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A Low Cost Approach for Energy Harvesting From Mechanical Vibrations

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ABSTRACT: Energy crisis is the major problem we are facing today. So we are in search of alternative form of energy sources. We know that existing resources are being depleted day by day. In this project we are planning to harness energy from mechanical vibration. These mechanical vibrations are produced from piezoelectric crystal by the process of piezoelectric effect. Piezoelectric effect states that when a mechanical stress is applied to one pair of opposite faces of a quartz crystal, then equal and opposite electric charges are developed on the pairs of opposite faces of the crystal. We plan to do it in various fields of applications like drums, dance floor, shoes, train etc

KEYWORDS: energy harvesting, vibrational energy, piezoelectric crystal, piezoelectric effect, mechanical vibrations

I. INTRODUCTION

With the advancement of technology, the ability and efficiency of devices to capture even small amount of energy from surrounding or from an environment and converting it to electrical energy is increasing day by day. Moreover the microprocessors used have better power, efficiency and also have less power consumption techniques due to the advancement in its field. As a result more and more research is being conducted out in the field of electronics in order to develop more applications that utilize energy for harvesting power. Energy harvesting from naturally available source is better than other modes of production. These energy sources must be inexhaustible and must be able to produce better output powers. This free energy sources when properly designed and constructed will provide energy for a lifetime source and maintenance for these kinds will be low. These are more reliable than conventional wall plugs or batteries. It can also be viewed as an alternate source to the primary sources of power and enhance its overall reliability and can prevent any power interruptions. The piezoelectric effect depicts the mechanical and energy relation in solids and it is a reversible process. The mechanical stress produces energy (voltage) and if energy (voltage) is applied a mechanical energy is obtained sometimes which might change the volume of solids to a very small extent.

II. LITERATURE REVIEW

Ding Han et.al reported the production of power from shoes. It harnesses the vibrations while walking. They used a dc-dc converter for converting the voltages to low power applications. The equipment could be installed in the shoes as it is light weight and low cost.

Henry A. Sodano et.al reported the production of harnessing energy from piezoelectric materials. They studied the properties and the possible suitable techniques for production of energy. The explained the working principles that usually occurs in these piezoelectric materials.

P. Miao et.al reported the production of power from variable capacitors. They are based on the electrostatics principle. They are also capable of producing power to a required amount.

Mitcheson et.al reported the basic architecture layout design for the harnessing of vibration driven micro power generators. Various techniques to be considered for the design of devices to harness power is explained.

Kornbluh et.al .reported the conversion of energy using electrostrictive polymers. They used compact and light weight

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energy sources as the power source. They were able to achieve the expected power, and it was low cost and required less maintenance.

Monika Jain et.al reported the charging of mobile phones from the power generated from the shoes. The transducer is used to convert the charges. It also employs a bridge wave rectifier and the variable capacitor. It is the most promising source of energy and is low cost, light weight and maintenance cost is less.

