Design of a Portable Charger with Energy Conservation

Susmita Das, Sagar Patra, Mugdha Mondal, Sandipan Deb

Abstract— There is a wastage of energy when people are in motion generating enormous energy. The charge generated from the piezoelectric material represents an opportunity for harvesting energy that could be invested for proper energy conservation and utilization also. By placing piezoelectric sensor inside the sole of a shoe, it should be possible to preserve or reuse significant amounts of energy to charge electronic gadgets during walking. This innovative work is mainly focused on designing a shoe charger for mobile phone. Due to any movement of feet, the bending of the sole of the shoe should be able to compress a piezoelectric plate and generate electricity. The produced energy can be the resource for charging portable gadgets.

Index Terms— Charge storage, Energy conservation , Electrical energy, Mobile phone charger, Mechanical energy, Piezoelectric sensor, Renewable energy.

1 INTRODUCTION

Renewable energy is obtained by natural processes with continuous replenishment. There is a wasted energy everywhere. A huge number of people walking, jogging and running everyday generate enormous energy that is just a loss. The compression and bending of the shoe sole represents a way for harvesting energy that could be put to useful applications. Arranging piezoelectric plates in the sole of a shoe, there is a possibility to regain justified amount of energy. There are some existing devices in recent time those harvest the kinetic energy produced by human being for the production of useful energy[1].

As the power sources for microelectronics are continuously decreasing, environmental or natural energy resources can begin to replace batteries in certain subsystems[2]. In this paper an investigational design idea is presented on a power generator shoe with a specially structured piezoelectric transducer. The properties of the transducer are similar to the regular shoe filling and it is designed to collect energy from human walk without affecting the user's own gait. The generated power is regulated to achieve a high efficiency for converting the high piezo-electrically generated charge to a low voltage compatible for portable electronic devices. The goal of this project work is to find out a path to charge a small personal electronic device using a piezoelectric energy harvester placed inside a shoe. During walking or jogging or any type of physical activities the flexing of the sole of the shoe should be able to give a pressure on a piezoelectric plates or sensors and generate electricity. The objective is to design a charger implementing into shoe in order to generate electricity to charge gadget during walking[3]. The purpose of developing this model is to solve the problems of time consumption for waiting mobile phone to be fully charged. Besides this, the project design also can convert the wasted energy during walking into a usable electrical energy. As a result the generator will be able to produce about 2-4 Volt DC voltage from the walking action. Due to this desired voltage of charging could not be achieved. Most of the Mobile phone batteries are rated at 3.6 V/500 mA. So a DC/DC boost converter should be designed to increase the output voltage to the desired charging level[4].

Piezoelectricity was present ever since mid-18th century. The prefix piezo- is a Greek word which means 'press' or 'squeeze'. Piezoelectricity is the electric charge that accumulates in certain solid materials (such as crystals, certain ceramics) in response to applied mechanical stress or pressure. It can be actually found in old earphones from the 90's[6]. Piezoelectric materials can be used in quality checking, process control mechanism and industrial research oriented applications. This technique has excellent and inherent reliability. This gives piezoelectric sensors ruggedness, high natural frequency and an excellent linearity over a wide amplitude range. These materials are very much appropriate in medical, aerospace, nuclear instrumentation and as a tilt sensor in consumer electronics[7].

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The broad application area is spread over the area of pressure sensor in the touch pads of mobile phones. In the automotive industry, piezoelectric elements are used to monitor combustion when developing combustion engines[8]. Piezoelectric technology is not sensitive to electromagnetic field and radiation also. These are able to give measurements in hazardous and rough conditions. Some materials used such as Gallium phosphate or Tourmaline are highly stable at higher temperature (1000° c)[9].

