Energy Harvesting and Utilization in Mobile phones.

Swayam Kumar Tibrewal[#1], Shreedutt Hegde[*2], Piyush Arora[3]
[#]ECE, VIT University
VIT University, Vellore, Tamil Nadu-632014. India.

Abstract— This paper aims at presenting an innovative way of charging mobile phones by harvesting energy from piezoelectric keypads and Electromagnetic transducers. The touch input from the user on piezoelectric keypad will be converted to electrical signals which will then be stored for future discharge. Noise and sound from one's vocal cord can also be utilized for supplementing the energy harvesting process. The project involves designing a mobile phone by which its battery can be charged using both mechanical and sound energy. This falls under the category of wireless charging and conservation of energy.

Index Terms— Piezoelectric keypads, Electromagnetic Transducers, Energy Harvesting, Wireless Charging, Conservation..

1 INTRODUCTION

Energy is one of the most ubiquitous requirements for meeting today's growing demands for development and modernization. The concept of energy management and effective utilization therefore commands utmost attention and investigation. Undoubtedly we need to shift our dependency on renewable energy resources, to meet the energy demands. The best way of development is by proper exploitation of untapped energy resources. One such way of harvesting and conserving energy is presented in this paper.

The problem statement concerned here is harvesting energy and efficient utilization of resources. There are two areas to deal with in this paper, one being charging using piezoelectric keypads and the other is charging using sound energy.

Charging using piezoelectric keypads: The basic working model consists of power generation by piezoelectric keypad. Secondly, rectification of the AC voltage power generated and lastly DC voltage storage. Once the DC voltage is stored it is then used to charge the battery by discharging the storage element. The Mobile phone keypad is made up of piezoelectric material or the pressure sensor in touchscreen phones is made up of piezoelectric. Designing the circuit in such a way that while the keypad is pressed, the piezoelectric material responds by generating a voltage in direct proportion with the amount to force one presses the keypad. This then is rectified and the voltage is used in charging the storage element.[1]

Energy is one of the most ubiquitous requirements for meeting today's growing demands for development and modernization. The concept of energy management and effective utilization therefore commands utmost attention and investigation. Undoubtedly we need to shift our dependency on renewable energy resources, to meet the energy demands. The best way of development is by proper exploitation of untapped energy resources. One such way of harvesting and conserving energy is presented in this paper.

The problem statement concerned here is harvesting energy and efficient utilization of resources. There are two areas to deal with in this paper, one being charging using piezoelectric keypads and the other is charging using sound energy.

Charging using piezoelectric keypads: The basic working model consists of power generation by piezoelectric keypad. Secondly, rectification of the AC voltage power generated and lastly DC voltage storage. Once the DC voltage is stored it is then used to charge the battery by discharging the storage element. The Mobile phone keypad is made up of piezoelectric material or the pressure sensor in touchscreen phones is made up of piezoelectric. Designing the circuit in such a way that while the keypad is pressed, the piezoelectric material responds by generating a voltage in direct proportion with the amount to force one presses the keypad. This then is rectified and the voltage is used in charging the storage element.[1].

Charging using Sound: It is known that Microphones and other appliances converts sound to electrical energy. Now once electric energy is generated using sound, charging a battery or capacitor can be done. Using techniques of piezoelectric effect, zinc oxide nanowires can be used to convert sound caused by vibrations to electricity.[2]

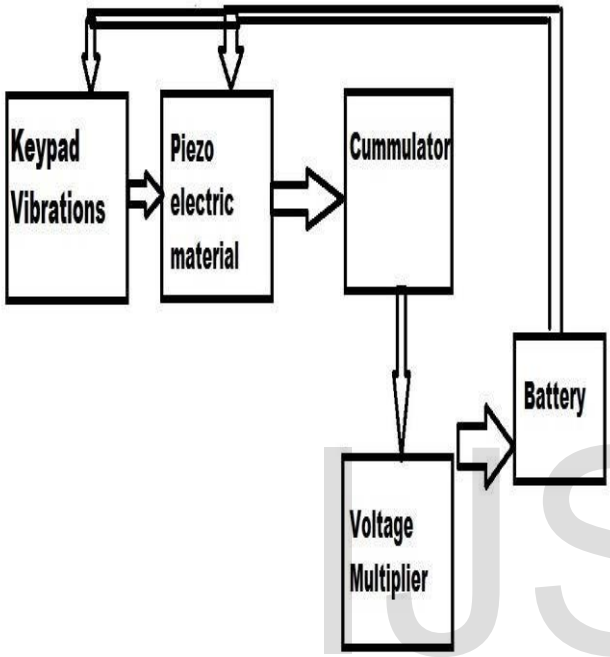
Therefore, by incorporating these two ways in the mobile phone, significant amount of power can be saved. Energy crisis is one of the challenges most people are facing. Charging using piezoelectric keypads and sound energy can be seen as one of the methods by which we can limit the pressure on non-renewable energy sources. This technology by far can be a step towards sustainable development.

