International Journal of Advanced Engineering Science and Information Technology (IJAESIT)
ISSN: 2349-3216
Vol.6, No.6, June 2023

Footstep Power Generation using Piezoelectric Technology

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ABSTRACT

Utilising power has become a need in modern life for all tasks. The energy presented in this paper is not going to pollute the environment and is not going to be dependent on the weather. The article suggests a cutting-edge method for producing electricity using piezoelectric sensors placed along footpaths that are ready to charge the battery and ready to give the force whenever we need it. Through the use of piezoelectric sensors, the step power generation method generates electrical force by converting mechanical energy from human movement on the ground to electrical energy. The advantages of a piezoelectric force generation system include the fact that it is safe and secure to use, that it causes no problems or anguish for pedestrians, and that it is cost-effective.The electrical power consumption is increasing exponentially. Therefore, the need for a continuous and economically viable power generation and distribution system is at its peak. The project proposes utilisation of human locomotion energy which, although extractable, goes mainly to waste. The project proposes a model that uses human walking, jumping and running as a source of energy and stores it for essential use. This innovative method not only provides a sustainable solution for electricity generation but also encourages physical activity by harnessing human movement.

INDEX TERMS : Piezoelectric sensors, Battery, Electricity, Voltage Splitter, Footstep power generation.

I. INTRODUCTION

Power plays a crucial role in the nation's development. Power is defined as a collection of physical marvels related to the flow of charge. There are two distinct types of power. Static electricity, which can remain constant, and dynamic electricity, which can flow from one potential to another. An enormous amount of interest in the demand for power to operate various types of machinery and equipment has arisen as a result of the expanding population and the establishment of new businesses and production lines. Flash or current in metal can -another. Generators produce power in the power plants. These generators themselves need a large amount of information energy to produce power, so depend on the "NON RENEWABLE" sources of energy to produce power in order to run them. Power can also be obtained by using "renewable" energy sources like solar cells and wind power. These sources, however, are limited to a certain area. For instance, we can say that SOLAR ENERGY can only be used at the location where the sun's focus is completely great and continuous. Generally speaking, wind energy can be used in coastal regions where the wind's accessibility and speed are constant. It is possible to deliver power without using any human movement at all by continuously turning hand wrenches and using small generators, but this feat of power production necessitates constant human effort and inspection. Additionally, as the cost of the resources needed to deliver power rises over time, the price of electricity also rises dramatically. As a result, many members of the general public from the weaker segments of society still lack access to electricity and are unable to operate even simple appliances. In order to make power easily accessible to even the poorer sector and needy members of the general public, it is necessary to find a substitute technology for its generation that is apart from these techniques. It is possible to employ piezoelectric plates to deliver electricity since they can generate voltage when power is applied to them, which can then be used to charge batteries and easily produce power.

II. RELATED WORK

It is true that there is a rising demand for energy, and that renewable sources like solar and wind power are gaining importance. These energy sources are numerous, clean and have the capacity to give us access to a nearly endless supply of power. Renewable energy is currently insufficient to meet our present energy needs, despite the fact that it offers a number of advantages. Transitioning to renewable energy sources not only mitigates the environmental impact of traditional energy generation but also fosters energy independence and resilience. Continued advancements in solar panels, wind turbines, and energy storage systems hold the potential to revolutionise the energy sector and create a cleaner and more sustainable future achieving a balance between energy demands and environment requires long-term investments, policy support, and a collective commitment to prioritize sustainable practices. By embracing renewable energy on a global scale, we can pave the way for a greener and more prosperous planet for generations to come. As a result, in order to produce electricity, we are compelled to use additional energy sources like fossil fuels and nuclear power. Although these energy sources are efficient, they have a number of disadvantages, such as pollution, greenhouse gas emissions, and the possibility of accidents or disasters. Therefore, it is crucial to keep creating cutting-edge renewable energy production methods such enhanced solar panels, wind turbines, and energy storage technology.We can build a more sustainable and environmentally friendly future by putting money into renewable energy and decreasing our dependence on non-renewable sources. However, we must also be aware of how crucial it is to strike a balance between our need for energy and our obligation to safeguard the earth and its resources for coming generations.

