A

Project Report On

MOBILE CHARGER USING PIEZOELECTRIC EFFECT

Submitted By

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CERTIFICATE

This is certify that the project report entitled
"MOBILE CHARGER USING PIEZOELECTRIC EFFECT"
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Acknowledgement

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ABSTRACT

The increase in energy consumption of portable electronic devices and the concept of harvesting renewable energy in human surrounding arouses a renewed interest. This technical paper focuses on one such advanced method of energy harvesting using piezoelectric material. Piezoelectric materials can be used as mechanisms to transfer mechanical energy, usually ambient vibration, into electrical energy that can be stored and used to power other devices. A piezoelectric substance is one that produces an electric charge when a mechanical stress is applied. Conversely, a mechanical deformation is produced when an electric field is applied. Piezo-film can generate enough electrical density that can be stored in a rechargeable battery for later use. Piezoelectric materials have a vast application in real fields. Some of the latest applications are mentioned below. Currently, there is a need to utilize alternative forms of energy at passenger terminals like airports and railways across the world. Cleaner, more sustainable forms of electrical power are needed in order to keep costs lower, to maintain positive and productive relationships with neighbors and to insure a healthier environment for future generations. The use of piezoelectric devices installed in terminals will enable the capturing of kinetic energy from foot traffic. This energy can then be used to offset some of the power coming from the main grid. Such a source of power can then be used to operate lighting systems. The increasing prevalence and portability of compact, low power electronics requires reliable power sources. Compared to batteries, ambient energy harvesting devices show much potential as power sources. A piezoelectric generator can be developed that harvests mechanical vibrations energy available on a bicycle. The electrical energy thus produced can be used to power devices aboard the bike, or other portable devices that the cyclist uses. Electrical energy can also be generated from traffic vibrations (vibrations in the road surface) using piezoelectric material.

Contents

List of Figures

Chapter 1

Introduction

In the current era, which is witnessing a skyrocketing of energy costs and an exponential decrease in the supplies of fossil fuels, there arises a need to develop methods for judicious use of energy which lay emphasis on protecting the environment as well. One of the novel ways to accomplish this is through energy harvesting. Energy harvesting, or energy scavenging, is a process that captures small amounts of energy that would otherwise be lost as heat, light, sound, vibration or movement. It uses this captured energy to improve efficiency and to enable new technology, like wireless sensor networks. Energy harvesting also has the potential to replace batteries for small, low power electronic devices. Piezoelectric materials can be used as a means of transforming ambient vibrations into electrical energy that can then be stored and used to power other devices. With the recent surge of micro scale devices, piezoelectric power generation can provide a convenient alternative to traditional power sources used to operate certain types of sensors/actuators, telemetry, and MEMS devices. The advances have allowed numerous doors to open for power harvesting systems in practical real-world applications. Much of the research into power harvesting has focused on methods of accumulating the energy until a sufficient amount is present, allowing the intended electronics to be powered. We have cited implementation of piezoelectric materials in harvesting energy from tapping of keys of keyboard and use it for various application like charging the mobile phones.

1.1 Aim of the Project

The aim of our project is to build a system that can generate power from that energy which was previously used to get lost.Our project is extremely simple but highly useful.This system when applied on large scale can generate very high amount of power this power then can be used for upliftment of the civilization.

Chapter 2

Literature Survey

2.1 Energy Harvesting using Piezoelectric Materials

Parul Dhinga from dept. of E.C.E of M.I.T Manipal has explained theoretical model for energy harvesting system using piezoelectric materials have been presented. It is evident that harnessing energy through piezoelectric materials provider a cleaner way of powering lighting systems and other equipment. It is a new approach to lead the world into implementing greener technologies that are aimed at protecting the environment. Piezoelectric energy harvesting systems are a one time installment and they require very less maintenance, making them cost efficient. One of the limitations of this technology is that its implementation is not feasible in sparsely populated areas as the foot traffic is very low in such areas. Further experimentation has to be carried out for its implementation on a larger scale, with an efficient interface circuit at a low cost in universities.

2.2 Power Harvesting System in Mobile Phones and Laptops using Piezoelectric Charge Generation

Karthik Kalyanaraman has proposed energy conservation systemfor mobile phones and laptop keyboards have been presented in this paper. The design presented here will be quiteeffective in providing an alternate means of power supplyfor the mentioned devices during emergency.Further, the approach presented in this paper can beextended to many other applications where there is scope forsimilar kind of energy conservation. The material used for the current application is a PZT with 1.5 Mba lateral stresses operating at 15Hz. Thevolume of the material used is 0.2cm3. The output powerproduced is 1.2W. The energy/power density is 6mW/cm3.The output voltage is 9V. This voltage can beused to produce the required amount of charge after beingprocessed.

