Piezoelectric Energy Harvesting System in Mobiles with Keypad and Sound Vibrations

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Abstract

This paper targets the transformation of mechanical and sound energy to electrical energy using piezoelectric materials. In mobiles, the vibrations generated by keypad stress and sound waves will apply to a permanently-polarized material such as quartz (SiO_2) or barium titanate ($BaTiO_3$) which produces an electric field due to imposed mechanical force. It has been already proven that, micro to milli watts of power can be generated from vibrating materials. This harvested energy is stored and when it crosses a particular threshold value, it is given as an input to a voltage multiplier which multiplies the voltage and is used for charging the mobile battery. This charged battery is supplied to mobile operations again so that it will harvest the energy and this cycle will be continued.

1. Introduction

Nowadays, power usage is becoming predominant when compared to the past and at the same time, it becomes challenging to satisfy the user's needs with available power. In particular, mobile electronics needs more power comparatively as they are operated by batteries and as it is the most common device in daily usage for all sorts of people. This paper illustrates a concept of self charging mobiles with the vibrations that are generated by keypad and sound waves from mobiles. The conversion of mechanical vibration to electrical energy is done by using the piezoelectric material[8]. This converted electric energy is accumulated until the threshold value is reached. Voltage multiplier which is operated with low power is used to multiply the electrical energy. The source that is used to operate the piezoelectric and the multiplier section is got from the battery by feedback.The energy gets harvested whenever the mobile is in use and thus the feedback continues and avoids external charging.

When a piezo ceramic transducer is stressed mechanically by a force, its electrodes receive a charge that tends to counteract the imposed strain. This charge may be collected, stored, amplified and delivered to a mobile battery[2].

2.Overview

The idea pertains generally to a mechanism for capturing mechanical energy and converting it to electrical energy, and is particularly useful for continually charging or providing emergency power to mobile battery. The mechanism comprises of elongated piezoelectric elements for generating electric energy from mechanical energy[6]. The mechanical energy acts as an input which is from the keypad and sound vibrations. According to the present idea, a piezoelectric material is mounted below the keys of the particular device. During key operations, the piezoelectric material is subjected to vibrations due to the pressure applied on the keys and therefore, the piezoelectric material is expanded or contracted. The piezoelectric material is provided with a pair of electrodes. The mechanical energy generated from sound waves are also applied to the piezoelectric material and then it gets converted to electrical energy. Generated electrical energy gets amplified i.e. (converts ac to dc voltage) and is stored in an accumulator. The charge thus stored in the accumulator gets multiplied by a multiplier when it crosses a particular threshold value. It is used for charging the battery.

3.Piezoelectric transducer

Piezoelectricity is found useful in various applications such as the production and detection of sound, generation of high voltages, electronic frequency generation, microbalances, and ultrafine focusing of optical assemblies. It is also the basis of a number of scientific instrumental techniques with atomic resolution, the scanning probe microscope such as STM, AFM, MTA, SNOM, etc., and also for everyday use by acting as the ignition source for cigarette lighters and push-start propane barbecues[3].

When piezoelectric ceramics were introduced, they soon became the dominant material for transducers due to their good piezoelectric properties and their ease in manufacturing them into a variety of shapes and sizes. They also operate at low voltage and are usable even at about 300^{o}C. The first piezoceramic in general use was barium titanate, and that was followed during the 1960's by lead zirconate titanate compositions, which are now the most commonly employed ceramic for making transducers. New materials such as piezo-polymers and composites are also being used in some applications. The self powered Piezo Energy Harvesting Circuit collects intermittent or continuous energy input from the piezo generator for both keypad depression and sound waves and efficiently stores their associated energy in a cummulator. During the charging process, the capacitor voltage is continuously monitored.

4.Multiplier

In the proposed concept, low input voltage multiplier plays an important role as the energy harvested by the piezoelectric material is very low. Depending upon the efficiency, we can change the multiplier when it increases the output level.

Simple x2 voltage multiplier circuit

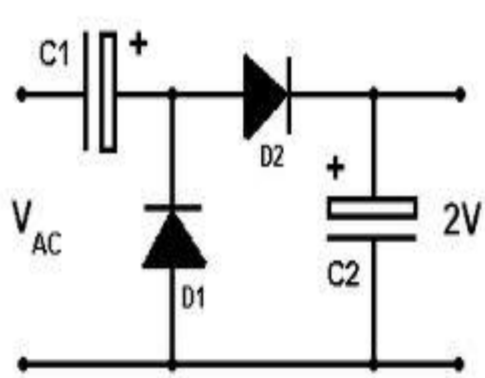

FIGURE 1

The multiplier which has low noise level must be used in order to get efficient output.