III. THE PROPOSED MECHANISM

Energy of human locomotion can be converted to electrical energy with the help of promising technologies. In this proposed system, there is a sub flooring block of piezoelectric crystals, which imparts an electrical current when people walk across it. Piezoelectric materials possess a unique property of generating an electrical charge when subjected to mechanical stress. This phenomenon, known as piezoelectric effect.The sub-flooring block, consisting of piezoelectric crystals, is strategically placed beneath flooring surfaces such as footpaths, stairs, or platforms. As individuals walk or apply pressure on these surfaces, the mechanical energy of their footsteps is transferred to the piezoelectric crystals within the subflooring block. The mechanical stress induced on the piezoelectric crystals causes them to deform, resulting in the separation of positive and negative charges within the material. This charge separation generates an electrical current, which can be collected and harnessed for various applications. The design and placement of the sub-flooring block must be optimised to maximise the conversion efficiency of locomotion energy into electrical energy. Piezoelectric energy harvesting systems offer the potential to transform human locomotion into usable electrical energy. By strategically placing piezoelectric crystals beneath common walking surfaces, such as footpaths or stairs, the mechanical stress from footsteps can be converted into electrical current through the piezoelectric effect. Optimising the design and placement of the sub-flooring block is crucial for maximising the efficiency of energy conversion, taking into account factors like crystal size, orientation, sub-flooring block thickness, and composition.

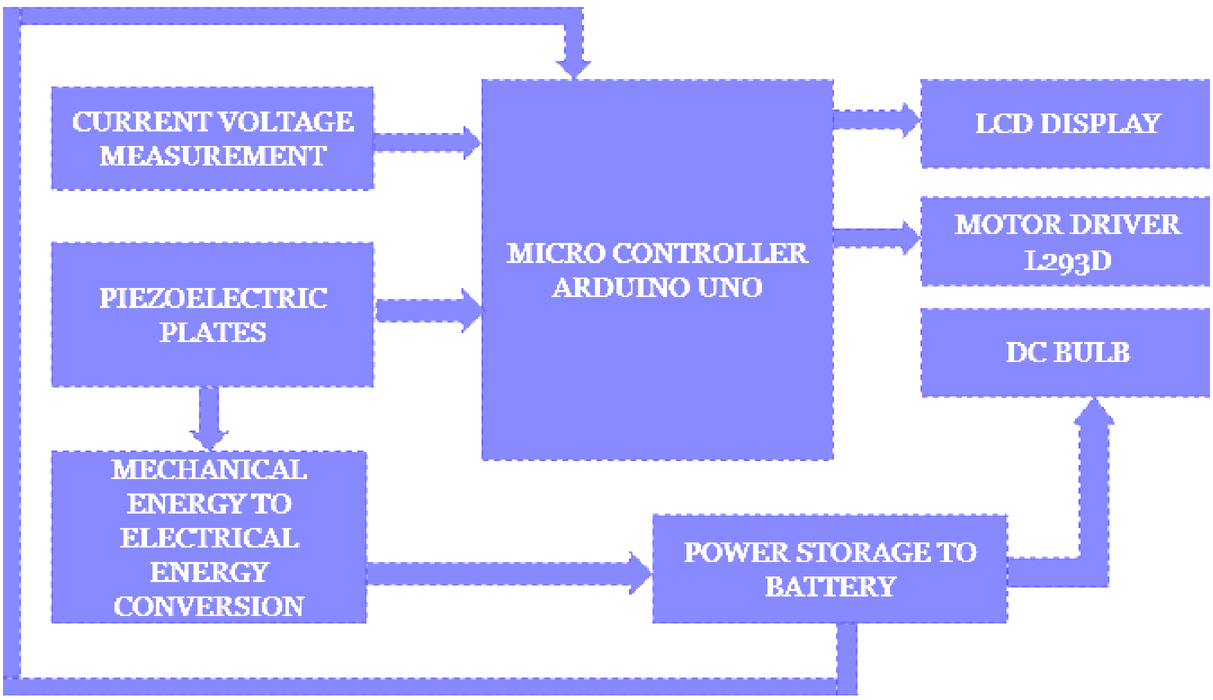

FIGURE 1: PROPOSED BLOCK DIAGRAM

IV. PERFORMANCE EVALUATION

Size of a Piezoelectric sensor = 10mm X 10mm X 0.2mm
Average human foot area = 10 square inches = 6451.6 square mm
Number of Sensors = Area of foot / Area of each sensor
= 6451.6 / (10 X 10)
= 64.516 sensors.

