

Foot Step Power Generation Using Piezo Electric Crystals

V.Sunil Kumar¹, T.Venkata Sai Kalyani², Ch.Srinivas³

Associate Professor, Department of EEE, St.Martin's Engg. College, Hyderabad, TS, India^{1,3}

Assistant Professor, Department of EEE, St.Martin's Engg. College, Hyderabad, TS, India²

ABSTRACT: The Footstep Power Generation, here we proposed an advanced footstep power generator system that uses the piezo electric sensors to generate power through footsteps as a source of renewable energy that we can obtain while walking on a certain arrangement like stepping foot on a piezo tiles. This project describes the use of piezoelectric materials in order to harvest energy from people walking vibration for generating and accumulating the energy. The basic working principle of "footstep power generation system" is based on piezo electric sensors. When the flooring is engineered with piezo electric technology, the electrical energy produced by the pressure is captured by floor sensors and converted to an electrical charge by piezo-electric transducer. These sensors are placed in such a way that it generates maximum output voltage. Our project model is cost effective and easy to implement.

In this paper the conversion of the force energy in to electrical energy. The control mechanism carries the piezo electric sensor, A.C ripples neutralizer, unidirectional current controller and 12V, 1.3Amp lead acid DC rechargeable battery and an inverter is used to drive AC/DC loads. The battery is connected to the inverter. This inverter is used to convert the 12 volt D.C to 230 volt A.C. this 230 volt A.C voltage is used to activate the loads. We are using conventional battery charging unit also for giving supply to circuitry.

I. INTRODUCTION

The one of major source of external energy which can used to separate outer orbit electrons away from their parent atom is pressure. Whenever you speak into a telephone or any similar type of microphone, the pressure waves of the sound energy which your voice generates make a diaphragm move. This diaphragm movement can be used to give rise to an electric charge in the following away. There exit in nature certain materials whose crystals develop an electric charge when pressure (as form a moving diaphragm) is exerted or them. Quartz, tourmaline and Rochelle salts are examples. If a crystal from one of the material is placed between two metal plates and pressure is exerted on the plates, an electric charge will be created between the plates. It size will depend on the amount of pressure exerted. Conversely, application of a voltage between certain faces of the crystal produces a mechanical distortion of the material. This reciprocal relationship is referred to as the piezoelectric effect. The phenomenon of generation of a voltage under mechanical stress is referred to as the direct piezoelectric effect, and the mechanical strain produced in the crystal under electric stress is called the converse piezoelectric effect. See also Polarization of dielectrics.

Piezoelectric effect is reversible in that materials exhibiting the direct piezoelectric effect (the production of an electric potential when stress is applied) also exhibit the reverse piezoelectric effect (the production of stress and/or strain when an electric field is applied). For example, lead zirconate titanate crystals will exhibit a maximum shape change of about 0.1% of the original dimension. The effect finds useful applications such as the production and

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018

detection of sound, generation of high voltages, electronic frequency generation, microbalances, and ultra fine focusing of optical assemblies.

It is also the basis of a number of scientific instrumental techniques with atomic resolution, the scanning probe microscopes such as STM, AFM, MTA, SNOM, etc., and everyday uses such as acting as the ignition source for cigarette lighters and push-start propane barbecues.

The pyroelectric effect, where a material generates an electric potential in response to a temperature change, was studied by Carl Linnaeus and Franz Aepinus in the mid-18th century. Drawing on this knowledge, both René Just Hauy and Antoine César Becquerel posited a relationship between mechanical stress and electric charge; however, experiments by both proved inconclusive. The first demonstration of the direct piezoelectric effect was in 1880 by the brothers Pierre Curie and Jacques Curie. They combined their knowledge of pyroelectricity with their understanding of the underlying crystal structures that gave rise to pyroelectricity to predict crystal behavior, and demonstrated the effect using crystals of tourmaline, quartz, topaz, cane sugar, and Rochelle salt (sodium potassium tartarate tetrahydrate). Quartz and Rochelle salt exhibited the most piezoelectricity.