5.BLOCK DIAGRAM

The block diagram for the proposed idea is shown in the Fig 2.It consists of 1.Piezo electric energy harvester 2.accumulator for storage 3.Multiplier to multiply power. The energy gets harvested from the sound and mobile keypad vibrations and is stored in the accumulator. It is then multiplied with voltage multiplier and stored in a battery.

Block Diagram

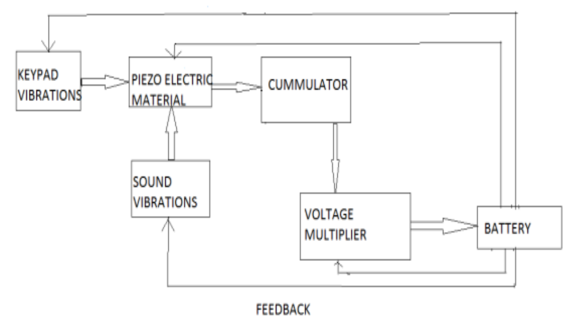

FIGURE 2

It is used as the power for operating the mobile and also for the extra circuits added for power multiplication

.6.DESCRIPTION

The whole concept is based on piezoelectric effect. Basically piezo electric transducers will convert mechanical vibrations into electrical energy and herein mobiles the keypad vibrations generated while messaging and the sound energy produced during speech will get converted into mechanical vibrations by exposing sound to 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. The eardrum is a very durable and tightly stretched membrane that vibrates as the incoming pressure waves reaches it. As shown below, a compression forces the eardrum inward and a rarefaction outward, thus vibrating the eardrum at the same frequency of the sound wave thus producing mechanical vibrations.[4] Then, these generated vibrations are converted to electrical energy by piezo electric effect using piezoelectric ceramics.

Piezoelectrics create an electrical charge under stress, and thus zinc oxide, the main ingredient of calamine lotion, was bent into a field of nanowires sandwiched between two electrodes. The researchers subjected the sandwich to sound waves of 100 decibels which produced an electrical current of about 50 millivolts. On an average, a mobile phone operates by a few volts, and as a normal conversation is conducted at about 60-70 decibels, it is clear that an useful amount of charge can be produced from this method.[5]

7.CIRCUITRY EXPLANATION

The circuitry explains the whole paper in fig 3.The input to the piezoelectric ceramics from the mechanical vibrations generated from keypad stress and sound waves is converted into electrical signal by piezo electric effect. The electrical signals get rectified by using a rectifier in order to convert AC to DC as AC voltage is generated from piezo electric material. The rectifier shown in the Fig. may be 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-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 0.065 volts while the threshold voltage of a Schottky diode is approximately 0.30 volts. Accordingly, the use of Schottky diode instead of p-n diode will reduce the power consumption required for rectification and will effectively increase the electrical charge available for accumulation by the capacitor. A full-wave rectifier is able to rectify an alternating current without blocking any part of it.

Circuit Diagarm of Whole Process

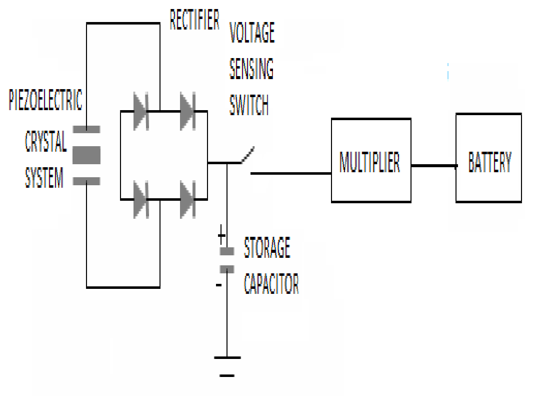

FIGURE 3

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 , 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 make it useful, this signal must be smoothened 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[1]. This discharge continues until the increasing voltage of the next pulse again equals the voltage across the capacitor[9]. The rectified voltage is stored into a storage capacitor as shown in Fig. , which gets charged up to a pre-decided value (threshold value as 0.5v) at which the switch closes and the capacitor discharges and has to be given to voltage multiplier circuit. In this way, the energy can be stored in the capacitor, and can be multiplied when it crosses the threshold value. The multiplied voltage is stored in the battery. The power stored will act as feedback source for mobile operations and again mechanical vibrations are generated as well as harvested and the process is continued.