When considering the arrangements of these sensors under a tile, approximately 40 sensors can be arranged. One piezoelectric sensor can generate up to 0.02 Watts per footstep. Then 40 sensors can generate up to 0.8 Watts. Here the resistor used is 7.5 kΩ.

Power calculation, Power = Voltage X Current
0.8 = Current X Resistance X Current
0.8 = Current ^ 2 X 7500
Current = 0.0102 Amperes.

Similarly Voltage calculation, Voltage = Current X Resistance
= 0.0102 X 7500
Voltage = 76.5 V

40 sensors can generate up to 76.5 volts. So theoretically 5 sensors can generate up to
Voltage = (76.5 / 40) X 5
Voltage = 9.5625 Volts.

In our project, we have used 5 sensors in our tile, which is generating voltage in the range of 10-15 volts for a press. The theoretical and practical calculations are the same and we have generated the expected voltage.

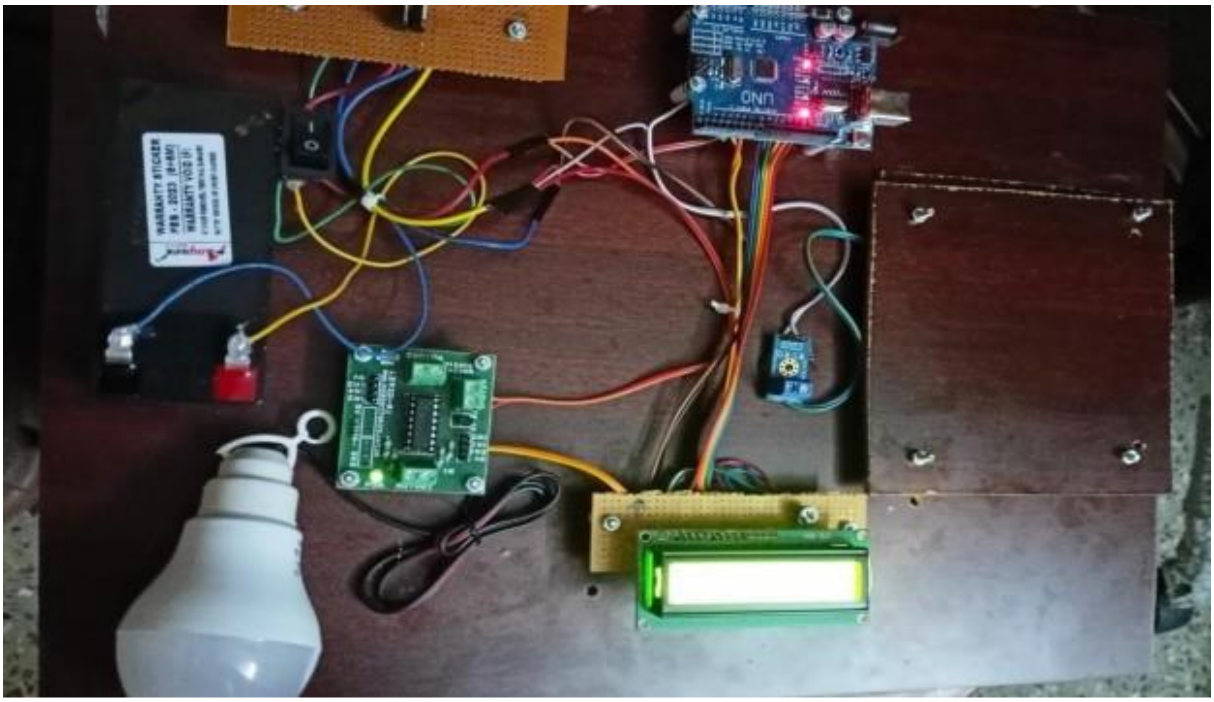

FIGURE 2 : HARDWARE IMPLEMENTATION

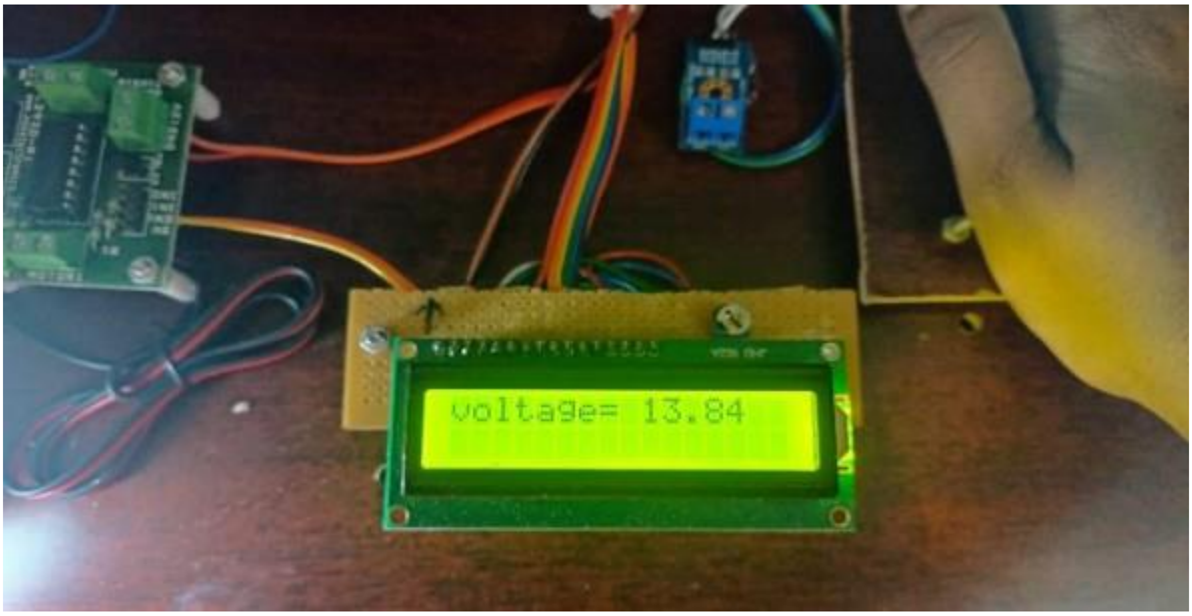

FIGURE 3: OUTPUT

V. CONCLUSION

In this project, we are generating electrical power as a non-conventional method by simply walking or running on the foot step. Non-conventional energy system is very essential at this time to our nation. Non-conventional energy using the foot step is converting mechanical energy into electrical energy. By using this energy conservation theorem and piezoelectric sensor we are proposing a new method for power generation. It can also be used in rural areas when access to