2.3 Electrical Power Generation Using Piezoelectric Crystal

Anil Kumar has proposed that the technology is based on piezoelectric materials that enable the conversion of mechanical energy exerted by the weight of passing vehicles into electrical energy. As far as the drivers are concerned, the road is the same, she says Edery-Azulay added that expanding the project to a length of one kilometer along a single lane would produce 200 KWh, while a four-lane highway could produce about a MWh sufficient electricity to provide for the average consumption in 2,500 households. As the results shows that by using double actuators in parallel we can reduce the charging time of the battery and increase the power generated by the piezoelectric device. In second research where a piezoelectric generator was put to the test and generated some 2,000 watt-hours of electricity.

The setup consists of a ten-meter strip of asphalt, with generators lying underneath, and batteries in the roads proximity. So that it is clear by using parallel combination we can overcome the problems like of impedance matching and low power generation. The results clearly show that piezoelectric materials are the future of electric power generation.

2.4 Piezoelectric Crystals: Future Source of Electricity

Pramathesh T has explained that in India, maximum public movements is observed inrailways stations and holy places, hence, such places can beexploited for use of piezoelectric crystals for generation of electricity. Gathering ranging from thousands to millions areobserved in holy places, thus installation of piezoelectric crystals at floorings would generate enough power to light up lights of houses as well as air circulation systems. Use of piezoelectric crystals has being started and positiveresults are obtained. With further advancement in field of electronics, better synthesized piezoelectric crystals and better selection of place of installations, more electricity can begenerated and it can be viewed as a next promising source of generating electricity.

Chapter 3

Proposed Work

3.1 Problem Definition and Objectives

In todays era, energy is die hard need of the world. For which various methods of energy generation are developed. But methods employed for these purposes are expensive, space consuming, material consuming and hazardous to environment. The Power plants need large amount of land for which deforestation and rehabilitation of settlements is to be done .Which in turn affects entire ecosystem and entire social system. Also these power generation leads to depletion of resources. Therefore there is a vacuum for alternative efficient eco friendly power resource. Thus piezoelectric power generation can be a good alternative for fossil fuels. It is clean, non hazardous, easy implementable, inexpensive and eco friendly source of energy. There is no byproduct in this power generation. It occupies less space and is easily portable. We can implement this piezoelectric effect in various ways to generate energy. This system can be used at domestic level as well as at the high industrial level. We are implementing this at small level for power generation using keyboard and charging small gadgets like mobile phones.

Chapter 4

Project Design

4.1 Block Diagram

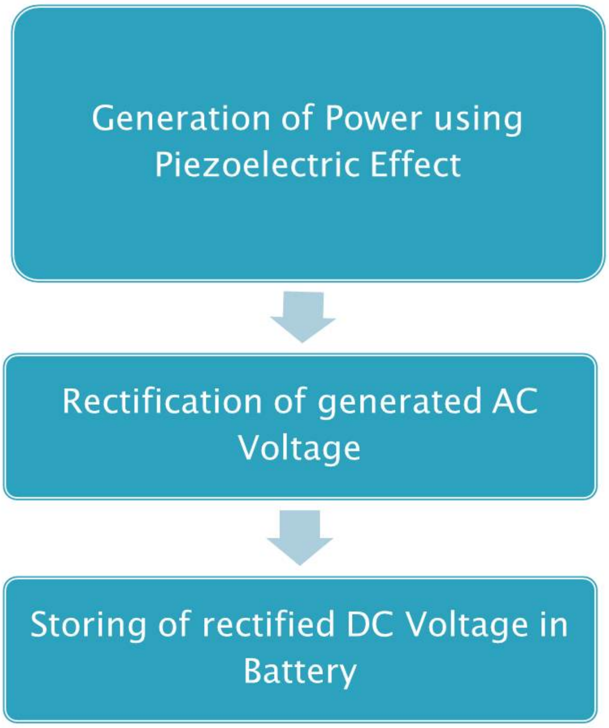

Figure 4.1: Basic Block Diagram

This shows the basic block diagram of our project. It is divided into three main block:

1. Generation of power from the piezoelectric material.This is the starting point of our project,here the power is generated by striking the piezoelectric keys

2. Rectification of generated AC voltage.As the power generated from the piezo material is AC is needed to be rectified.

3. Storage of rectified voltage.

Chapter 5

Implementation & Technologies Used

5.1 Charge Generation with Piezoelectric Material

Piezoelectric effect is expressed in single crystals, ceramics, polymers, composites, thin-films and relaxer type ferroelectric materials, but the majority of the energy harvesting devices fabricated in the past work have been made up of polymers (PVDF) and ceramics (lead zirconateleadtitanate, PZT).Electromagnetic generators use electromagnetic force to move free electrons in a coil around the permanent magnet rotator. Piezoelectric material, which is used as non-conductive material does not have free electrons, and therefore electrons cannot pass freely through the material. Piezoelectric ceramics do not have free electrons, but are made up of crystals that have many fixed electrons. These fixed electrons can move slightly as the crystals deform by an external force. This slight movement of electrons alters the equilibrium status in adjacent conductive materials and creates electric force. This force will push and pull the electrons in the electrodes attached to the piezoelectric crystal as shown in Fig