2 METHODOLOGY

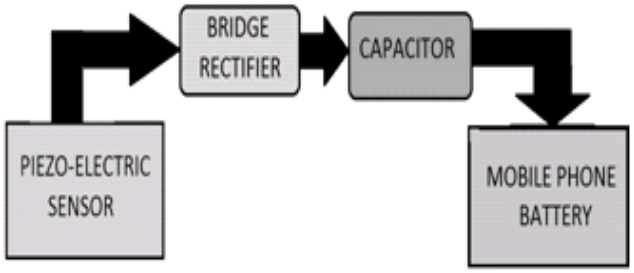

Fig. 1: Block diagram of the proposed work

Here, a plan is made for Mobile charger using piezoelectric sensors to charge mobile phones while travelling. It can recover cell phone battery charge three or four times in places where AC power is not available. A single pen torch cell can provide 1.5 volts and 1.5 amps current. Penlite cells (or any dry cells) are not rated as maximum current capability. They are rated in capacity (amp-hours or mAHr) and this cell has the capacity value about 1 amp-hour when discharged at about 10mA. So if four pen cells are connected in series, it will form a battery pack with 6 volt and 1.5 amps current. This would build 6volt and 4 amp-hours which is equivalent to 6wattHrs. To reduce the charging voltage to 4.7 volts, Zener diode may be used. Battery voltage rises to more than 3.6v during charging.

From the Fig. 1 the total planning of the work is represented. At first, the piezoelectric sensors are placed on the shoe-sole and connected serially. The voltage generated at the output due to walking is fed to the rectifier circuit. The electrical energy is stored within a capacitor. The stored energy is reused for the charging of the battery of mobile phone. The charging can be done for any other electronic gadgets also.

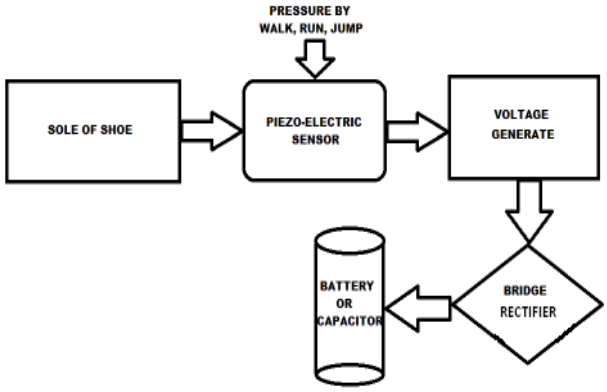

Fig. 2: Schematic diagram of the proposed work

Some piezoelectric sensors are connected in series and placed on a sole of a shoe. In Fig. 3 the piezoelectric sensors are shown which are used for the charge generation due to the pressure given by walking with the specially designed shoe-sole.

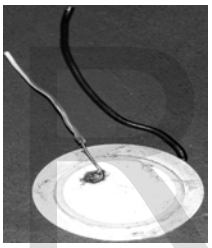

Fig 3: Type of piezo-electric sensor used in the project[5]

The voltage generated from the piezoelectric sensors is applied to the mobile charging circuit. In the Fig. 4 it is shown that the pressure is given on the piezoelectric sensors and voltage is generated in the range of 14-18 volt for a continuous walking. A normal walk of a human being produces up to 20 volt charge collectively from the sensors.

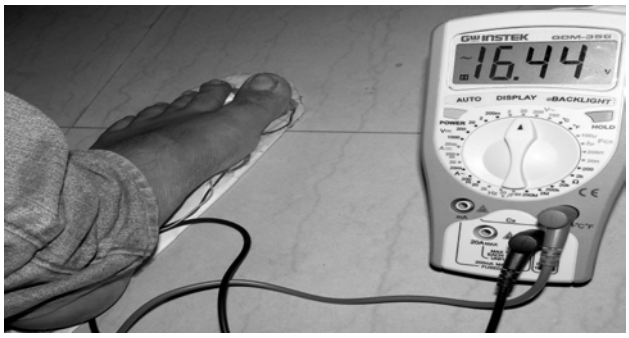

Fig. 4: Snapshot of the project work while voltage generated from Piezoelectric sensors

After the voltage generation from the Piezoelectric sensors, it is decided to store the electrical energy as a charge in the Re-chargeable battery with 12 volt capacity. Through the Fig. 5 it is shown that the generated voltage is continuously being stored within the rechargeable battery.