electricity is limited or nonexistent. Both AC and further DC loads can be driven by it. This kind of power generation can be used in emerging nations like India in order to tap into both renewable and non-renewable energy sources in large quantities.

REFERENCES

1. D. Gautam, V. Vittal, and T. Harbour, "Impact of increased penetration of DFIG-based wind turbine generators on transient and small signal stability of power systems,"IEEE Transactions on Power Systems, vol. 24, no. 3, pp. 1426–1434, Aug. 2009.
2. I. Xyngi, A. Ishchenko, M. Popov, and L. van der Sluis, "Transient stability analysis of a distribution network with distributed generators," IEEE Transactions on Power Systems, vol. 24, no. 2, pp. 1102– 1104, May 2009. 74 CSEE JOURNALS OF POWER AND ENERGY SYSTEMS, VOL. 8, NO. 1, JANUARY 2022.
3. M. Tajdinian, A. R. Seifi, and M. Alahbakhshi, "Sensitivity-based approach for realtime evaluation of transient stability of wind turbines interconnected to power grids, "IET Renewable Power Generation, vol. 12, no. 6, pp. 668–679, Apr. 2018.
4. Dwari.S and Parsa.L "An Efficient AC-DC Step-Up Converter for Low-Voltage Energy Harvesting" in IEEE Trans. on Power Electronics, vo1.25, no.8, pp.2188-2199, August 2010.
5. Aniket Mishra, Pratik Kale, Atul Kamble " Electricity Generation from Speed Breakers" in The International Journal Of Engineering And Science (UES) IIVolumell 2 Illssuell 11 IIPagesl1 25-2711201311 ISSN (e): 2319-1813 ISSN (p): 2319-1805.

6. Y. Liu, L. Jiang, Q. H. Wu, and X. X. Zhou, "Frequency control of DFIG-based wind power penetrated power systems using switching angle controller and AGC, "IEEE Transactions on PowerSystems, vol. 32, no. 2, pp. 1553–1567, Mar. 2017.
7. C. Liu, K. T. Chau, and X. Zhang, "An efficient wind-photovoltaic hybrid generation system using doubly excited permanent- magnet brushless machines," 67 IEEE Trans. Ind. Electron., vol. 57, no. 3, pp. 831–839, Mar. 2010. [11] F. Bonanno, A. Consoli, S. Lombardo, and A. Raciti, "A logistical model for performance evaluations of hybrid generation systems," IEEE Trans. Ind. Appl., vol. 34, no. 6, pp. 1397–1403, Nov./Dec. 1998.
8. Vinod Katti, Dr. Nagabhushan Katte "Foot Step Power generation system for rural energy application to run automated toll gate system" in International Journal of Computer Science and Mobile Computing, Vol.3 Issue.6, June- 2014, pg. 414-420.
9. S. Ghosh and S. Kamalasadan, "An energy function-based optimal control strategy for output stabilisation of integrated DFIG-flywheel energy storage system," IEEE Transactions on Smart Grid,vol. 8, no. 4, pp. 1922–1931, Jul. 2017.
10. Jian-Long Kuo; Kai-Lun Chao; Li-Shiang Lee "Dual Mechatronic MPPT Controllers with PN and OPSO Control Algorithms for the Rotatable Solar Panel in PHEV System" in IEEE Trans. on Industrial Electronics" vo1.57, no.2, pp.678-689, Feb. 2010.
11. A. K. Barik and D. C. Das, ''Integrated resource planning in sustainable energy based distributed microgrids,'' Sustain. Energy Technol. Assessments, vol. 48,
Dec. 2021, Art. no. 101622.
12. S. Debbarma and A. Dutta, ''Utilising electric vehicles for LFC in restructured power systems using fractional order controller,'' IEEE Trans. Smart Grid, vol. 8, no. 6, pp. 2554–2564, Nov. 2017.
13. S.-K. Kim, J.-H. Jeon, C.-H. Cho, J.-B. Ahn, and S.-H. Kwon, "Dynamic modelling and control of a grid-connected hybrid generation system with versatile power transfer," IEEE Trans. Ind. Electron., vol. 55, no. 4, pp. 1677– 1688, Apr. 2008.68
14. D. C. Das, A. K. Roy, and N. Sinha, ''GA based frequency controller for solar thermal– diesel–wind hybrid energy generation/energy storage system,'' Int. J. Electr. Power Energy Syst., vol. 43, no. 1, pp.262–279.
15. Dou Wei, Xu Zheng Guo, Peng Yan Chang Li Jing, and Xu Hong Hua, "Research on the Current Controller of Three Phase Photovoltaic Grid Connected Inverter," Acta Energiae Solaris Sinica, Vol.28, pp 1262-1265, No.4, 2007.
17. A. M. O. Haruni, A. Gargoom, M. E. Haque, and M. Negnevitsky, "Dynamic operation and control of a hybrid wind-diesel stand alone power systems," in Proc. IEEE APEC, Feb. 2010, pp. 162–169.
18. Dondi.D, Bertacchini.A, Brunelli.D, Larcher.L, and Benini.L "Modeling and Optimization of a Solar Energy Harvester System for Self-Powered Wireless Sensor Networks" in IEEE Trans. on Industrial Electronics, vol. 55, no. 7, pp. 2759-2766, July 2008.
19. S V. Karthik, S. Karthik, S. Satheesh Kumar, D. Selvakumar, C. Visvesvaran and A. Mohammed Arif, "Region based Scheduling Algorithm for Pedestrian Monitoring at Large Area Buildings during Evacuation," 2019 International Conference on Communication and Signal Processing (ICCSP), Chennai, India, 2019, pp. 0323-0327, doi: 10.1109/ICCSP.2019.8697968.
20. Cross, R. (1999, April). Standing, walking, running, and jumping on a force plate. American Association of Physics Teachers, 67(4), 304- 309
21. Dhruv Anandpara, Nirjal Shahare, Prof. Umesh Jawarkar, Prof. Ashish Choube ``Power Generation from Suspension System Using Pressure transducer" in International Journal for Engineering Applications and Technology ISSN: 2321- 813, 2015. 20. Ttika Tandon, Alok Kumar "A Unique Step towards Generation of Electricity via New Methodology " in International Journal of Advanced Research in Computer and Communication Engineering Vol. 3, Issue 10, October 2014.

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