III. PROPOSED METHOD

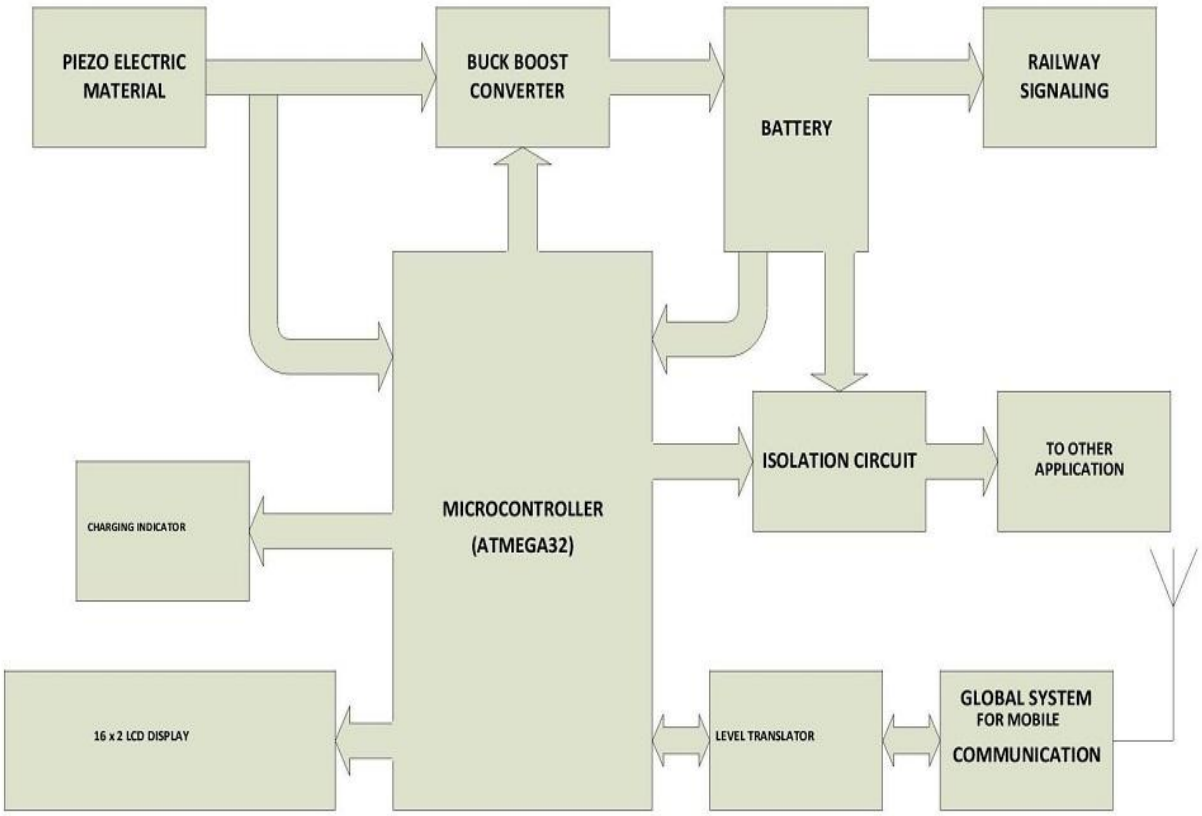

Fig: 1 Block Diagram

Fig (1) shows the block diagram. The block diagram of the proposed method is given in the figure 1 below. The principle used here is the piezoelectric effect. It states that when a mechanical stress is applies to a pair of opposite sides of the crystal equal and opposite charges are produced by the other pair of opposite sides of the crystal. The process is a reversible one. The energy from the vibrations is given to the piezoelectric crystal which converts the mechanical vibration into electrical energy. It is given to the energy harvester chip which produces an output of **5V**. The charging depends upon the intensity of the vibration. If the vibration received is low the energy produced will also be low. It needs to be given to the amplifier circuit to amplify these weak signals. Higher the rate of vibrations the higher the battery charge becomes. This voltage is given to the battery, and it stores it for future applications. The microcontroller used here is **Atmega32**. The **Atmega32** is selected because of its low cost and better efficiency. The

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microcontroller has 40 pins and has 4 ports having 8 pins. The data's are given to the appropriate pins of the ports. The battery charging and discharging is noted by the charge indicator device. The level translator circuit is used to convert the analog values into digital values and is given to the microcontroller. The GSM module is used to give proper messages to the user about the battery charge. In this the messages are generated when the battery charge drops below or equal to 20%. The next message is generated when the battery charge has risen above or equal to 80%. As a result appropriate action can be done. When the battery charge is greater than 80% it will be used to light the railway signals (as in this) using the help of a relay. It is usually given to the naturally open terminal of the relay. An isolator is used so as to send the signals only in a single direction. The battery charge can also be used for other applications for lighting a bulb or an LED. As the vibrations are produced the battery keeps charging and can be used as a supply. When there is no source, the power is preserved and when vibrations are present again charging process occurs. The process is repeated again and again. The LCD is used to display the appropriate messages. The LCD used here is the 2 x16 lines LCD.