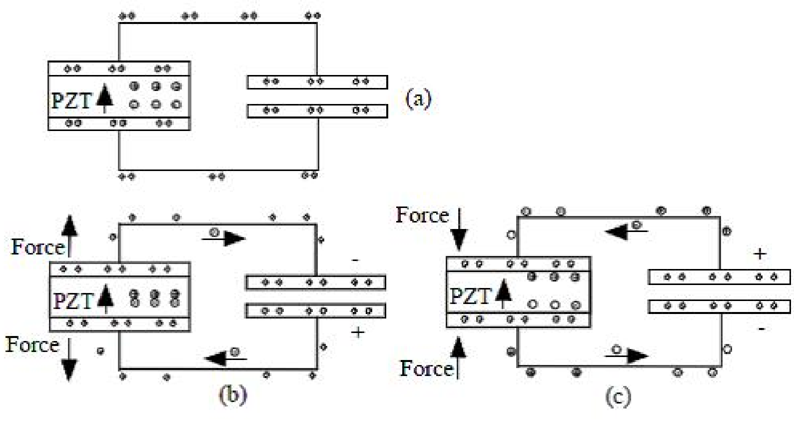

Figure 5.1: Charge generation in piezoelectric materials

Dielectric properties are observed on piezoelectric ceramics. The positively charged atoms are not in the center of the crystal, creating a charge dipole. The direction from the center to the positively charged atom is called the poling direction and in general is randomly distributed throughout the polycrystalline ceramic as shown in Fig. This poling direction can be modified by heat and voltage conditions. Piezoelectric crystals have their own temperature characteristics, known as Curie temperature. Common piezoelectric material has its own Curie temperature. Once the piezoelectric crystal is heated above Curie temperature, it loses its polarity and a new poling direction will appear by the application of the voltage across the piezoelectric material. The new poling direction appears along the applied voltage.

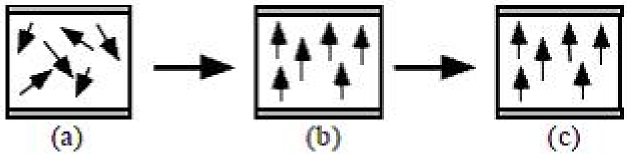

Figure 5.2: Poling process (a) Before poling (b) Apply voltage through the electrode at above Curie temperature (c) Remove external voltage and cool down

The poling direction is a very important property in piezoelectric material. Depending upon the poling direction, the input-output relations change. The most common types of mechanical loading investigated for piezoelectric energy harvesting devices are33 and 31 loading, which are depicted in Fig where x, y and z are represented as 1 ,2, and 3, respectively. In the 33loading mode the voltage and stress act in the same direction, and in the 31 mode, the voltage acts in the 3direction, while the mechanical stress acts in the 1 direction.

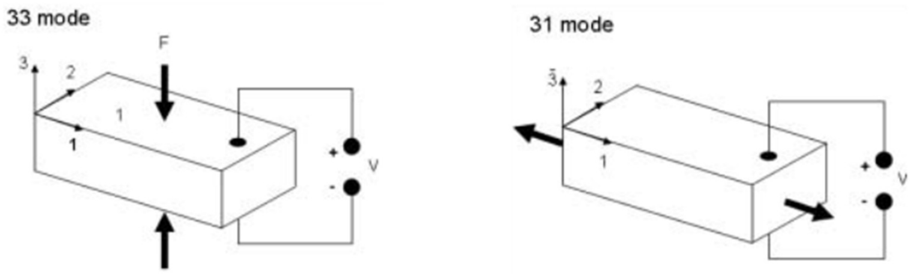

Figure 5.3: Poling direction: 33 mode and 31 mode respectively

For devices with a rectangular cross section, the poling direction is denoted as the 3 direction, and the 33 loading refers to the collection of charge on the electrode surface perpendicular to the polarization direction when tensile or compressive mechanical forces are applied along the polarization axis. When a material experiences 31 loading, the charge is collected on the electrode surface perpendicular to the polarization direction, for example, when the force is applied perpendicular to the axis of polarization.

5.2 Description (Piezoelectric Model for a Keyboard)

Figure 5.4: Usual Computer Keyboard

This fig shows a model of simple keyboard without applying piezoelectric keys.The slots under the keys would be used to attach piezoelectric layer.

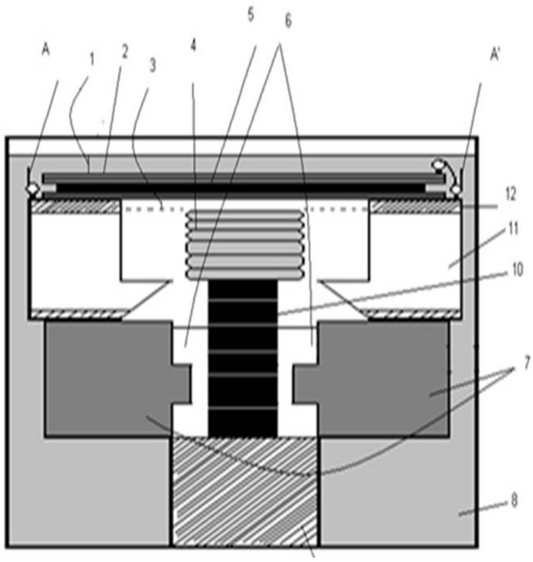

Figure 5.5: Diaphragm type of PE generator

A-A electrodes for the primary crystal
1. 0.3-0.33mm for keyboard
2. Keypad
3. Gap less than 0.1mm
4. Low tension spring
5. Primary piezoelectric crystal (PEC)
6. Perfect conductors for secondary PEC
7. Charge storage space for charges from secondary PEC
8. Hard casing to avoid deformation of structure
9. Perfect solid to generate high pressure
10. Secondary PEC
11. n-Si
12. SiO2 substrate.

