e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:04/Issue:03/March-2022 Impact Factor- 6.752 www.irjmets.com

FOOTSTEP POWER GENERATION USING PIEZOELECTRIC PLATE

Kunal Soni*1, Nikhil Jha*2, Jai Padamwar*3, Devanand Bhonsle*4, Tanu Rizvi*5

*1,2,3Students, Department Of Electrical Engineering, Shri Shankaracharya Technical Campus, Junwani, Bhilai 490020, Chhattisgarh, India.

*4,5Assistant Professor, Department Of Electrical Engineering, Shri Shankaracharya Technical Campus, Junwani, Bhilai 490020, Chhattisgarh, India.

ABSTRACT

Electricity usage is expanding at an exponential rate. This research recommends making use of human locomotion energy, which, despite being extractable, is largely wasted. This research presents an energy storage concept that employs human movement, skipping, and running as energy. The piezoelectric sensors are used in this innovative footstep power production system. The piezo sensors are positioned below the platform to generate a voltage from footstep. The sensors are arranged in such a way that maximum output voltage is generated, which is then sent to our monitoring circuitry. This energy is then stored in the batteries and can be used whenever it is convenient. A model like this is near suitable for India, which has a large pedestrian people. This method of generating charge and storing it for later use encourages an environmentally responsible approach to energy creation and the development of clean green energy.

Keywords: Piezoelectricity, Plates, Footsteps, Power Generation, Electricity.

I. INTRODUCTION

Increasing demand of electricity day by day is due to advancement and applications in the present life of humans. There are a variety of ways to generate electricity, and one of them, footfall energy generation, could be an efficient way to generate electric power[1]. In a person's life walking is the most vital activity done by him. While walking weight is transferred to the road surface through foot falls on the ground at each step, a person loses energy to the road surface in the ways of sound, throbbing, and impact. The piezoelectric concept underpins footstep power production technology[2]. When pressure and strain are applied to piezoelectric materials, they can build up an electrical charge. In other words, Piezoelectricity refers to the ability of a few materials to generate an electric potential in the presence of a load[3].

The proposal for utilising waste energy from human movement to generate electricity is particularly relevant and significant for densely populated nations such as India and China, where the mobility of their people will prove to be a godsend in producing electricity from their footfall. Roads, train stations, and bus stops are all overcrowded in India, and thousands of public travel in an hour[4]. As a result, this promising technology may be used to generate a vast amount of power. Also, the utilization of such technology shifts the civilization toward renewable energy from the non-renewables like coal, petroleum, and natural gas[5].

Piezoelectricity

The phrase "piezoelectric" is taken from Greek word "piezein," which implies "to squeeze or press." When mechanical stress is applied to certain materials, an electric AC current is generated as shown in Fig.1. It's a charge that builds up in crystalline solid materials because of mechanical force[6]. The piezoelectric action is also reversible, which is a unique feature of piezoelectric materials. This means that putting stress on them produces current, whereas inducing current causes them to expand or contract depending on the polarity of the applied source[7].

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:04/Issue:03/March-2022 Impact Factor- 6.752 www.irjmets.com

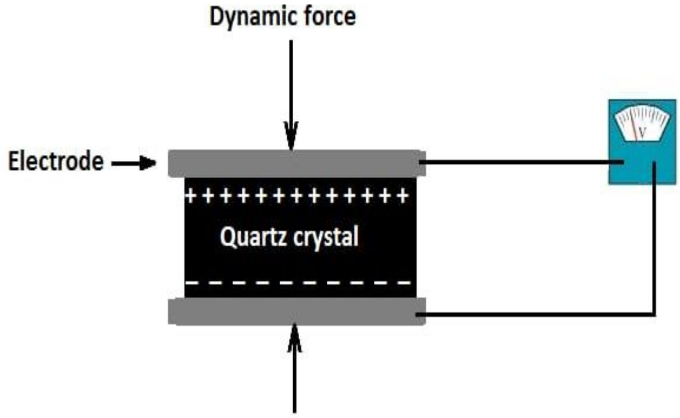

Fig 1: Working of Piezoelectric Sensor

Study of Piezo Materials

Piezoelectric effect can be seen in a variety of materials which can be found in both man-made and natural state. Materials that demonstrate this effect include:

1. Crystalline materials: Quarts (SiO_2), Topaz
2. Ceramic: Sodium Tungstate (Na_2WO_3)
3. Zinc oxide (ZnO)
4. Gallium orthophosphate ($GaPO_4$)
5. Lead-free piezoceramics Bismuth Titanate ($Bi_4Ti_3O_{12}$) and Bismuth ferrite ($BiFeO_3$)
6. Tourmaline Barium Titanate ($BaTiO_3$) and various other solids[5].

II. MODEL DESCRIPTION AND WORKING

Footstep power generation utilising piezoelectric sensor is the name of our project. The piezoelectric sensor, ARDINO UNO, LCD, battery, LED, bridge rectifier, rubber pad, and connecting cables are all included in this project as shown in Fig.2 . The energy or force is provided by the human stepping at any location where we have tiles equipped with piezoelectric sensors. The basic idea of a piezoelectric sensor is that when the step is delivered, the piezo converts mechanical energy into electrical charge[8].

Fig 2: Model setup of Footstep power generator system using piezo electric

The intended prototype of the device is built, and a number of tests were conducted to assess the proposed stepping-type piezoelectric actuator's performance [9]. A circuit diagram of the prototype is shown in the Fig.3 A prototype, a computer, a transmitter, a signal booster, and a capacitance micrometre are all part of the established experimental system[10]. An original voltage signal is generated by the signal generator, the signal amplifier then amplifies it to drive the prototype. Capacitance micrometre measures the distance between capacitance sensor and the mover's fixed reflector at the same time[11]. Finally, the computer compiles and analyses all the information. The entire experimental setup can be mounted on a separate table, and all tests are performed at a temperature of 25 degrees Celsius.

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:04/Issue:03/March-2022 Impact Factor- 6.752 www.irjmets.com

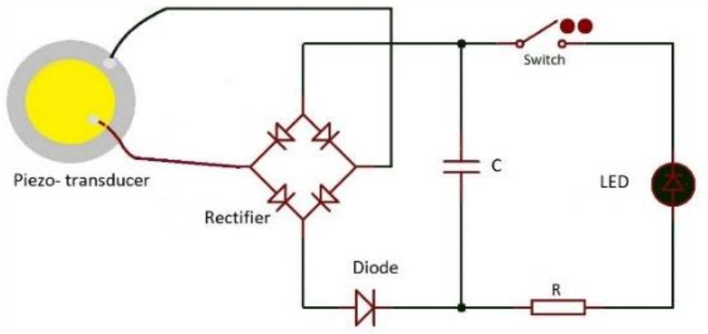

Fig 3: Circuit diagram of footstep generator

T is the tension that a piezoelectric material undergoes when it is stressed. It produces Polarization (P), which would be a linear function of T (P=dT) (d: piezoelectric strain constant). D=ε E is the connection between electrical displacement D and electric field strength E for a dielectric medium where ε is the relative permittivity. Therefore, the basic Piezoelectric Effect equation is given by[12]:

$$D_n = d_{nj} T_j + \varepsilon^T_{nm} E_m$$

III. EXPERIMENTS

In this project, we connect three piezos in parallel on one tile, such that the series connections are placed in parallel. As a result, connecting five piezoelectric discs in series raises the equivalent capacitance. Power generated varies with different steps in piezoelectric array that is used. The voltages obtained are based on practical results:

- Min. emf = 2V /step
- Max. emf= 8V /step

Assume that the average weight of the person using the system is 55 kg, the average computation is:

Steps must be taken to enhance the battery's 1 V charge. = 680

- To boost the battery's 12 volts:
- Total footfall required = (12 × 680) =8160 steps