IV. RESULTS

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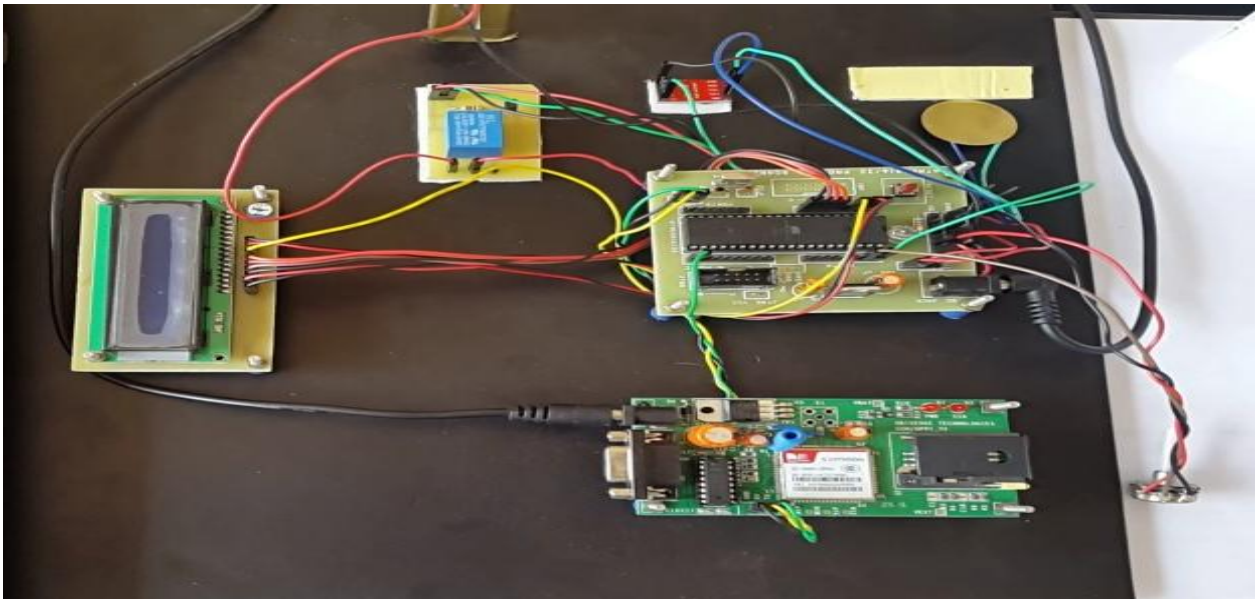

Fig: 2(a) Layout Design

Fig: 2(a) shows the circuit and design of layout. The hardware parts are shown in this figure. The hardware components consist of a piezoelectric crystal, an energy harvester chip, a GSM module, a Microcontroller, an LCD, a light and the power supplies. According to our analysis quartz crystal can convert vibrational energy in to electrical energy, but the energy obtained is very small. So by using buck boost converter, we amplify the weak signal. Hence the output obtained for our project is **5V**.By using this output energy the battery is charged. The output of the quartz crystal also varies according to the intensity of the vibration. The rate of charging time of the battery varies according to the intensity of the vibration. With the help of GSM module the appropriate message are sent to the user in order to indicate the charge level of the battery. When the battery charge falls below or equal to 20% the message is sent informing that the battery charge is low. When the charge is greater than or equal to 80% another message is sent informing the user the battery charge is high. And also the relay is triggered and the traffic lights will glow after the message is sent. A portion of the charge can also be used to light or charge other applications. With the help of more advanced technologies this project can be used in high power applications.

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Fig: 2(b) Working.

Fig: 2(b) shows the working. The input vibration is converted to electrical energy and is given to the battery. When the battery charge is greater than 80%, after the message is sent, the light glows, which is shown in the above figure.

V. CONCLUSION

The piezoelectric crystal produces a **5V** output with the help of the energy harvester circuit. The circuit is simple and easy to design. The harvester circuit is able to produce power even for higher power applications. The selection of the harvester circuit is based on the type of application and also the output power energy required. With the help of battery, the charging applications can be carried out. With the presence of ADC circuit in the microcontroller the bulkiness of the circuit is reduced and also the need for the voltage conversion circuit is eliminated. The rechargeable battery can be charged and can be used to power any electronic devices for any period of time while being continuously charged by ambient motion.

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