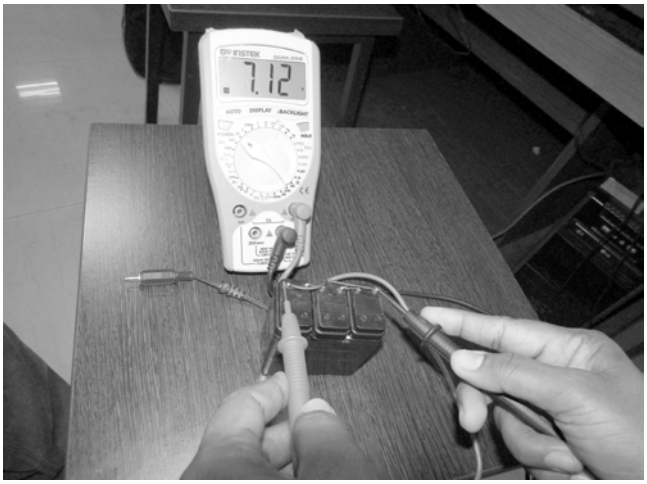

Fig. 5: Snapshot of the project work while generated voltage is stored into a Rechargeable battery (12 volt)

The storage of the energy is utilized in the charging of a mobile phone using a cable and the total system is portable which is shown in the Fig. 6. The output of the rechargeable battery is connected to the mobile charging port through wire.

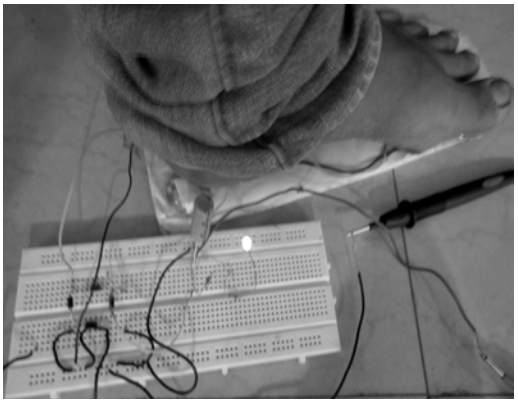

Fig. 6: Snapshot of the project work while the capacitor or re-chargeable battery is discharging

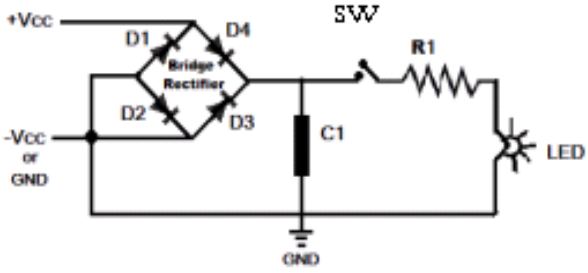

Fig. 7: Circuit Diagram of the project work for charging

The voltage generated from the piezoelectric sensor due to pressure is an AC signal. This signal needs to be rectified to get DC output. In the Fig. 7 it is depicted that the DC output is stored within a capacitor and at the end terminal any load can be activated using switch connection. To demonstrate the load activation LED is connected at the output. The prototype of the model is designed in this innovative work.

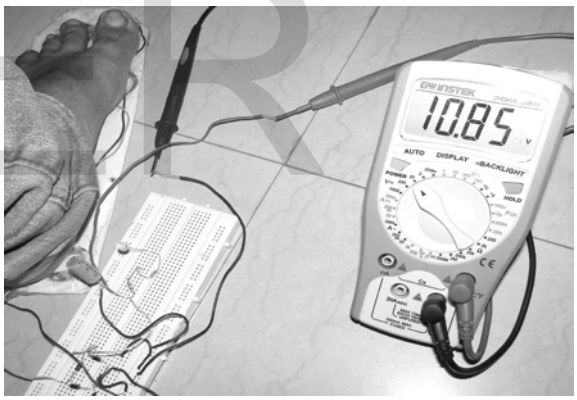

Fig. 8: Snapshot of the total project work

4 RESULTS

The input requirement of the mobile charging circuit is almost 3.5volt for different types of mobile phones or 1000μF. This need can be replaced by the energy produced as the outcome of walking wearing the special shoe. At the output of the mobile charging circuit the cell phone should be plugged for charging.