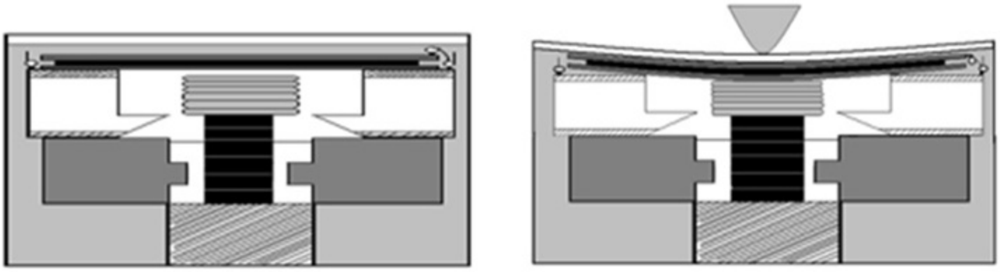

Figure 5.6: State of piezoelectric module before and after key depression

The output of this model is extracted through the electrodes AA. When the film is subjected to an external pressure due to the occurrence of key depression while typing the keyboard, it compresses into the space (5) between the spring and the piezoelectric material and returns to back to its original position when the pressure on the key is released. This downward and upward motion of the film causes vibrations in it. Since the film is itself a piezoelectric material it generates electricity in the form of very low voltage. This creates charges in the electrodes. According to the law of inertia, the film returns back to its original position if an external force drives it to do so. Here the external force is air resistance. When the film is initially pressed, the extent to which it bends downwards is more. After a small time interval due to air resistance the magnitude of the downward bend reduces gradually. This causes a vibration of a high frequency. The displacement of the centre most part of the film is more than 0.1mm initially. After sometime the displacement decreases and the film comes back to its original position. From Fig 5.6 it can be seen that, if the central part of the film displaces itself from its original position, then it tends to touch a low tension spring that is connected to a secondary piezoelectric crystal. Since the spring has a low tension, the film tends to deform the spring by applying a very low pressure. This pressure is transferred to the secondary crystal. Since the primary film touches the spring more than once, the spring transfers the pressure more than once to the secondary crystal. The secondary crystal is placed on a rigid surface (a perfect solid). Hence the solid cannot be deformed. Now, due to the pressure in the crystal, it starts to vibrate. By the property of piezoelectric effect, an AC voltage is generated in the axis that is perpendicular to the axis on which pressure is applied. So a perfectly conducting medium is placed on that particular axis. This conductor transfers the charges developed to a medium where the charges could be stored. For the secondary piezoelectric material, a stack arrangement is employed. These materials operate in longitudinal direction (orthogonal direction to the layer). Common stack arrangements are made with large number of thin piezoelectric disks that are glued together.