IJSER

International Journal of Scientific & Engineering Research Volume Ħ(ÚÚÜÌ Ħ , ÈÙÊÏ ı l ɣ Ƙ
ISSN 2229-5518

IMPLEMENTATION:

The whole process can be summarised in a block diagram format which consist of a Mechanical energy harvester, Accumulator for storage, Multiplier to amplify voltage. The energy harvested from the mobile keypad is stored in the accumulator. It is then given to a voltage multiplier and stored in a battery.



The implementation of the project involves two stages:

- Generation of electricity.
- Storage of charge.

Generation:

The basic working of the project consists of: Piezoelectric power generation, Rectification and Storage of DC voltage.AC voltage is generated from the piezoelectric material which is rectified by the rectification block and then it is stored in a storage device such as a capacitor and then given to the battery.

The whole concept is based on piezoelectric effect. Basically piezoelectric transducers will convert mechanical some oscillating material which is similar to the vibration of a human ear drum. The human ear serves as an astounding transducer, converting sound energy to mechanical energy and then to a nerve impulse that is transmitted to the brain. Then, these generated vibrations are converted to electrical energy by piezoelectric effect using piezoelectric ceramics. [2]On an average, a mobile phone operates by a few volts, and as a normal conversation is conducted at about 60-70 decibels which will produce sufficient amount of charge from this method.

The idea pertains generally to a mechanism for capturing Mechanical energy and converting it to electrical energy and is particularly useful for continually charging mobile phones. The mechanism comprises of elongated piezoelectric elements for generating electric energy from mechanical energy. In the proposed concept, low input voltage multiplier plays a major role as the energy harvested by the piezoelectric material is very low, in the order of few micros to millivolts. A piezoelectric material is placed below the keys of the particular device. During key depressions, the piezoelectric material is subjected to vibrations due to the pressure applied on the keys and therefore, the piezoelectric material is expanded or contracted.AC voltage generated in the pair of electrodes provided in the piezoelectric material is rectified and stored in a capacitor.[3]

Charging using Sound:

To supplement the charging process by pressure, the next step ahead is to utilize the sound from one's vocal cord and noise from the surrounding in the charging mechanism. Sound energy produced during speech will get converted into mechanical vibrations by exposing sound to mechanical diaphragm material. Then, these generated vibrations are converted to electrical energy by piezoelectric effect using piezoelectric ceramics.

STORAGE:

Till now, the spikes produced by the piezoelectric material have been discussed.

The next major stage in this project is the storage of the energy produced, so that it can be utilized for later use. It's essential to have a quick, and minimal-loss storage cycle, for improving the efficiency. Now to analyse these spikes in great detail in order to study the process of storing the energy, they are mathematically represented by the periodic impulse train which is given by:

$$V(t)=\Sigma A(k)\delta(t-kT)Nk=0 \text{ ----------}(1)$$

Where:

V(t): Voltage spikes produced from the piezoelectric material

A(k):Instantaneous amplitude of these spikes

delta(): Impulse function

t:Instantaneous time

T: Time Period of these spikes occur

Now, A(k) will depend on the amount of pressure applied on the piezoelectric material and the piezoelectric material itself

IJSER

International Journal of Scientific & Engineering Research Volume Ħ(ÚÚÜÌ Ħ , ÈÙÊÏ ı l ɣ Ƙ
ISSN 2229-5518

T is chosen around that according to statistics given on this reference link: stating the average time spent by the user on a smart phone.
Using the equation

