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MICRO-CONTROLLER BASED EARTHQUAKE DETECTION USING SENSING ELEMENT

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ABSTRACT



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An earthquake (also known as a tremor or temblor) is the result of a sudden release of energy in the Earth's crust that creates seismic waves. Earthquakes are recorded with a seismometer, also known as a seismograph. The moment magnitude of an earthquake is conventionally reported, or the related and mostly obsolete Richter magnitude, with magnitude 3 or lower earthquakes being mostly imperceptible and magnitude 7 causing serious damage over large areas. Intensity of shaking is measured on the modified Mercalli scale. Here we are presenting Microcontroller based An Earthquake Detection using Sensing Element to reduce its destructive losses.

Keywords: Earthquake, Mercalli Scale, Microcontroller, Richter magnitude, Seismic Waves.

1. INTRODUCTION:

An earthquake is a sudden vibration or trembling in the Earth.. Earthquake motion is caused by the quick release of stored potential energy into the kinetic energy of motion. Most earthquakes are produced along faults, tectonic plate boundary zones, or along the mid-oceanic ridges .At these areas, large masses of rock that are moving past each other can become locked due to friction. Friction is overcome when the accumulating stress has enough force to cause a sudden slippage of the rock masses. The magnitude of the shock wave released into the surrounding rocks is controlled by the quantity of stress built up because of friction, the distance the rock moved when the slippage occurred, and ability of the rock to transmit the energy contained in the seismic waves. Sometime after the main shock wave, aftershocks can occur because of the continued release of frictional stress. Most aftershocks are smaller than the main earthquake, but they can still cause considerable damage to already weakened natural and human constructed features. At the Earth's surface, earthquakes manifest themselves by shaking and sometimes displacing the ground. When a large earthquake epicenter is located offshore, the seabed sometimes suffers sufficient displacement to cause a tsunami. The shaking in earthquakes can also trigger landslides and occasionally volcanic activity.

In its most generic sense, the word earthquake is used to describe any seismic event whether a natural phenomenon or an event caused by humans — that generates seismic waves. Earthquakes are caused mostly by rupture of geological faults, but also by volcanic activity, landslides, mine blasts, and nuclear experiments. An earthquake's point of initial rupture is called



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its focus or hypocenter. The term epicenter refers to the point at ground level directly above the hypocenter.

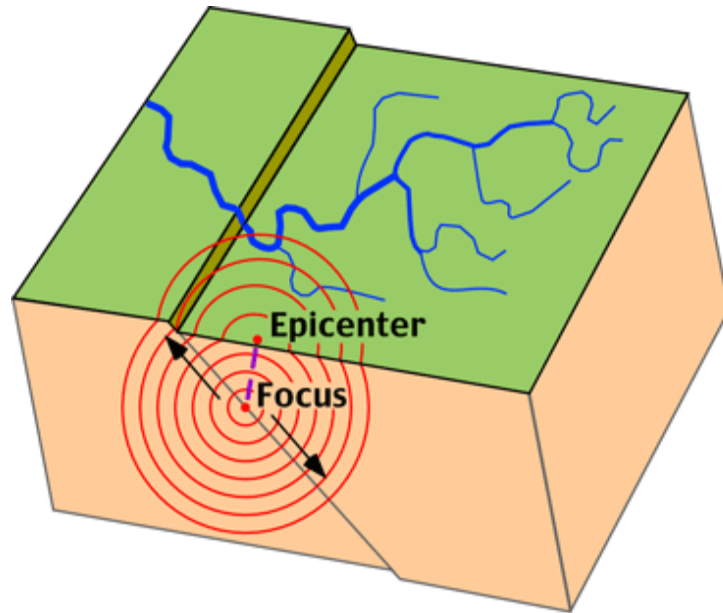


Fig.1 Movement of body waves away from the focus of the earthquake. The epicenter is the location on the surface directly above the earthquake's focus.

2. System Building Blocks:



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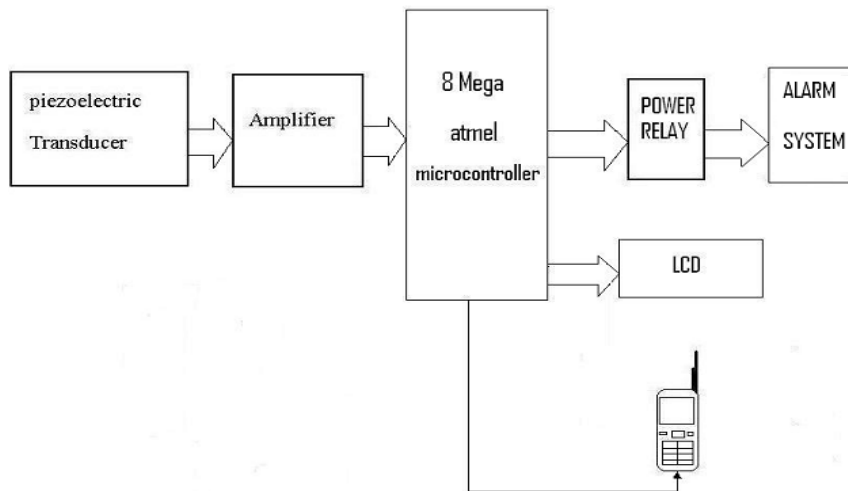
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Fig. 2 System Block Diagram

The ATmega8 is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega8 achieves throughputs approaching 1 MIPS per MHz, allowing the system designer to optimize power consumption versus processing speed.

