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Smart Charging Shoes Using Piezoelectric Transducer

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ABSTRACT: Due to our busy lifestyles, our health is an adventurous one now a day. We had design a device using piezoelectric material that furnishes as an alternate means for powering mobile devices. Additionally it can also be intended for lighting solutions like flashlights and emergency torch. Noting that it is an energy regeneration device it encourages walking and thus can also be acknowledged as an electrical health gadget which endorses physical fitness. One more feature which has been incorporated into this gadget is a battery bank which is used to store the charge when the phone is 100 percent charged or there is no need for emergency lighting. The piezoelectric crystals are incubated into the sole and the heel of the shoes as they are considered as the maximum pressure points and via trotter moment and vibrations on the crystals, so that while walking or jumping they generate voltage pulses and minute quantities of current which is stored in the battery and can be used to charge mobile devices.

KEYWORDS: Piezoelectric, mobile phone, power generation

I.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. 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 up liftment of the civilization. In today’s 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, nonhazardous, easy implementable, inexpensive and eco-friendly source of energy. There is no by product 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.[1][3]

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II.LITERATURE REVIEW

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 sparse 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.[1][3]

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

Karthik Kalyanaraman has proposed energy conservation system for mobile phones and laptop keyboards have 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. The material used for the current application is a PZT with 1.5 Mba lateral stresses operating at l5Hz. The volume of the material used is 0.2cm3, The output power produced is 1.2W The energy/power density is 6mW/cm3.The output voltage is 9V. This voltage can be used to produce the required amount of charge after being processed.[2][10]

2.3 Electrical Power Generation Using Piezoelectric Crystal:

Anil Kumar has proposed that the technology is based on piezoelectric materials that enable the con-version 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 high-way 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.[3][4][9]

2.4 Piezoelectric Crystals: Future Source of Electricity

Pramathesh T has explained that in India, maximum public movements is observed in railways stations and holy places, hence, such places can be exploited for use of piezoelectric crystals for generation of electricity. Gathering ranging from thousands to millions are observed 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 positive results are obtained. With further advancement in field of electronics, better synthesized piezoelectric crystals and better selection of place of installations, more electricity can be generated and it can be viewed as a next promising source of generating electricity[3]

III. SYSTEM METHODOLOGY AND ASSUMPTION

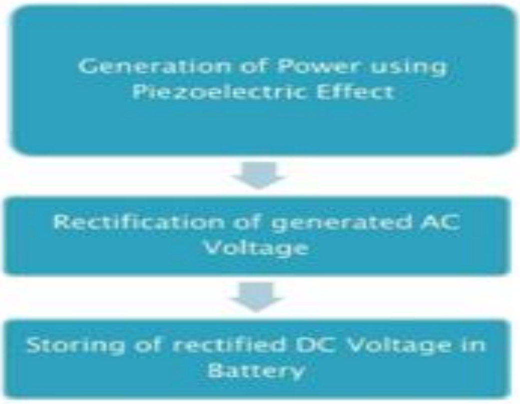

Fig. 1 Charge Generation with Piezoelectric Material

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Piezoelectric effect is expressed in single crystals, ceramics, polymers, composites, thin-films and re-laxer 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. [1][2] This force will push and pull the electrons in the electrodes attached to the piezoelectric crystal as shown in the figure below.

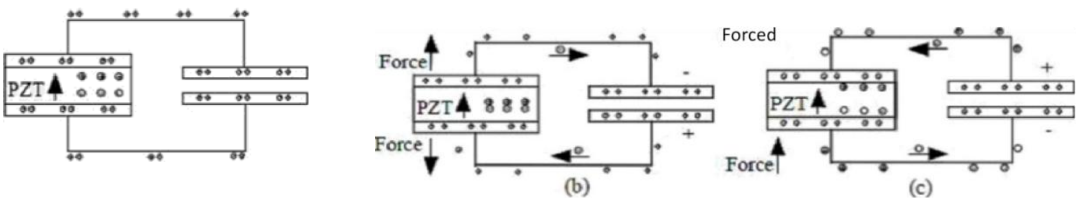

Fig. 2 Charge generation in piezoelectric materials

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. This poling direction can be modified by heat and voltage conditions, Piezo-electric 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. 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 33loadinp 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.[2][5]

Fig. 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. 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. [7][8]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 center most pan of the film is more than 0 1 mm initially. After sometime the displacement decreases and the film comes back to its original position. From the figure 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 aapplying 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. 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.[6][7]