5.3 Circuitry

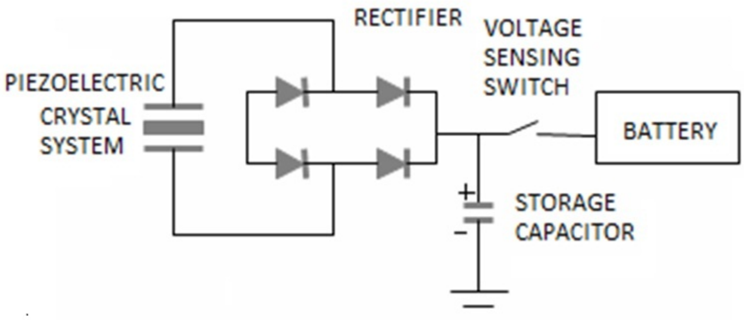

Figure 5.7: Circuit diagram of whole process

Fig. 5.7 illustrates the overall circuit diagram of the entire process. The rectifier shown in the Fig.5.7 maybe either a fullwave rectification circuit or a half wave rectification circuit based on the combination of diodes or a voltage double rectifier. Since a diode is being used in the rectifier, a p-njunction diode or a Schottky diode can be used. The Schottky diode has a threshold voltage which is smaller thanthat of a p-n junction diode. For example, if the diode isformed on a silicon substrate, a p-n diode may have athreshold voltage of approximately 0.065 volts while the threshold voltage of a Schottky diode is approximately 0.30 volts. Accordingly, the uses of Schottky diode instead of p-ndiode will reduce the power consumption required fo rrectification and will effectively increase the electrical charge available for accumulation by the capacitor. When the electromotive force in the piezoelectricity generation section is small, a Schottky diode having a low rising voltage is more preferable.The bridge rectifier section provides rectification of the AC voltage generated by the piezoelectric section. By arranging the rectification section on a monolithic n-Sisubstrate, it is possible to form a very compact rectification section. A typical diode can rectify an alternating currentthat is, it is able to block part of the current so that it will pass through the diode in only one direction. However, in blocking part of the current, the diode reduces the amount of electric power the current can provide.A full-wave rectifier is able to rectify an alternating current without blocking any part of it. The voltage between two points in an AC circuit regularly changes from positive to negative and back again. In the full-wave rectifier shown in Fig 5.7, the positive and negative halves of the current arehandled by different pairs of diodes.The output signal produced by the full-wave rectifier is a DC voltage, but it pulsates. To be useful, this signal must be smoothed out to produce a constant voltage at the output. A simple circuit for filtering the signal is one in which a capacitor is in parallel with the output. With this arrangement, the capacitor becomes charged as the voltage of the signal produced by the rectifier increases. As soon as the voltage begins to drop, the capacitor begins to discharge, maintaining the current in the output. This discharge continues until the increasing voltage of the next pulse again equals the voltage across the capacitor. The rectified voltage is stored into a storage capacitor as shown in Fig. 5.7, which gets charged up to a pre-decided value, at which the switch closes and the capacitor discharges through the storage device or the battery. In this way the energy can be stored inthe capacitor, and can be discharged when required.

5.4 Mobile charging after storage of power

Once the power is generated it can be used to charge a cell phone. We can either directly connect the cell phone to the main circuit or first charge a rechargeable battery and then use that battery to charge the mobile phone.

Figure 5.8: Mobile charging after storage of charge in super capacitor

5.5 Tools to be used

The tools used are:

- PCBwizard

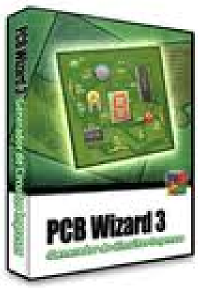

Figure 5.9: PCB wizard software

- Etching machine

Figure 5.10: PCB wizard software

- Drilling machine

Figure 5.11: PCB wizard software

5.6 Final circuitry

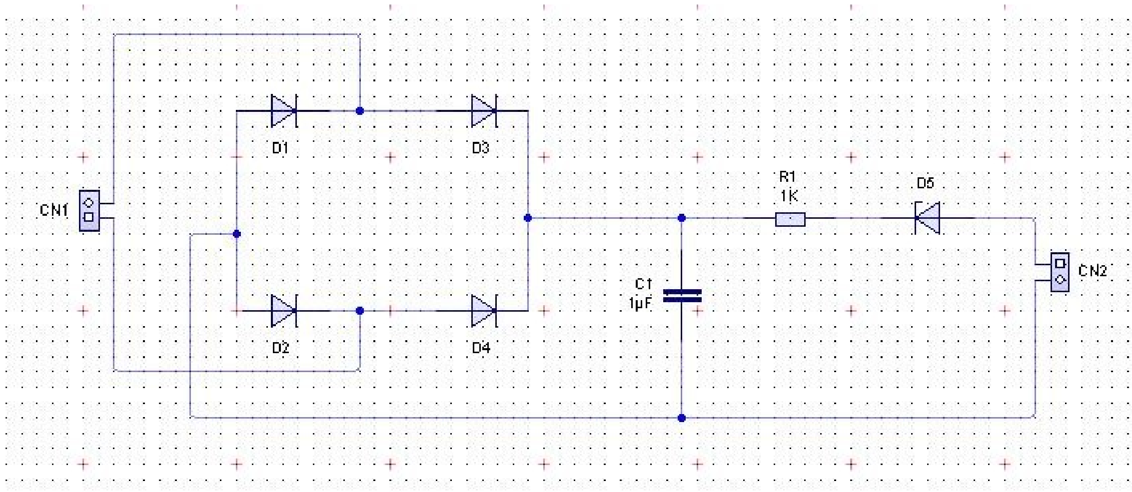

Figure 5.12: Circuit Diagram

5.7 PCB Layout

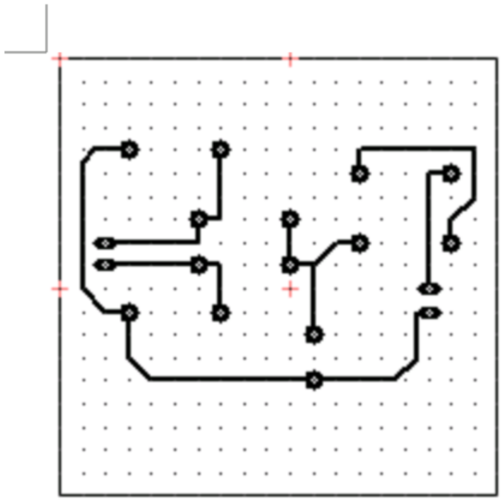

Figure 5.13: PCB Layout

5.8 Real World Image Of PCB Layout

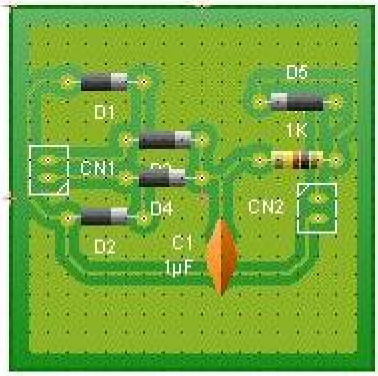

Figure 5.14: Real World Image

Chapter 6

Test Cases, Project Time Line & Task Distribution

6.1 Test Cases

6.1.1 Case 1: Circuit employing ic 7806

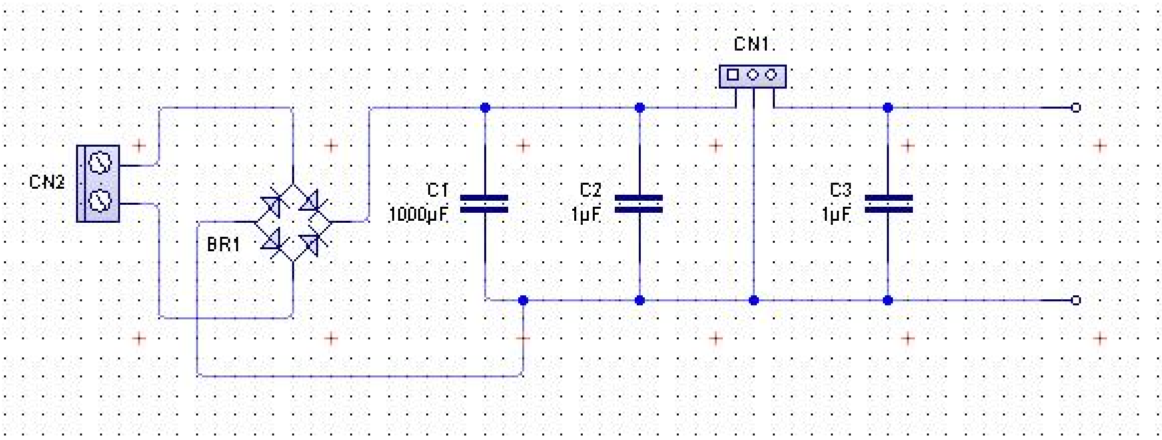

Figure 6.1: Circuit Diagram

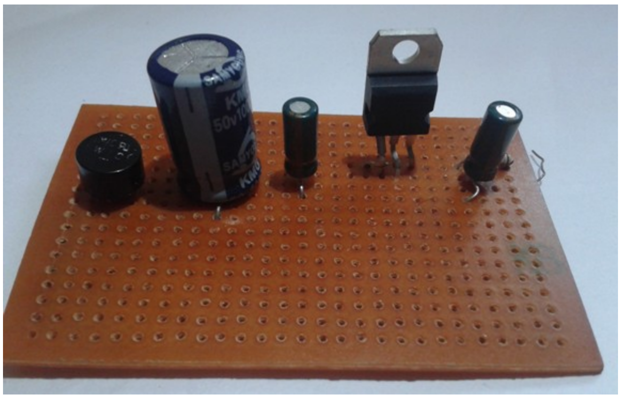

Figure 6.2: Final circuitry

This circuit was our initial approach. The rectifier used was bridge rectifier and IC 7806 was used to stabalise any ripple in the left after the bridge rectifier. Storage capacitor used was 1000 micro farad.

This circuit failed as we did not considered the less current generated by piezoelectric material. Each component has its own resistance which lead to drop of current. Due to least amount of current, it did not drive into entire circuit.