II. BLOCK DIAGRAM

This paper uses piezoelectric sensor. In this paper the conversion of the force energy in to electrical energy. The control mechanism carries the piezo electric sensor, A.C ripples neutralizer, unidirectional current controller and 12V, 1.3Amp lead acid dc rechargeable battery and an inverter is used to drive AC/DC loads. The battery is connected to the inverter. This inverter is used to convert the 12 Volt D.C to the 230 Volt A.C. This 230 Volt A.C voltage is used to activate the loads. We are using conventional battery charging unit also for giving supply to the circuitry. This project uses regulated 5V, 500mA power supply. 7805 three terminal voltage regulator is used for voltage regulation. Bridge type full wave rectifier is used to rectify the ac output of secondary of 230/12V step down transformer.

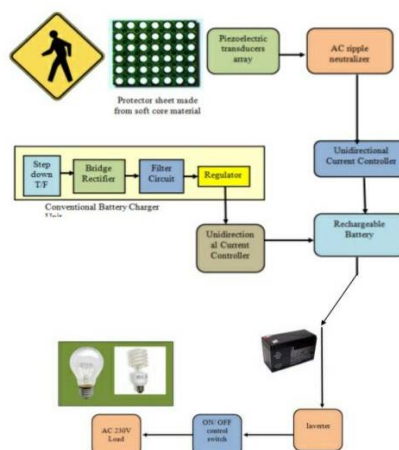


Fig.2.1 Block diagram of foot step power generation

2.1 Piezo Electric sensor:

A piezo electric sensor is a device that uses the piezoelectric effect to measure pressure, acceleration, strain or force by converting them to electrical signal. Piezoelectric materials exhibit the unique property known as the piezoelectric effect. When these materials are subjected to a compressive or tensile stress, an electric field is generated across the

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018

material, creating a voltage gradient and a subsequent current flow. This effect stems from the asymmetric nature of their unit cell when a stress is applied. As seen in Figure 1, the unit cell contains a small positively charged particle in the center. When a stress is applied this particle becomes shifted in one direction which creates a charge distribution, and subsequent electric field. These materials come in several different forms. The most common is crystals, but they are also found as plastics and ceramics.

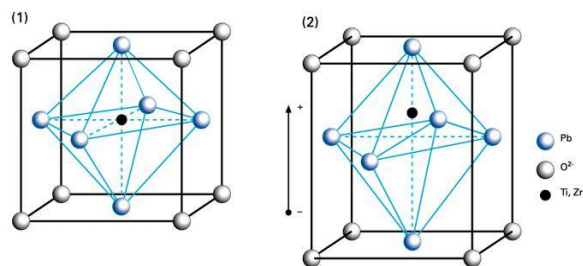


Fig. 2.2 Lead Zirconate Titanate unit cell

It has been successfully used in various applications, such as in medical, aerospace, nuclear instrumentation, and as a pressure sensor in the touch pads of mobile phones. In the automotive industry, piezoelectric elements are used to monitor combustion when developing internal combustion engines. The sensors are either directly mounted into additional holes into the cylinder head or the spark/glow plug is equipped with a built in miniature piezoelectric sensor. The rise of piezoelectric technology is directly related to a set of inherent advantages. The high modulus of elasticity of many piezoelectric materials is comparable to that of many metals and goes up to $10 \times 10^6 \text{ N/m}^2$. Even though piezoelectric sensors are electromechanical systems that react to compression, the sensing elements show almost zero deflection. This is the reason why piezoelectric sensors are so rugged, have an extremely high natural frequency and an excellent linearity over a wide amplitude range. Additionally, piezoelectric technology is insensitive to electromagnetic fields and radiation, enabling measurements under harsh conditions. Some materials used (especially gallium phosphate or tourmaline) have an extreme stability even at high temperature, enabling sensors to have a working range of up to 1000°C . Tourmaline shows pyroelectricity in addition to the piezoelectric effect; this is the ability to generate an electrical signal when the temperature of the crystal changes. This effect is also common to piezoceramic materials.