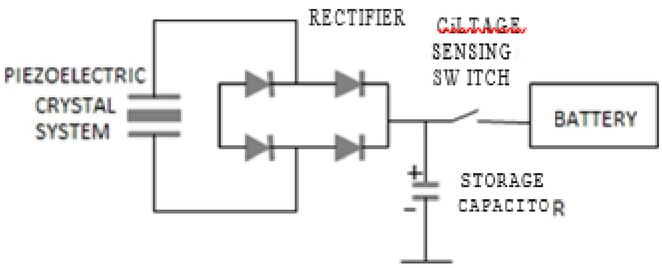

Fig. 4 Circuit Diagram of Whole process

The figure above shows the overall circuit diagram of the entire process. The rectifier maybe either a full wave 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-n junction diode or a Schottky diode can be used. The Schottky diode has a threshold voltage which is smaller than that of a p-n junction diode. For example, if the diode is formed on a silicon substrate, a p-n diode may have a threshold voltage of approximately 0 0G5 volts while the threshold voltage of a Schottky diode is approximately 0.30 volts. Accordingly, the uses of Schottky diode instead of p-n diode will reduce the power consumption required for rectification and will effectively increase the electrical charge avail-able for accumulation by the capacitor. When the electromotive force in the piezoelectricity The bridge rectifier section provides rectification of the AC voltage generated by the piezoelectric section. By arranging the rectification section on a monolithic n- Si substrate, it is possible to form a very compact rectification section.[10] A typical diode can rectify an alternating current hat 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, the positive and negative halves of the current are handled 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, 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 in the capacitor, and can be discharged when required.[9][10]

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.

Fig. 5 Mobile charging after storage of charge in super capacitor

CASE 1: CIRCUIT EMPLOYING IC 7806

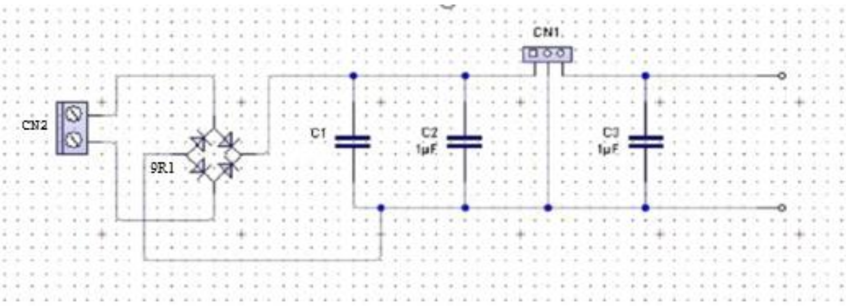

Fig. 6 PCB layout

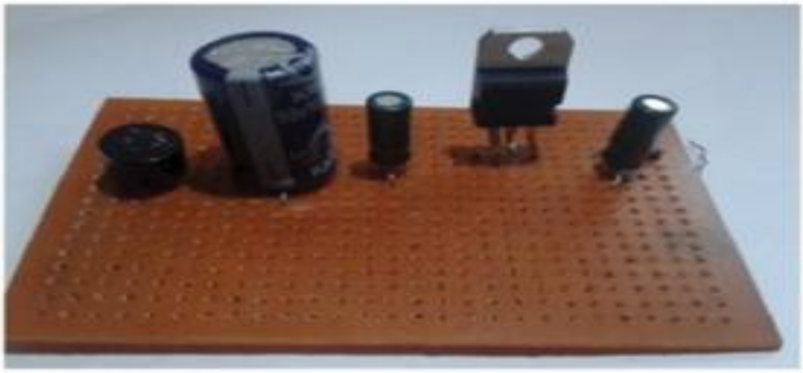

Fig. 7 Final Circuit

This circuit was our initial approach. The rectifier used was bridge rectifier and IC 7806 was used to stabilize 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.

CASE 2: CIRCUIT EMPLOYING IC MAX 1675

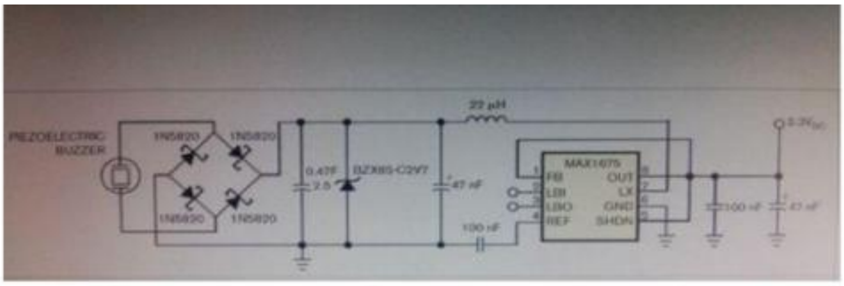

Fig. 1.5 Circuit Diagram

Fig.8 IC MAX 1fi75 On Breakout Board

IV. FUTURE SCOPE

Our next approach was to use IC MAX 1675 and super capacitor IC MAX 1G75 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.

Future scope of our project is extremely good. It can be applied in any place where ever there is mechanical stress. Also this system can be employed under walkway, so whenever people walk on the way it will lead to the generation of power. 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. 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.

V.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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