6.1.2 Case 2: Circuit employing IC MAX 1675

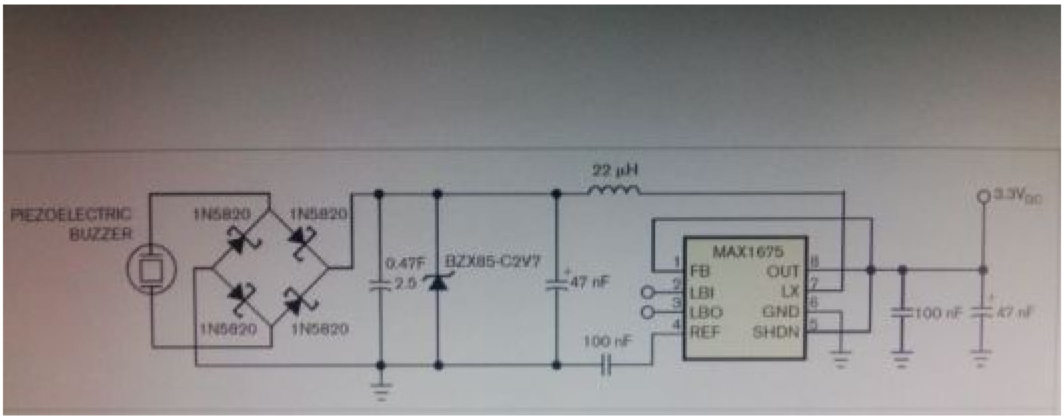

Figure 6.3: Circuit Diagram

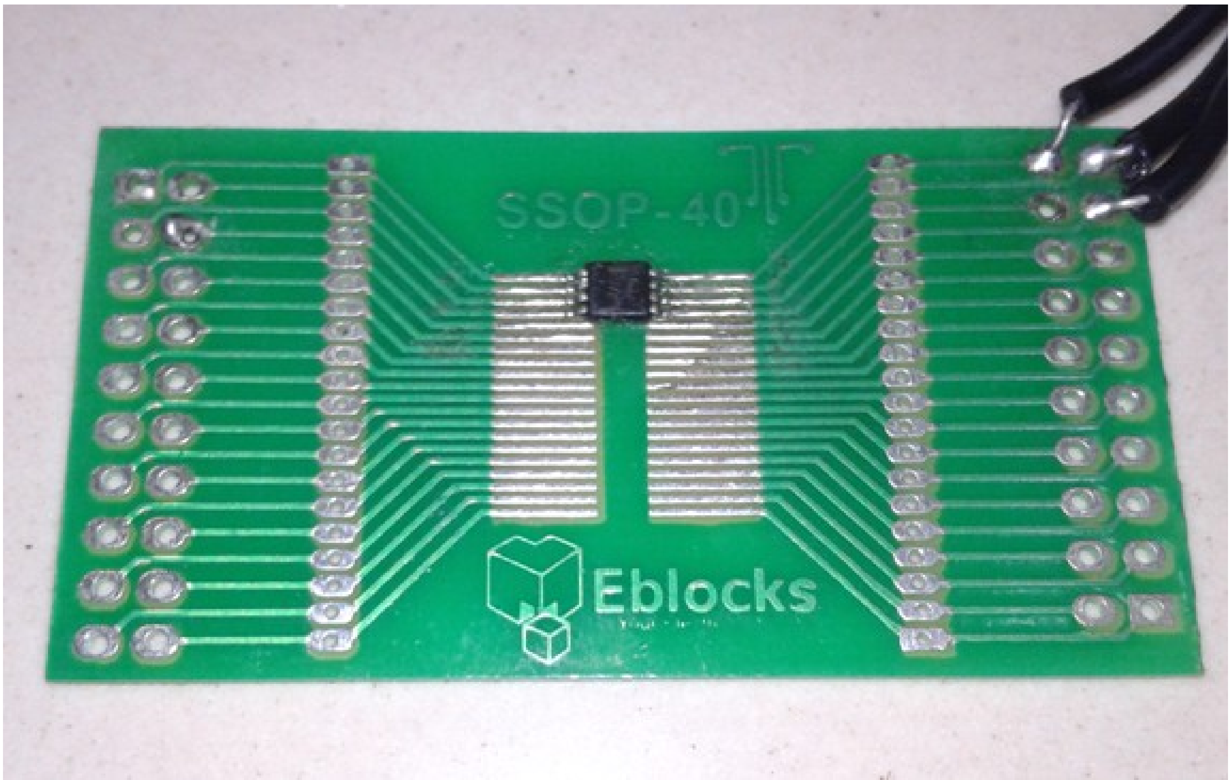

Figure 6.4: IC MAX 1675 on breakout board

Our next approach was to use IC MAX 1675 and super capacitor. IC MAX 1675 is a DC-DC converter and was used to entirely stabilize any AC component in voltage. Super capacitor used was of 0.47 farad and 2.5 volts. It was used because charge holding capacity of the super capacitors are high and we needed to hold the charge in the capacitor as long as possible.

The reason for the failure of this circuit was the same reason, we did not consider the low current generated by the piezoelectric material.

6.2 Task Distribution

Member 1: Major contribution in research work, massive contribution in overall work of the project.

Member 2: Major contribution in fieldwork, vast help in building the project.

Member 3: Vast contribution in fieldwork and did the job of black book.

Member 4: Developement of PCB, etching and soldering. Also helped in fieldwork.

6.3 Project Time Line

The following table shows the expected flow of work for the accomplishment of the required result.
In the table, some of the tasks were carried on simultaneously. So adding up the weeks won't give total number of weeks taken for completing the project.