TABLE 1
OUTPUT FROM THE PIEZO-ELECTRIC SENSOR

SL. NO.	Condition	AC Output voltage(volt)
1	Standing	2.23-4.68
2	Walking	5.28-7.19
3	Jogging	8.4-12.62
4	Jumping	11.62-20.57

Fig. 9: Snapshot of the output of piezoelectric sensors while standing

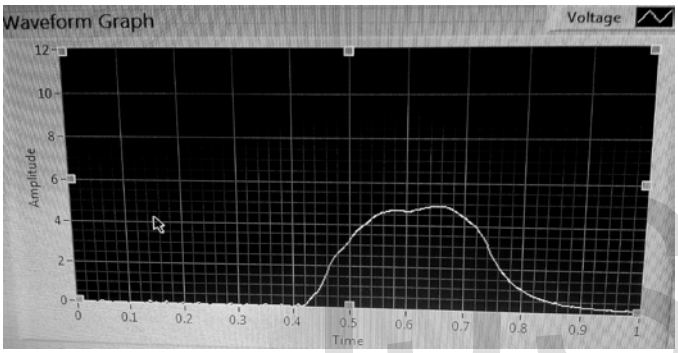

Fig. 10: Snapshot of the output of piezoelectric sensors while walking

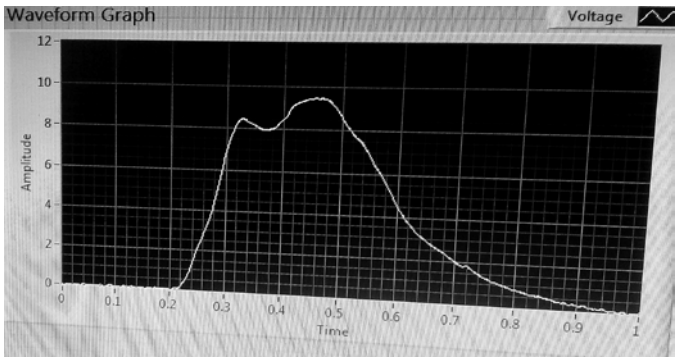

Fig. 11: Snapshot of the output of piezoelectric sensors while jogging

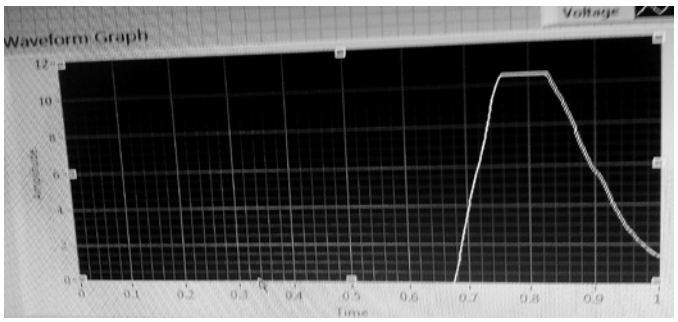

Fig. 12: Snapshot of the output of piezoelectric sensors while jumping

4 ADVANTAGES

- Its an eco-friendly device.
- It works real time, when our feet move anyway.
- We use it for any electronics gadgets at anytime.
- It works without ant external source.
- For mobile phones 3.5 volt is needed which can be achieved easily.

5 FUTURE SCOPE

Although Piezoelectric energy harvesting can be used as a cheapest form of alternate energy source in future. The analysis of the voltage stored in the battery with respect to the pressure applied can be done and the efficiency of this work can be calculated. Perfect storage of the generated power can be achieved. An array of piezo-sensors can be connected in series to get larger output and can be used for higher load applications. A portable piezoelectric energy harvesting model can be used for charging efficiently wirelessly. It can also be used as an energy source for wearable electronic gadgets. This system also can be implemented in the entrance of the big shopping mall for the power generation to make up the shortage of the power supply.

6 CONCLUSION

During the work progression of the project the arrangement of the shoe-sole was the most challenging part. In future, this model can be modified for the more powerful batteries for smart phones also. Using other resources of electrical energy generated from the human body can also be a renewable source of battery charger for different types of electronic gadgets with a portability feature. The most important matter is that this model is comprised of natural power and portable.

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