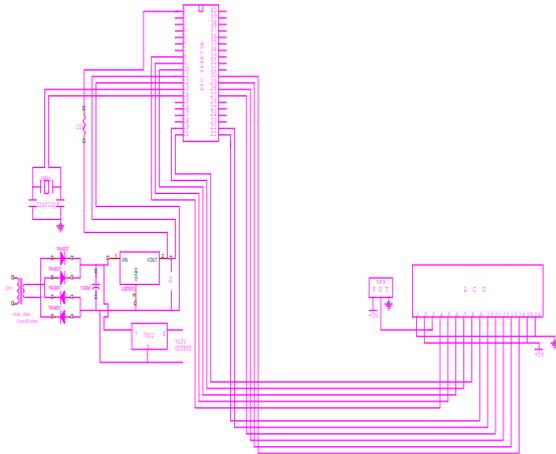

Figure 11. Interfacing PIC microcontroller to LCD

SOFTWARE TOOLS:

➢ HI-Tech PIC C Compiler
➢ MPLAB
➢ Protel
➢ Propic

HI-TECH PICC is a high-performance C compiler for the Microchip PIC 10/12/14/16/17 series of microcontrollers. HI-TECH PICC is an industrial-strength ANSI C compiler - not a subset implementation like some other PIC compilers. The PICC compiler implements full ISO/ANSI C, with the exception of recursion. This ANSI C Compiler integrates into Microchips MPLAB(R) IDE and is compatible with all Microchip debuggers and emulators. All data types are supported including 24 and 32 bit IEEE standard floating point. HI-TECH PICC makes full use of specific PIC features and using an intelligent optimizer, can generate high-quality code easily rivalling hand-written assembler. Automatic handling of page and bank selection frees the programmer from the trivial details of assembler code.

MPLAB INTEGRATION:

MPLAB Integrated Development Environment (IDE) is a free, integrated toolset for the development of embedded applications employing Microchip's PIC micro and PIC microcontrollers.

MPLAB IDE runs as a 32-bit application on MS Windows, is easy to use and includes a host of free software components for fast application development and super-charged debugging. MPLAB IDE also serves as a single, unified graphical user interface for additional Microchip and third party software and hardware development tools. Moving between tools is a snap, and upgrading from the free simulator to MPLAB ICD 2 or the MPLAB ICE emulator is done in a flash because MPLAB IDE has the same user interface for all tools.

III. TEST & RESULT ANALYSIS

Test 1: The overall circuit design is placed on a ground surface during actual earthquake.

Result 1: Earthquake is detected by the designed device and alerts are received to various registered mobile numbers.

Test 2: The overall design circuit is placed on a test bridge for experiment.

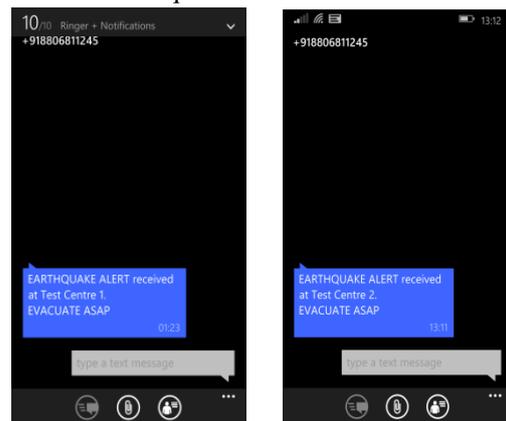**Result 2**: Earthquake is not detected.

Figure 12. Results for test condition 1&2

The overall design of the circuit is successfully designed and verified. This project first discussed the best Earth quake finding Technology. Our project is going to concentrate on the Environmental Changes By Using MEMS technology.

IV. CONCLUSION

This project studied the process is going to concentrate on the Earthquake Alert system. The MEMS Sensors are used to find out the movements in all directions. The movement will be observed by the MEMS sensor. While MEMS observe the movement it sends a request to the microcontroller. Microcontroller will automatically send a message to the authority through GSM. And it displays in the Display unit.

Applications:

- ➢ Automated Alerts to emergency services like Hospitals and Fire Stations.
- ➢ Used in Environmental Changes.
- ➢ Used in Theft Finding In Industries
- ➢ Used in Reducing Robbers.

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