The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

The ATmega8 provides the following features: 8K bytes of In-System Programmable Flash with Read-While-Write capabilities, 512 bytes of EEPROM, 1K byte of SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible Timer/Counters with compare modes, internal and external interrupts, a serial programmable USART, a byte oriented Two wire Serial Interface, a 6-channel ADC (eight channels in TQFP and QFN/MLF packages) with 10-bit accuracy, a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and five software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, SPI port, and interrupt system to continue functioning. The Power down mode



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saves the register contents but freezes the Oscillator, disabling all other chip functions until the next Interrupt or Hardware Reset. In Power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping.

The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low-power consumption. The device is manufactured using Atmel's high density non-volatile memory technology. The Flash Program memory can be reprogrammed In-System through an SPI serial interface, by a conventional non-volatile memory programmer, or by an On-chip boot program running on the AVR core. The boot program can use any interface to download the application program in the Application Flash memory.

Software in the Boot Flash Section will continue to run while the Application Flash Section is updated, providing true Read-While-Write operation. By combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the AtmelATmega8 is a powerful microcontroller that provides a highly-flexible and cost-effective solution to many embedded control applications.

PIEZOELECTRIC TRANSDUCER:

A transducer is a device which converts physical quantity into electrical one. Transducer is classified into two types such as:

- 1) Active transducer
- 2) Passive transducer

Piezoelectric Effect is an effect that occurs when mechanical stress is applied to certain materials. An electrical polarization is set up in the crystal with the result that the faces become electrically charged. The charge reverses if the compression changes to tension. Because the effect is reversible an electric field applied across the material causes it to contract, or expand, according to the sign of the field. Piezoelectric materials include; Quartz crystals, Rochelle salts, barium titanate.



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The piezo-transducer consists of a thin slab of piezoelectric material sandwiched between two flexible metallic connections (usually a thin piece of flexible brass sheet metal and on top a thin gold layer). Obtain a piezo-transducer, as large as you can. As we know that the earth's vibrations due to earthquake is a physical quantity which is to be converted into electrical one. For this purpose we are using piezoelectric crystal since it is very sensitive to vibration.

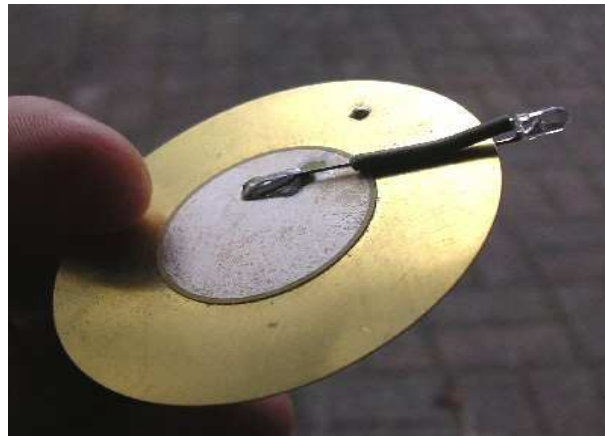


Fig.3 Piezoelectric Sensor

3. Proposed Flow Diagram:



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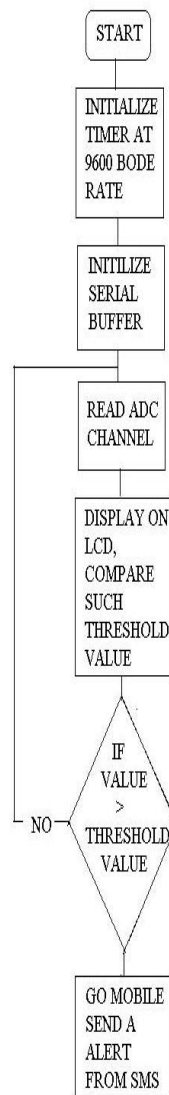
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Fig. 4 Flow Chart

We have already discussed the details of ATMEGA ATMEL in proceeding section of this report. Now we will discuss the working of project. We know that earthquake is natural disaster for us, but nature provides remedy to overcome this disaster by giving the boon of Piezoelectric materials which include Quartz crystals, Rochelle salts, barium titanate..The very first element of



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our project is sensing element which is a piezoelectric transducer, which works on basic principle of piezoelectric effect.

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The output of piezoelectric transducer is in mvolt. That is why there is need to amplify it for further processing. thus output of it is given to PIN NO2 of LM 124. The LM124 series consists of four independent, high gain, internally frequency compensated operational amplifier switch were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

The LM124 series can be directly operated off of the standard +5V power supply voltage which is used in digital systems and will easily provide the required interface electronics without requiring the additional $\pm 15V$ power supplies.

4. ADVANTAGES:

- 1) Our system has the potential to add vital seconds to earthquake warnings, giving extra time for action to be taken.
- 2) Early warning systems can play an important role in reducing the negative impact of these catastrophic events on densely populated areas and in mitigating the damage to strategic structures and lifelines.



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- 3) Provides information to support decision making for the rapid response of emergency management services.
- 4) It can activate the control system to protect crucial structures.
- 5) It requires less power supply.
- 6) Portable circuit easy to handle.

5. FUTURE ASPECTS:

- 1) Satellite phone can be introduced instead of cell phone to eradicate the network problem.
- 2) External memory can be interface to increase the capacity of cell phone of sending 'n' numbers of SMS.
- 3) 8megaATMEL microcontroller can be replace by other advance microcontroller.

6. CONCLUSION:

We have presented a novel technique to solve the automatic detection and classification problem of earth tremor in a single step by using microcontroller based earthquake detection. In our system the majority of cases offers real practical benefits in the event of an earthquake to safeguard lives and resources.

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