Design of footstep power generation using piezoelectric sensors

P.Venkatesh, M.Satya kalyan varma, M.Sahil, P.Sai ajay

UG Student, EEE Dept, Pragati Engineering College (autonomous), Surampalem, Andhra Pradesh.

samueljayakarsammu@gmail.com, mns14398@gmail.com, sahilmogal17@gmail.com, pajay0973@gmail.com

Abstract

In this paper, we have presented the design of power generation using footstep based on available piezoelectric sensors. Human race requires energy at very rapid rate for their living and wellbeing from the time of their arrival on this planet, because of this reason power resources have been worn out and enervated. Proposal for the employment and application of extravagant energy in foots of human is very much to the purpose for extremely populated nations like China and India. Where the streets, rail and bus station are over peopled and packed like sardines moving around the clock. So, using such concept the power can be availed and deployed by converting mechanical energy to electrical energy.

***Index Terms*— Piezoelectric sensors, Diode, Inverter**

1. Introduction

At present, electricity is the necessary part of the human life in daily activities and demand of electricity is increasing exponentially day by day. Modern technology requires a vast amount of power in the form of electricity for its different operations. Worldwide electricity generation contributes maximum in pollution as the single largest source. Also, exponential increasing demands of electricity creating a large gap between demand and supply. Due to this, researcher and innovators working in the field of energy harvesting are trying to explore the alternate sources of energy and its feasible use. Accordingly, main objective of present day technology is to invent and provide a pollution free method of electricity from the growing human population that does not negatively impact the environment. In this technology, piezoelectric effect is used to generate the electricity. When pressure and strain are applied to a material which shows piezoelectric effect have the capability to build up an electrical charge. Piezoelectric sensors generate electricity when we apply pressure on the sensors as shown in figure below.

Piezoelectric materials act as a transducers and pressure exerted by the moving people transformed into electric current. This paper presents the design of power generation using footstep based on piezoelectric sensors with detailed study of their merits, demerits, the sub equipment and their requirements. Many Research groups are actively working in the area of footstep power generation using piezoelectric methodology. locomotion. Yaramasu et al., proposed high power wind energy conversation system as an emerging technology using same technology [2]. Taghavi and Andrew Stinchchombe et al., proposed a self-sufficient wireless transmitter powered by footpump urine operating variable [3]. Ghosh et al., proposed electrical power generation using footstep for urban area energy application [4]. Meirer et al., proposed a piezoelectric energy harvesting shoe system for podiatric sensing [5]. Pedchenko and Alexander V. et al., proposed analytical tools for investigating stability and power generation of electromagnetic vibration energy of harvesters [8]. Others [6-7] proposed footstep generation through walking and its mechanical impact during piezoelectric operations.

2. Experimental Setup and Working

Piezoelectric ceramics fit to the group of ferroelectric materials. The piezoelectric effect is common in piezo ceramics like PbTiO3, PbZrO3, and PZT. Heart of the present footstep power generator is the piezoelectric sensor which works as shown in Figure 2.

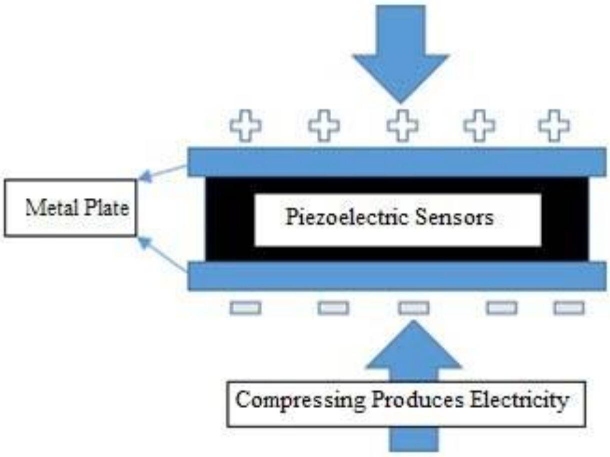

Fig. 1. Piezo electric mechanism

In this present footstep power generator, the piezoelectric material plays a great role so its choice is of great importance. PZT and PVDF are the two most commonly available piezoelectric materials, so an analysis on these two materials was carried out, to chose the most suitable material. The basis for selection was better output voltage for various pressures applied.