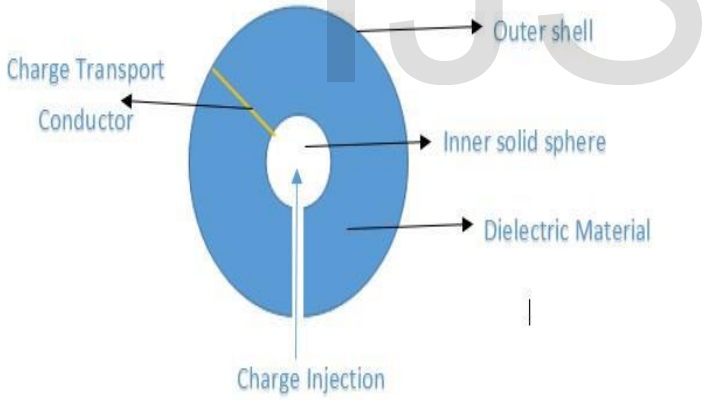
$$Q = C.V \ldots\ldots (2)$$

Where C is the capacitance of the spherical dielectric material given by
C=(4πε)r. ; r: radius of dielectric sphere
From equation 1 and 2 , the charges being delivered to the storage device will be given by:

$$Q(t) = C.V(t)$$

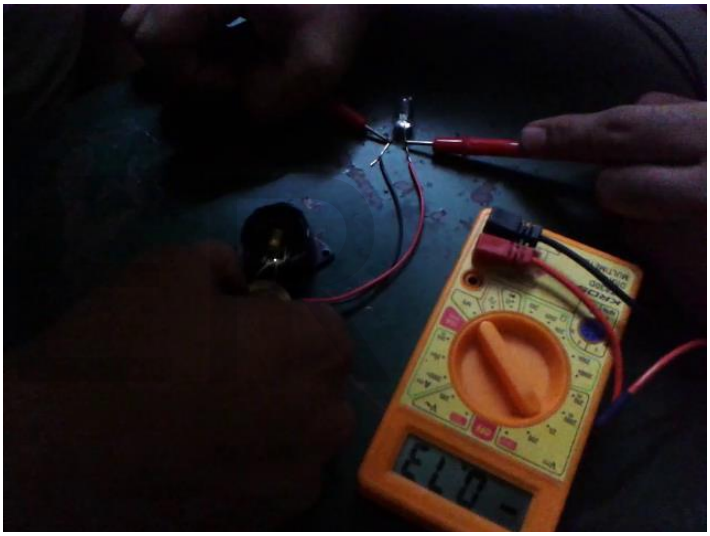
$$Q(t) = (\Sigma A(k)\delta(t - kT)Nk = 0).C \ldots\ldots (3)$$

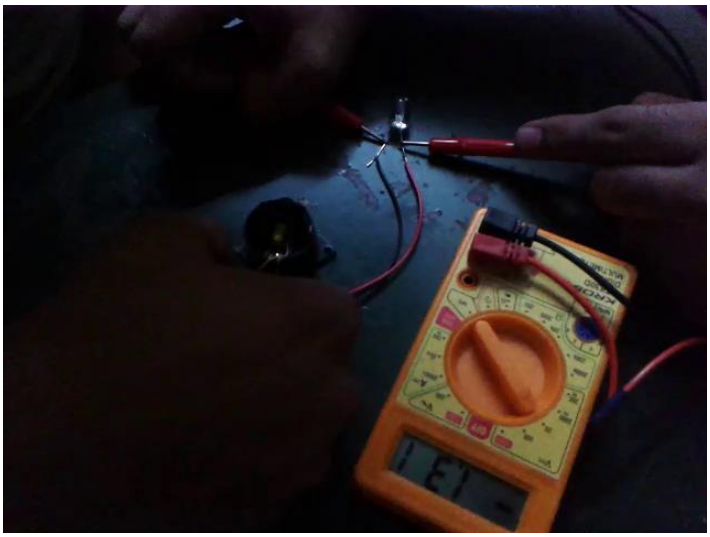
The equation 3 shows that these charges will be produced in a form of periodic impulse train separated by the distance T.
Without any loss of generality we can safely assume that period T of these spikes or impulse will be much greater than 1/f, where f is the clock frequency of the microprocessor used inside mobile phone which is nowadays more than 800Mhz.



