“DASH” – The Charging Shoe

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INTRODUCTION

Due to our hectic and torpid lifestyles, personal health is often abandoned. Herein, we have created a device using piezoelectric material as an alternate means for powering mobile devices. Vibration energy is generated from any perceivable activity, and is usually heard as the noise. Our research merges these two technologies to develop a hybrid harvesting energy system, that will capture the ambient source of energy from vibrations.

A phone is no longer an item used only for communication, it has become “smart.” Thus, it requires a larger battery to keep it running throughout the day. It is not feasible to expand the value of a battery endlessly; therefore, we need to supplement it. We can do this by recharging devices with a renewable resource. Thus, we have designed a portable charger, whose energy will be equal to the number of steps you take. The gadget will harness the voltage generated across a piezoelectric material kept within a shoe, storing it in a battery. The battery can then be utilized to charge a cellular phone, or other device, using a USB wire whenever needed. The device will weigh around 200 grams, and can be strapped around an ankle; it will provide a charge on the go, and is a perfect traveler’s companion, that focuses on capturing the renewable energy otherwise wasted.

PRINCIPLES & RELATED LITERATURE

The elementary principle involved is the transformation of human mechanical power into electrical signals. The mechanical power generated is due to the trotter moment of an ankle. When a person is walking or running, he possesses a certain amount of kinetic energy, and thus applies some amount of pressure on the ground, via the shoe. This is the pressure we are concerned with, and are utilizing in our product development. This mechanical energy, in terms of vibrations, is fed to the piezoelectric disc transducer which causes the piezo crystals to vibrate; this excitation when taken with reference to the base plate generates a voltage.

In figure 1, the golden layer is the ground plate, and the crystals are embedded in the center (as shown). The voltage yield of this transducer is then attached to an amplifier, rectifier and it is then synchronized to a value adequate enough to charge a mobile phone battery.

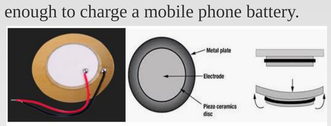


Figure 1. 35mm Piezo Ceramic Transducer (with wire)

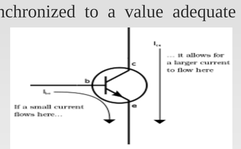
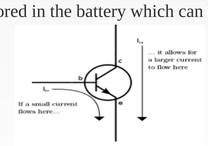


Figure 2. How the transistor works

The circuit of the device is comprised of a Darlington transistor (Figure 2), an amplifier (dual op-amp) (Figure 3), a full wave rectification circuit (Figure 4), regulating IC, namely 7805, to make a constant voltage of 5V, and a switch. A capacitor (1000 uF) is used to stock the electric charge so that when the person is not in motion the power is continually supplied. The piezoelectric disc is attached amid the upper and lower part of the sole. The external circuitry is fabricated and fitted to the back part of the shoe and dissimilar connectors outspread for charging the phone batteries. The control of the charger is given to the user via a switch, so that he can decide when he wants to charge the phone. When it is not charging the mobile phone, the power is stored in the battery which can be used whenever needed.



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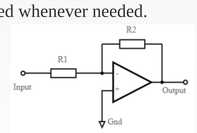


Figure 3. Voltage amplification circuit diagram

MATERIALS & METHOD

A. Building the Piezoelectric Generator

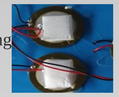
1. The Foot and Shoe Insole Measurement

The first element that we need for designing a piezoelectric generator is the insole foam frame. We take out the base from the shoe and make appropriate measurements using the architectural scale ruler.

2. Attaching the Piezo Elements

After we finished creating the base for our piezoelectric generator, we paste the piezo elements on base with a hot glue gun. We are careful that the glue doesn’t touch the Positive (RED) and Negative (BLACK) joints because those joints will be soldered later on. We ensure that the piezo elements are glued on both sides of the plastic. Using a digital multimeter, we make sure that our piezo elements are working.

3. Connecting the Bridge Rectifier

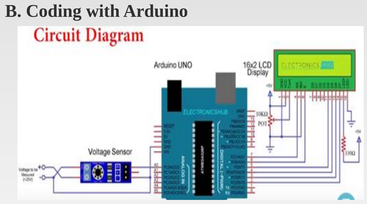


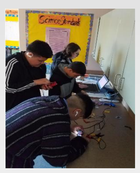
The piezo wires are connected to the bridge diode, according to the circuit diagram. Since the current is AC, the position of the wires are interchangeable, as long as they connect to the correct diodes in the diagram.

4. Final Installation

After we have assembled all of the components, and our Piezoelectric generator is ready, we move towards installation. We adjust the piezoelectric generator, inside the shoe, and then insert the original sole on top of it. We take the USB cable, wired previously, and thread it between the tongue and the outside of the shoe.

B. Coding with Arduino





C. Testing

Since we completed the installation part, we need to test it to see whether it works or not. To check how well it works we should EXERCISE daily. We can play sports every day, except for football because the gadget can be damaged while hitting the ball with our foot. The battery will charge only when we take a step; as our steps increase, our phone will charge more rapidly.

WORKING EQUATIONS

A. Voltage Developed

Voltage = Papp*Tp*C

Where:

Papp= Pressure applied on piezo,
Tp = Thickness of the piezo, and
C = piezo rating

B. Amplification Model

The voltage gain depends on the impedances connected across the pnp transistor.

$gain = (rf/\ ) + 1$

Here, rf = resistance in parallel, ri = resistance in series.

RESULTS

Conditions

- The piezoelectric disc used for the experiment had the same piezoelectric constant, C
- The thickness of the disc was 2 mm and the diameter 20 mm (assuming no manufacturing defect)
- The same person stepped on the piezo all the time

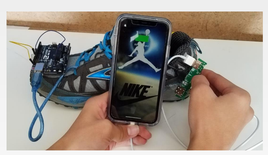
Table 1: Voltage generated due to normal walking

System Test Number	Voltage Generated
1	1.2
2	1.9
3	1.0
4	1.4
5	2.0

TABLE 2: Voltage generated on running

System Test Number	Voltage Generated
1	3.4
2	3.6.
3	3.7
4	3.1
5	3.8

THE PRODUCT



CONCLUSION

In this experiment, we examined a piezo-material based gadget. This gadget uses trotter moment to generate sufficient voltage capable of charging a mobile phone’s batteries, in remote places where plugin points are not available (at 5V DC). Since the gadget requires actual walking, it was fabricated; factual data has been recorded accordingly. The major conclusion drawn is that a generator, as an only power source, is not capable of producing enough current to be of plausible application. Thus, we need a transistor pair to amplify this value. It was also noted that voltage increased as the person started running, and time required to charge the phone declined. Hence, the gadget also proves to be a benefit for human health, by reassuring a positive fitness exercise, like walking and running. Moreover, the gadget is a potent renewable invention that can be used specifically in remote places that lack electrical supply.

RECOMMENDATION

Piezoelectric materials can be placed under the floor on various busy areas, and can be used as a renewable energy source for lighting systems presently installed. It can also be placed under the floor of discos, as a large amount of pressure is applied on the floors there while jumping. In the future, we would like to make the device water proof.

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