As Shown in Figure 3. The physical foot interface is layed on chain sprocket arrangement and spring which is connected to the piezoelectric sensors. The sensors generate AC voltage which is converted to DC supply using DC generators; the DC outputs will be stored in two (six volt each) batteries that are connected to an inverter which will convert 12V to 220V AC. The AC output power will used in running of load.

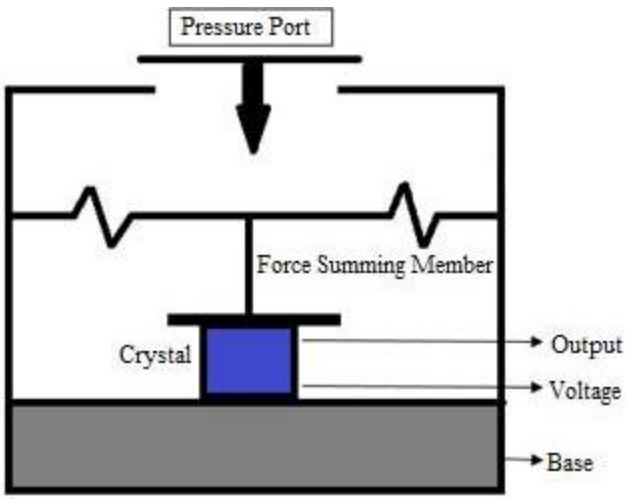

Fig. 2. Piezo electric crystal sensor

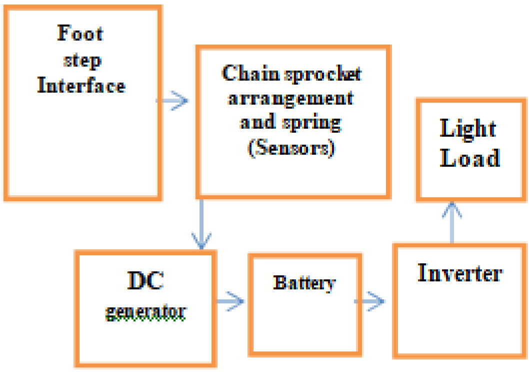

Fig. 3. Block Diagram of foot step power generator.

Figure 4 depicts the experimental setup of the performed foot power generation system which comprises of diodes, capacitors, astable vibrator, inverter and peizo electric sensors. The number of piezo electric sensors that we will be using is 20. Piezoelectric sensors are the sensors that will be producing AC voltage so in order to convert the AC voltage into DC we will be using general purpose diode i.e.1N4001 series.

This is followed by a capacitor, and the capacitor charged by the rectifier. Charging threshold voltage of this capacitor is pre- decided and at this voltage the switch closes and discharging of capacitor takes place through the device.

Fig.4. Experimental setup of Foot step power generator system using piezo electric sensors.

RESULT AND DISCUSSION

V-I characteristics (as in Figure 5) of both the piezoelectric material under consideration were studied to understand the output corresponds to the various pressure and strain applied on them. Voltmeters and ammeter are used for measuring the voltages developed across the piezoelectric materials and amount of current flowing them respectively. As different observed pressure and strain are tested on the piezoelectric material, different voltage readings were noted corresponding to the different pressure and strain.