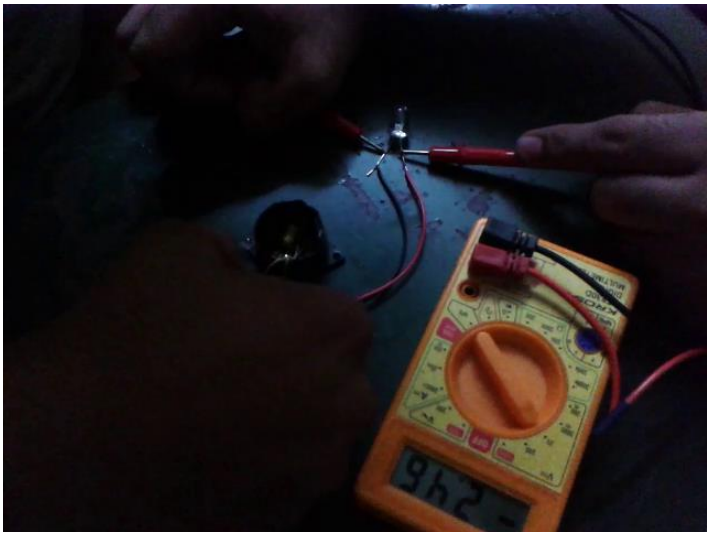
Hence these impulses of charge can be treated as static charges for the microprocessor.
Now these static charges will be stored by the method employed in the van de graaff generator by virtue of which these static charges will be sprayed on to the solid spherical ball inside a hollow metallic sphere and the entire setup being isolated from the rest of the circuitry inside the mobile phone to avoid any leakage. The basic principle of van de graaff generator is that electric potential outside a charged metallic sphere varies inversely proportional to the distance from surface. Thus in the van de graaff generator setup, electrically the inner sphere is at a higher potential compared to outer shell. Since charges flow from higher potential to lower potential, thus if we are able to somehow introduce charge on inner sphere, and then connect the inner and outer spheres by a conductor, then we can go on piling charges on outer shell.
Thus outer shell acts as a reservoir of charges, and amount of charge can be easily monitored by using a mobile application. A MOSFET as a switch connected between load and outer shell can be used whenever the user requires the charge to be discharged from outer shell for driving the mobile phone processes. The toggling between the modes can easily be done using a mobile application.

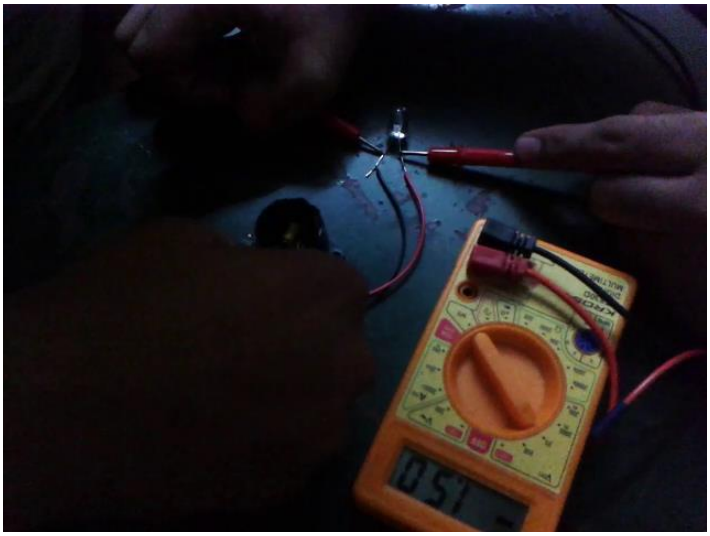
Project Demo:
This circuit shows the generation of voltages in volts by applying pressure in the piezoelectric keypads. A mobile application is also displayed wherein the display of various parameters will be shown.