Table 6.1: Project Time Line

No.	Describtion	Duration	Complexity	Status
1	Literature Survey of papers on various domains	1 week	2	Done
2	Sorting some papers and studying them in detail	2 weeks	2	Done
3	Finalizing the domain and aim of the project	1 weeks	1	Done
4	Gathering further information regarding implementation of project	1 week	1	Done
5	Estimating the hardware requirements of the project	1 week	2	Done
6	Begin assembling required stuff such as components	2 weeks	3	Done
7	Start implementing hardware on PCB Wizard Software	3 weeks	4	Done
8	Two major failure attempts	4 week	5	Done
9	Getting proper and flawless layout on PCB Wizard	1 week	3	Done
10	PCB Eyching, drilling and soldering	1 week	3	Done
11	Mounting Components on prepared PCB	1 week	2	Done
12	Checking for mounted component's connections using digital multimeter and checking components for polarity to assure proper connections	2 weeks	3	Done
13	Resoldering PCB where dry solder was found	1 week	2	Done
14	Project ready and desired output was achieved			

Chapter 7

Conclusion and Future Scope

7.1 Application

This system can be used to charge any gadget which supports rechargable battery. It is not confined to only mobile phones.

7.2 Future Scope

Future scope of our project is extremely good. It can be applied in any place where ever there is mechanical stress is in the picture. Few examples are as shown.

Figure 7.1: Piezo electric system employed under the railway tracks

This piezoelectric system can be employed under the railway tracks so as when the train passes over it, it will lead to the generation electric power. The power generated by this system will be very large as the force applied by the trains would be very high.

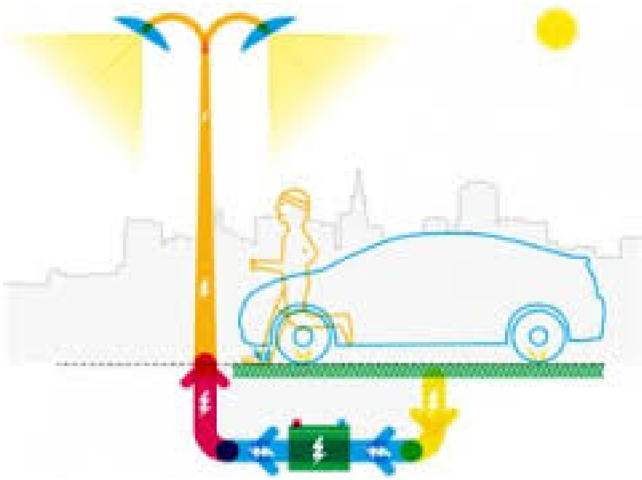

Figure 7.2: Piezo electric system employed in asphalt on road

Figure 7.3: Piezo electric system employed on roads

This system can be applied under the roads so when the cars passes over the road it will lead to the generation of electrical power. This power can be then used to power street light.

Figure 7.4: Wireless keyboard employing piezoelectric system

This system can very efficiently be used in wireless keyboards. Such keyboards then can be self-charging which will eliminate the frequent charging requirement of such keyboards

Figure 7.5: Piezo electric system employed on pedestrian walkway

Also this sytem can be employed under walkway, so when ever people walk on the way it will lead to the generation of power.

7.3 Conclusion

The design of the proposed energy conservation system for mobile phones and laptop keyboards has been presented in this paper. The design presented here will be quite effective in providing an alternate means of power supply for the mentioned devices during emergency. Further, the approach presented in this paper can be extended to many other applications where there is scope for similar kind of energy conservation.

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Appendix A

Publication

A short length paper was presented in International Conference held at Thakur College of Engineering.

Conference: MULTICON-W 2014

Authors: Naved Ahmed, Abdul Wafee, Khan Zuber, Mohammed Qaasim

Title: Gadget Charger using Piezoelectric Effect.

Appendix B

Components to be used

The componenets required are:

- Piezoelectric material (sheet or crystals)

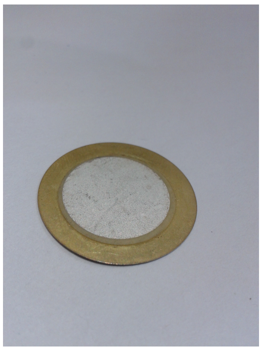

Figure B.1: Piezoelectric Crystal

- Super capacitor (0.47 F,5 V)

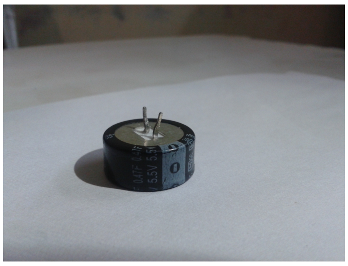

Figure B.2: Super Capacitor

- A computer keyboard

Figure B.3: Computer keyword

- Schottky diodes (1N5818) 4 pcs

Figure B.4: Schottky Diode

- Zener diode (5.6 V)

Figure B.5: Zener Diode

- Resistor (47 ohms)

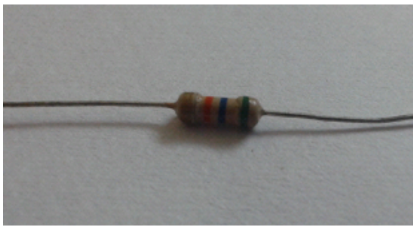

Figure B.6: Resistor

- Other circuital components.

The use of piezoelectric sheet will be more convenient instead of crystals as it more easy to assemble in the keyboard and also it will lead to less complex circuitry to charge the battery.

Appendix C

Project Hosting

Project Link : https://code.google.com/p/proquiz

QR CODE: