WALKING CHARGER USING PIEZO-ELECTRIC MATERIAL

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Abstract: Due to our hectic and torpid lifestyles, health has been on the receiving end. Herein we discuss a device using piezoelectric material that furnishes as an alternate means for powering mobile devices, etc. Additionally, it can also be intended for emergency 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 they generate voltage pulses and minute quantities of current.
Keywords: Piezoelectric materials, Nanogenerators, walking charger, emergency lighting.

I. INTRODUCTION

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. But since it is not at all feasible to expand the mAh value of a battery endlessly, therefore we need to supplement it and what better than recharging it with a renewable resource. Thus, herein we are designing a portable charger whose energy will be equal to the number of steps we take. The gadget will then harness the voltage generated across a piezoelectric material kept within a shoe moreover, store it in the battery which can be utilized to charge the cellular phone using any USB wire whenever needed. It will be a device weighing around 200 grams which can be strapped around our ankle. And will provide is charge on the go. It's a perfect traveler's equipment which focuses on capturing the renewable and waste energy present around us.

II. LITERATURE REVIEW

"Global conference Wikimedia 2014 London states that 97 out of 100 total members are cell phone users". But due to the urbanization going and the dependence on life increasing so rapidly, the battery research has been unable to keep up. Thus the problem of fast discharging batteries and mobiles running out of charge in approximately 8 hours as compared to previous phones that used to last 3 days. Thus now charging mobile phones and making sure that it lasts a sufficient time period requires user a lot more user attention as the conventional or the age old method requires appropriate socket and electrical connectivity. But the problem arises specifically for tourists, mountaineers or in remote places like villages where the electrical supply isn't there or even if it's there the assurance of 24*7 supplies is not there thus this offers specific limitations in charging mobile phones. These hindrances are mostly observed in charging mobile phone often due to increase battery drainage in our smartphones. A lot of alternate measures have been suggested and there implementation has been tried out to make available emergency power for charging mobile phones and moreover renewable and sustainable measures has engrossed an increasing interest in last few years. One of the many such means is the extraction of human power using a Nano-generator like piezoelectric transducers etc. Previously, many such human power-driven generators and human driven harvesting system had been proposed but the uniqueness of this paper is that it gives extra importance to the actual development and implementation of the E-Health gadget. When a person actual walks or runs there is sufficient amount of inherent kinetic energy generated due to his action and harvesting this is really favorable because of plentiful motion and vibration in the ankle which is capable of producing produces moderate power renewably. Although utilization of the energy generated by the sun in the form of solar energy is also a very exciting prospect but its usage is not equivalent to that of these Nano-generators as it is dependent source, it depends on the intensity and the area of the solar panel and is thus more complicated way of generating renewable energy and even if we by some proper research and developments we are somehow able to overcome the above drawbacks, one major thing which we would never be able to eliminate will be its limited time availability as the sun can maximum provide energy for around 15 hours in a day. Thus in recent years, lots of development and researches have been made about ways of generating power from vibrational energy. Also since by using piezoelectric polymer transducer energy is harvested from human walk without affecting user's gate it proposes a solution that can be easily implemented with the existing shoe. The piezo transducer is capable of generating up to 2 V in a single press and by proper placing and designing we can rectify and regulate the voltage to 5V. But, it serves only an independent implementation of piezoelectric material without any amplification circuitry attached makes a portable mobile phone with a lesser efficiency, thus there is a need for an amplifier. Also in some previous related work, minimalistic mobile electronic systems such as biomedical drug delivery implants or the acceleration and pressure monitoring sensors have been suggested. But they have short operational lives due to the deficiency of storage space but in the application discussed in this paper there is sufficient space to provide an external battery pack thereby increasing its applicability.

III. DESIGN AND DEVELOPMENT

A. PRINCIPLE

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 our ankle. When a person is walking or running he possess a certain amount of kinetic energy and thus applies some amount of pressure on the ground via the shoe and 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.

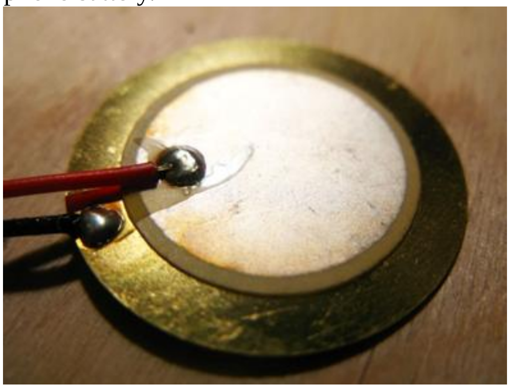

Figure 1 – Piezoelectric transducer disc

The circuit of the device chiefly 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 and when not and when it is not charging the mobile phone the power is stored in the battery which can be used whenever needed.

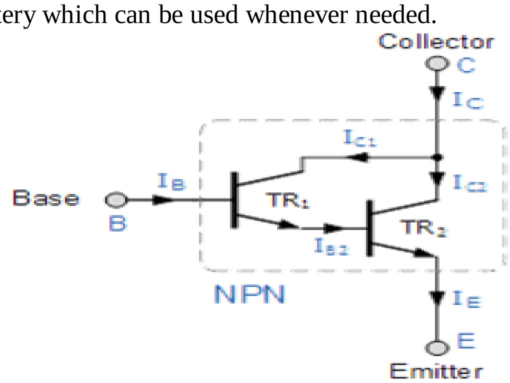

Figure 2 – Darlington Configuration

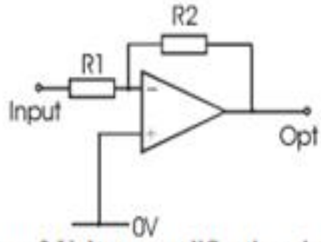

Figure 3 Voltage amplification circuit.

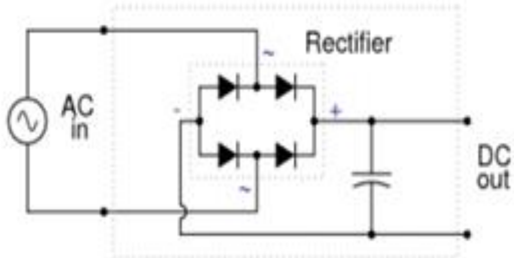

Figure 4 Rectification circuit.

B. Working

The application of this gadget is entirely based on human pressure and trotter movement of our ankle; here the mechanical stresses and voltages are used to generate power via the piezoelectric transducers which are put in our shoe. This vibrational energy is changed into electrical energy by the transducer. The productivity of the transducer system is then fed into a modifier ciruitary that consists of 4 subsystem, voltage amplification (by adjusting the voltage gain), rectification (DC-DC converter) – which converts pulsated DC to fixed DC, and current amplification – this increases the current to a value 20X the value. In walking condition for a 70 Kg man the disc produces a voltage of 1.75V-2V. This voltage is improved up to 8V by using a suitable resistance arrangement of 20 ohm and 5 ohm. With the help of this non-inverting configration we set the voltage gain of 4. This amplification is then put into a rectification circuit for converting pulsating dc signals to pure continuous form. Once we get continuous DC,then the current is magnefied about 20 times using the Darlington transistor and lastly voltage is regulated to 5V by using a regulating IC 7805. This output after regulation is sufficient enough to charge the mobile phone and to power the small electronic devices.

IV. EQUATIONS

Voltage developed

Voltage = P_{app}*T_p*C (1)

Where P_{app}= Pressure applied on piezo , T_p = Thickness of the piezo and C = piezo rating

AMPLICICATION MODEL

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

$$gain = \frac{rf}{ri} + 1$$

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

V. EXPERIMENT

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 working

SI NO.	VOLTAGE GENERATED
1	1.5 V
2	1 V
3	2.3 V
4	1.8 V
5	2.1 V
6	1.9 V
7	2.7 V

TABLE 2 : Voltage generated on running

SI NO.	VOLTAGE GENERATED
1	3.2
2	3.6
3	3.7
4	3.1
5	3.8

By Figure 5 we can observe that with the help of a double Darlington pair configuration it is possible to get a high current of 821 mA which is capable of giving 5V DC supply and at a rate faster than the normal mobile phone charger. Figure 6 gives us the entire network design, i.e., it consists of an op-amp for voltage amplification and a Darlington pair for current amplification.

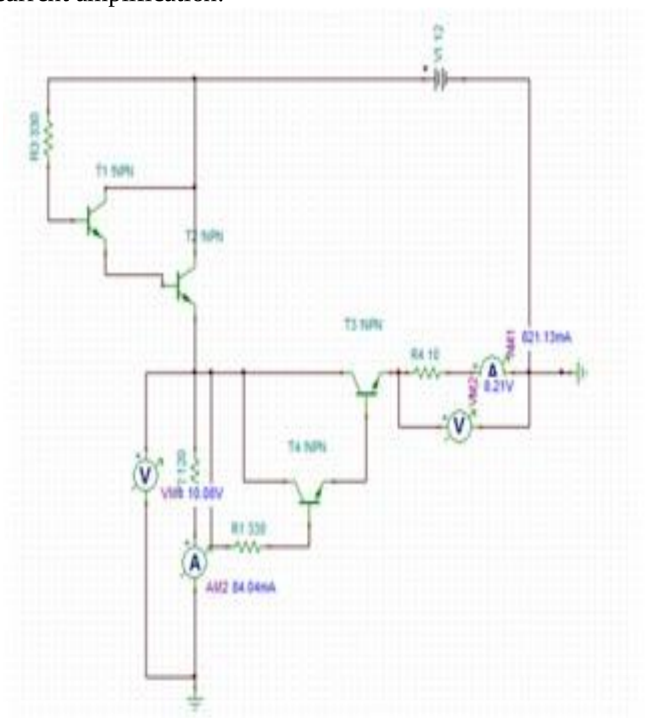

Figure 5 – Double Darlington Pair

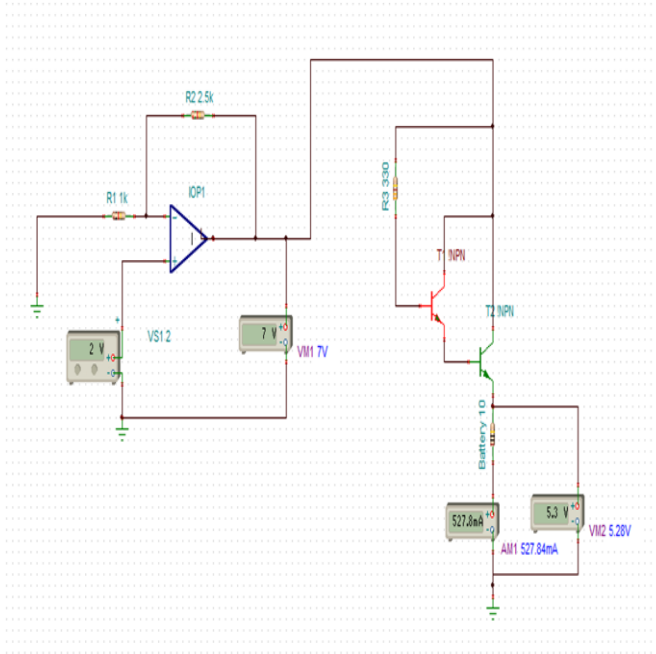

Figure 6 – Complete circuit

VI. CONCLUSION

This paper, we about discuss about a piezo-material based gadget which uses trotter moment to generate sufficient voltage which is capable of charging our mobile phone batteries at remote places where plug point isn't located at 5V DC. Since the gadget involves actual walking the gadget was fabricated and actual data has been recorded above. The major conclusion drawn by this is that Nano-generator as an only power source aren't capable of producing enough current to be of any plausible application, thus we need a Darlington pair to amplify this value. It was also noted that the voltage varied increased when the person started running and time taken to charge the phone declined. Thus, the gadget also proves to be a benefit for human health by reassuring an acclaimed fitness exercise like walking and running. So the gadget makes for a potent renewable gadget which can specially be used in remote places lacking electrical supply.

VII. SCOPE FOR THE FUTURE

Piezoelectric materials can be placed under the floor oN various busy areas and can be used as a renewable energy source for lighting system present around. It can also be placed under the floor of discos as a large amount of pressure is applied on the floors there while jumping.

REFERENCES

[1] B. Steele, “Timed walking tests of exercise capacity in chronic cardiopulmonary illness,” J. Cardiopulm. Rehabil. Prev., vol. 16, no. 1, pp. 25–33, 1996.

[2] S. Roundy, P. K. Wright, and J. Rabaey, “A study of low level vibrations as a power source for wireless sensor nodes,” Comput. Commun., vol. 26, no. 11, pp. 1131–1144, 2003.

[3] P. D. Mitcheson, E. M. Yeatman, G. K. Rao, A. S. Holmes, and T. C. Green, “Energy harvesting from human and machine motion for wireless electronic devices,” Proc. IEEE, vol. 96, no. 9, pp. 1457–1486, 2008.