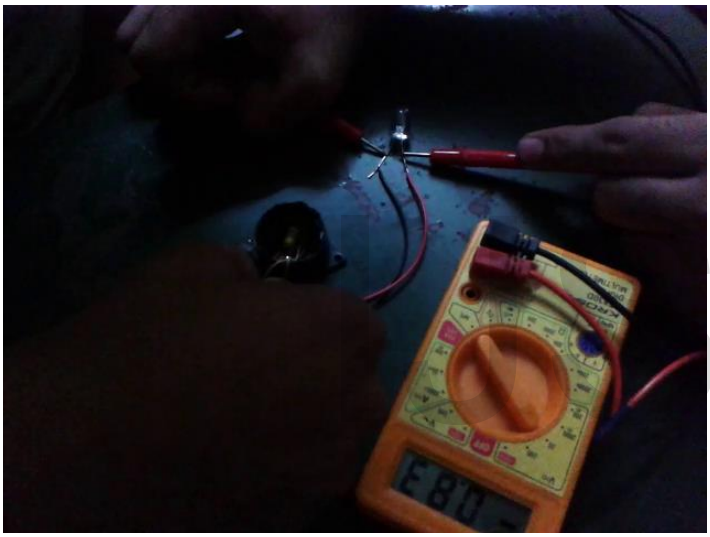


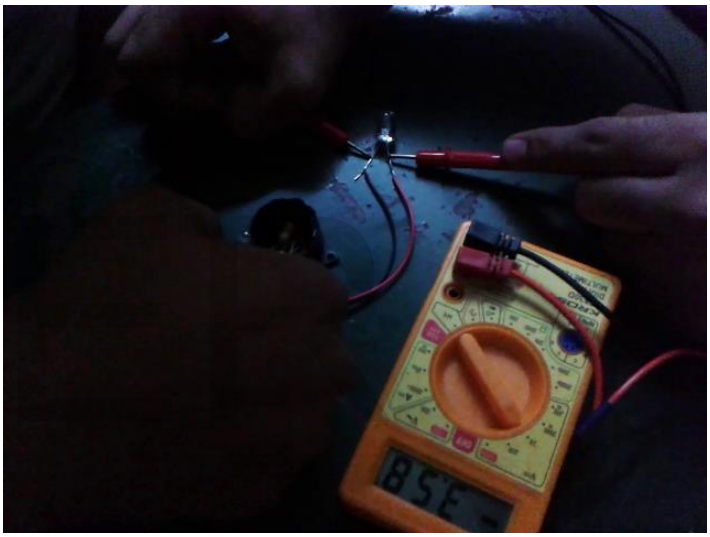


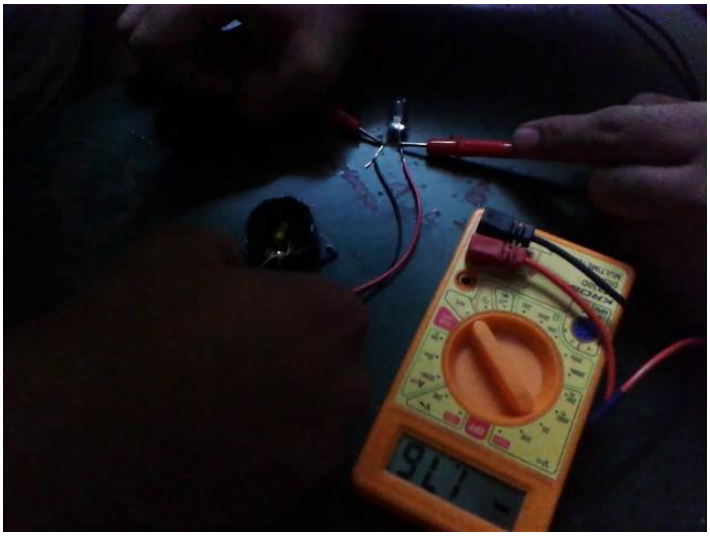
International Journal of Scientific & Engineering Research Volume ÞÛ(ÚÚÜÌÞÛ , ÈÙÊÏıl¥ÙkÞ
ISSN 2229-5518











International Journal of Scientific & Engineering Research Volume Ħ(ÚÚÜÌ Ħ , ÈÙÊÏ ı l ɣ Ƙ
ISSN 2229-5518

Conference Team for providing this opportunity to do research on this project.

REFERENCES

[1] en.wikipedia.org/wiki/**Piezoelectricity** .
[2] http://www.mediacollege.com/audio/microphones/how-microphones-work.html

[3] http://www.linear.com/solutions/supercapacitor_charging?type=circuit

Conclusion:

In this fast pace world, Mobile Phone has become a basic need. The production of mobile phones is increasing at an alarming rate. While in a developing country, Energy Crisis is the major issue. The solution provided enables us to effectively harvest and utilize energy from our hands and mouth. This being one of the best non-polluting production of energy.

This solution also provides help in emergency situations, think about people getting caught in the midst of drastic problems and they cannot even ask for help if there Mobile Phone is out of charge. The project proposed promises to be one of the innovative ways of conserving energy incorporating the mobile phone. We waste a lot of energy and power in charging our phones, thus this can be used as a renewable energy mechanism.

Ever imagined, when women/girls late at night if there phone gets switched off or while attending an important call suddenly your battery gets discharged! To avoid all the ill impacts of not having a charged phone, this technique can be used as one of the best ways to help the people prosper.

ACKNOWLEDGEMENT

We are grateful to our college for providing an excellent opportunity and research environment with highly educated professors. The highly equipped labs and the interaction with different students improved our domain of thinking. We would like to acknowledge the IIT Bombay

IJSER