Considering the implementation of this system in places like college biometrics where footsteps as source is easily available, if Time required for 2 steps is 1 second then Time required for 8160 steps = 8160/ (60 × 2) = 68 minutes

IV. RESULT AND DISCUSSION

The V-I characteristics of both piezoelectric effects were examined to better understand how output corresponds to the pressure and stress applied to them. The voltages formed across piezoelectric effect, as well as the quantity of current that passes through them, are measured using voltmeters and ammeters. When different pressures and stresses were evaluated on the piezoelectric element, different voltage readings were observed that corresponded to that same different pressures and strains. By charging the capacitor, energy that can be stored in it, and the resistive element can be discharged whenever needed.

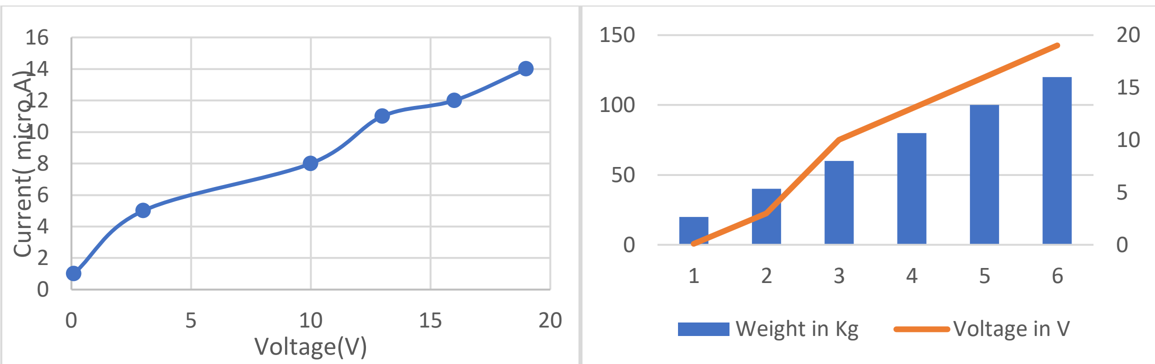

Fig 4: First Graph is of Current (in micro-A) versus Voltage (V) and second is Weight (Kg) versus Voltage (V)

IRJMETS
e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:04/Issue:03/March-2022 Impact Factor- 6.752 www.irjmets.com

However, this circuit's energy gathering potential is limited, with the installation of a DC-DC converter, energy harvesting improved by a factor of seven. It has a switching device on the same plane as the piezoelectric element [13]. A 6V battery will be used to store the DC voltage, with two batteries being employed. The power transistor converts the battery's 6V DC into AC[14]. The transistor's output is supplied to the inverter transformer, which converts 12 volts to 220 volts and lights the bulb. Different values of weight ranging from 20Kg to 120Kg with intervals of 20 Kg has been tested as shown in Table 1. And respective graphs with respect to voltage generated is plotted in Fig. 4 and Voltage with current in Fig.5.

Table 1: Power Generation at different weights

S. No.	Weight (Kg)	Voltage (V)	Current (µA)	Power (mW)
1	20	0.1	1	0.00
2	40	3	5	0.015
3	60	10	8	0.08
4	80	13	11	0.143
5	100	16	12	0.192
6	120	19	14	0.266

V. CONCLUSION

Based on foot stepping, this work presented a stepping type piezoelectric linear actuator. The structures and principles of operation are demonstrated and explained in depth. The designed actuator's prototype is built, and its primary performance is evaluated. The above experimental results were produced by the suggested actuator's driving capabilities. Displacement outputs illustrate good time linear correlations under various driving voltages and driving frequencies. This system can be put in places where people travel around the clock, such as residences, schools, and universities. People's weight provides power when they walk on the rungs or platform. A piezoelectric sensor transfers mechanical energy delivered through glass into electrical power as part of the control mechanism. Finally, this concept presents an appealing method to obtain clean, renewable power and is also very user-friendly.