8.SIMULATION RESULTS

The simulation results for the proposed idea is done with Virtual Instrumentation Lab View and depicted with graphs. In this result, input from mobile keypad and sound values are assumed to be random values which are generated and stored in the accumulator and when it crosses a particular threshold value, the multiplier will multiply the electricity and then charges the battery.

Simulation in VI Lab View

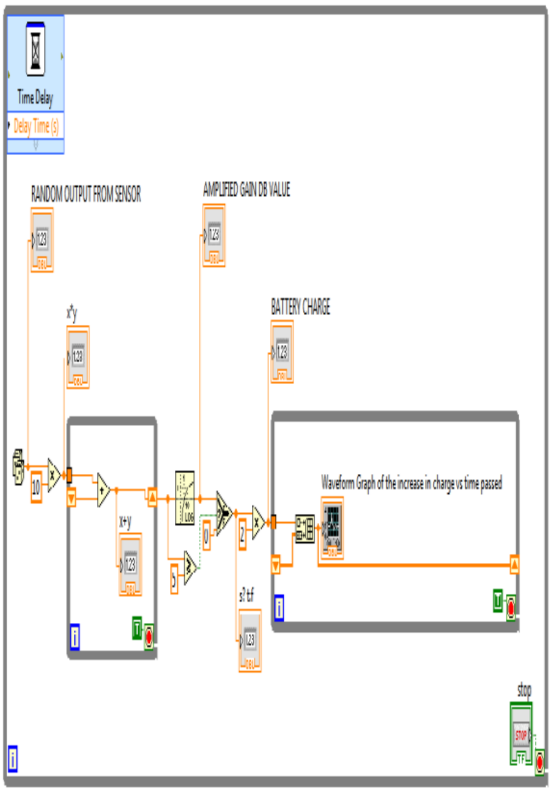

FIGURE 4

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Simulations Results in Graph

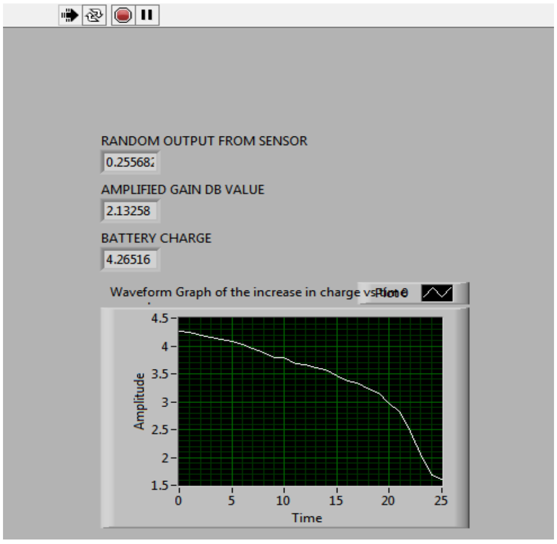

FIGURE 5

9.CONCLUSION

The design of the proposed self charging system for mobile phones has been presented in this paper. The design presented here will be quite effective in providing a power supply for the mobile phones without external charging.

Further, the approach presented in this paper can be extended to many other applications where there is a scope for similar kind of energy conservation.

10.REFERENCE

1.Karthik Kalyanaraman, Jaykrishna Babu “Power Harvesting System in Mobile Phones and Laptops using Piezoelectric Charge Generation”.2010

2.”Piezoelectric Transducer” www.ndt-ed.org

3.”Piezoelectric Effect” www.gizmag.com’.

4.”Sound properties and their perceptions”.

[5]”Mobile Technology” www.gizmag.com

[6] Shashank Priya, Robert. D. Myers , “Piezoelectric energy harvester”,United States patent application publication, July 24, 2008.

[7] Shashank Priya, Robert. D. Myers, “Piezoelectric energy harvester”,United States patent application publication, March 27, 2008.

[8] Shashank Priya, Robert. D. Myers, “Piezoelectric energy harvester”,United States patent, January 19th, 2010.

[9] Tanvi Dikshit, Dhawal Shrivastava, Abhijeet Gorey, Ashish Gupta,Parag Parandkar, Sumant Katiyal, “Energy harvesting via piezoelectricity”, Proceedings of the 4th National Conference;INDIACom 2010, Computing for Nation Development, February 25-26, 2010.