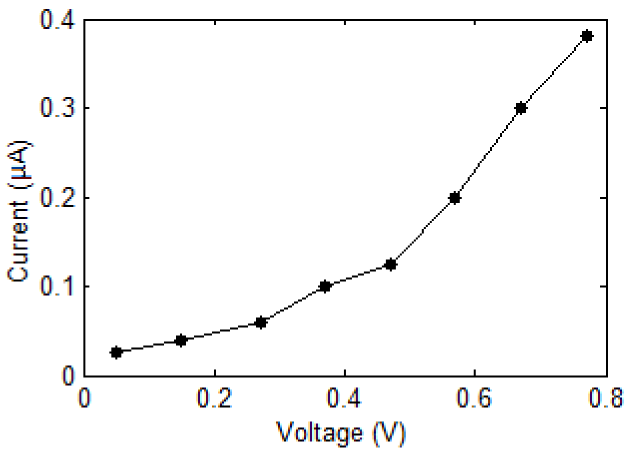

Fig.5. V-I Characteristics Graph

In this way, the energy can be stored in the capacitor by charging the capacitor, and the capacitor may be discharged on the basis of requirement. However the energy harvesting capacity of this circuit is not very much appreciable. To overcome this problem, after bridge rectifier stage, one may use a DC to DC converter. An improvement by a factor of seven in energy harvesting has been shown by the addition of DC-DC converter. In parallel with the piezoelectric element, it contains a switching device.

The DC voltage will be stored in 6V battery, the number of battery used is 2 in number. The 6V each DC of the battery is converted into AC by power transistor T-1

(NPN). The output of the transistor is fed to the inverter transformer which will convert 12 V to 220Volt which will light up. The number of press or number of jumps on a wooden plank is shown on the 0-99 counter.

CONCLUSION

In this paper we have calculated the various methodologies for foot step generation using piezoelectric sensors. The Experimental setup is discussed with all sub equipments. The results have been discussed in terms of output voltages. The plot between current and voltage shows the extent of power generated. The various merits are power generation is simply walking on the step and no need of fuel, power may also be generated by running or exercising on the step and battery may be used to store the conventional power. In future works one may attempt to overcome following limiting factors as it is only applicable for the particular place and limited power is generated using the conventional ICs present in market. In future we may implement the same methodology in treadmills, staircases and places with frequent human moment with their commercial usage model.

REFERENCES

[1] Arvind, Asha, Jilu Joy, S. Sreekalpa, S. Sujith, and Resmi Ramakrishnan "Power Generation through Human Locomotion," Journal of Electronics and Communication Systems, vol. 1, no. 1, pp. 1-9, 2016.

[2] Yaramasu, Venkata, Bin Wu, Paresh C. Sen, Samir Kouro, and Mehdi Narimani "High-power wind energy conversion systems: State-of-the-art and emerging technologies," Proceedings of the IEEE, vol. 103, no. 5, pp. 740-788, 2015.

[3] Taghavi, Majid, Andrew Stinchcombe, John Greenman, Virgilio Mattoli, Lucia Beccai, Barbara Mazzolai, Chris Melhuish, and I.A. Ieropoulos "Self sufficient wireless transmitter powered by foot-pumped urine operating wearable MFC," Bioinspiration & biomimetics 11, no. 1, pp. 016001, 2015.

[4] Ghosh, Joydev, Supratim Sen, Amit Saha, and Samir Basak. "Electrical power generation using foot step for urban area energy applications," Proceedings of IEEE International Conference on Advances in Computing, Communications and Informatics (ICACCI 2013), pp. 1367-1369, 2013.

[5] Meier, Rich, Nicholas Kelly, Omri Almog, and Patrick Chiang. "A piezoelectric energy- harvesting shoe system for podiatric sensing," Proceedings of IEEE 36th Annual International Conference of Engineering in Medicine and Biology Society (EMBC 2014), pp. 622-625., 2014.

[6] Pal, Prabir K., Vivek Mahadev, and K. Jayarajan. "Gait generation for a six-legged walking machine through graph search," Proceedings of IEEE International Conference on Robotics and Automation, pp. 1332-1337, 1994.

[7] Basari, Amat A., Sosuke Awaji, Shintaro Sakamoto, Seiji Hashimoto, Bunji Homma, Kenji Suto, Hiroaki Okada, Hideki Okuno, Kojiro Kobayashi, and Shunji Kumagai "Evaluation on mechanical impact parameters in piezoelectric power

generation," Proceedings of IEEE 10th Asian Control Conference (ASCC), 2015, pp. 1-6, 2015.

[8] Pedchenko, Alexander V., E. Bryn Pitt, and Eric J. Barth. "Analytical Tools for Investigating Stability and Power Generation of Electromagnetic Vibration Energy Harvesters." IEEE/ASME Transactions on Mechatronics 21, no. 2 (2016): 717-726.