ACKNOWLEDGEMENT

First and foremost, we would like to thank Dr. Devanand Bhonsle, faculty of the Department of Electrical Engineering, Shri Shankaracharya Technical Campus, Junwani, Bhilai, for guiding us through the major project assigned. We'd also like to thank everyone who has helped us thus far with their patience and resources. I acknowledge with extraordinary feelings of joy and a massive sense of gratitude.

VI. REFERENCES

[1] M. Chavan, S. Chauhan, M. Singh, and A. Tripathi, "Footstep Power Generation using Piezoelectric Sensor and Distribution using RFID," Int. Res. J. Eng. Technol., vol. 07, no. 09, pp. 1416–1420, 2020.

[2] G. S. Prakash, K. S. Kamalakant, S. S. Subhash, and Y. Tejas, "Footstep Power Generation System using Piezoelectric Sensor," Int. Res. J. Eng. Technol., vol. 08, no. 04, pp. 4212–4215, 2021.

[3] P. Venkatesh, M. Satya, M. Sahil, and P. Sai, "Design of footstep power generation using piezoelectric sensors," Pramana Res. J., vol. 9, no. 6, pp. 1358–1363, 2019.

[4] K. Kim, W. Jang, J. Yong, S. Bum, and D. Hwan, "Nano Energy Transparent and flexible piezoelectric sensor for detecting human movement with a boron nitride nanosheet (BNNS)," Nano Energy, vol. 54, no. July, pp. 91–98, 2018.

[5] P. Panthongsy, D. Isarakorn, P. Janphuang, and K. Hamamoto, "Sensors and Actuators A : Physical Fabrication and evaluation of energy harvesting floor using piezoelectric frequency up-converting mechanism," Sensors Actuators A. Phys., vol. 279, no. 5, pp. 321–330, 2018,
doi: 10.1016/j.sna.2018.06.035.

[6] K. Kim, J. Y. Cho, H. Jabbar, J. H. Ahn, S. Do Hong, and S. B. Woo, "Optimized composite piezoelectric energy harvesting floor tile for smart home energy management," Energy Convers. Manag., vol. 171, no.

May, pp. 31–37, 2018.

[7] K. Nam et al., “Silk fi broin-based biodegradable piezoelectric composite nanogenerators using lead-free ferroelectric nanoparticles,” Nano Energy, vol. 14, pp. 87–94, 2015.

[8] S. Wang, W. Rong, L. Wang, and L. Sun, “Design , analysis and experimental performance of a stepping type piezoelectric linear actuator based on compliant foot driving,” Smart Mater. Struct., vol. 25, no. 115003, p. 9, 2016.

[9] J. Liu et al., “Design and Experiments of a Single-Foot Linear Piezoelectric Actuator Operated in a Stepping Mode,” IEEE Trans. Ind. Electron., vol. 65, no. 10, pp. 8063–8071, 2018.

[10] K. Naresh, A. Balaji, M. Rambabu, and G. Nagaraju, “Practical oriented foot step electric power generation by using piezo Material and Microcontroller in campus,” Int. Res. J. Eng. Technol., vol. 5, no. July, pp. 1590–1596, 2018.

[11] P. Hole and P. Gophane, “Footstep power generation using Piezo electric sensor,” Int. Res. J. Eng. Technol., vol. 07, no. 3, pp. 270–272, 2020.

[12] S. Panghate, P. Barhate, and H. Chavan, “Advanced Footstep Power Generation System using RFID for Charging,” Int. Res. J. Eng. Technol., vol. 07, no. 02, pp. 2408–2412, 2020.

[13] S. S. Patil, M. K. Sushmitha, V. Baliga, and S. L. Vishwanath, “Footstep Power Generation,” Int. Res. J. Eng. Technol., vol. 08, no. July, pp. 2835–2837, 2021.

[14] M. M. Rodgers, “Pressure distribution on Morton’s foot structure.” pp. 1–6, 1988.