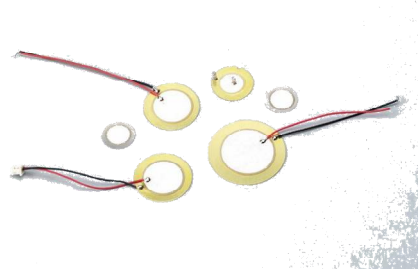


Fig.2.3 Tourmaline Piezo electric sensor

2.2 Rectifier:

The output from the transformer is fed to the rectifier. It converts A.C. into pulsating D.C. The rectifier may be a half wave or a full wave rectifier. In this project, a bridge rectifier is used because of its merits like good stability and full wave rectification.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018

The Bridge rectifier is a circuit, which converts an ac voltage to dc voltage using both half cycles of the input ac voltage. The Bridge rectifier circuit is shown in the figure. The circuit has four diodes connected to form a bridge. The ac input voltage is applied to the diagonally opposite ends of the bridge. The load resistance is connected between the other two ends of the bridge.

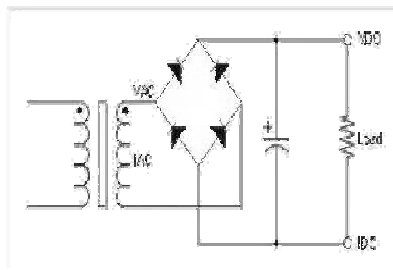


Fig.2.4 Rectifier Circuit

For the positive half cycle of the input ac voltage, diodes D1 and D3 conduct, whereas diodes D2 and D4 remain in the OFF state. The conducting diodes will be in series with the load resistance R_L and hence the load current flows through R_L .

For the negative half cycle of the input ac voltage, diodes D2 and D4 conduct whereas, D1 and D3 remain OFF. The conducting diodes D2 and D4 will be in series with the load resistance R_L and hence the current flows through R_L in the same direction as in the previous half cycle. Thus a bi-directional wave is converted into a unidirectional wave.

2.3 Filter:

Capacitive filter is used in this project. It removes the ripples from the output of rectifier and smoothens the D.C. Output received from this filter is constant until the mains voltage and load is maintained constant. However, if either of the two is varied, D.C. voltage received at this point changes. Therefore a regulator is applied at the output stage.

2.4 Voltage Regulator:

As the name itself implies, it regulates the input applied to it. A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. In this project, power supply of 5V and 12V are required. In order to obtain these voltage levels, 7805 and 7812 voltage regulators are to be used.

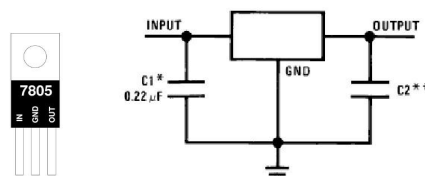


Fig.2.5 Voltage regulator circuit.

In order to obtain these voltage levels, 7805 and 7812 voltage regulators are to be used. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltage and currents.

2.5 Battery:

Battery (electricity), an array of electrochemical cells for electricity storage, either individually linked or individually linked and housed in a single unit. An electrical battery is a combination of one or more electrochemical cells, used to convert stored chemical energy into electrical energy. Batteries may be used once and discarded, or recharged for years as in standby power applications. Miniature cells are used to power devices such as hearing aids and wristwatches; larger batteries provide standby power for telephone exchanges or computer datacenters.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018

2.6 Inverter:

An inverter is an electrical device that converts direct current (DC) to alternating current (AC); the converted AC can be at any required voltage and frequency with the use of appropriate transformers, switching, and control circuits. Solid-state inverters have no moving parts and are used in a wide range of applications, from small switching power supplies in computers, to large electric utility high-voltage direct current applications that transport bulk power. Inverters are commonly used to supply AC power from DC sources such as solar panels or batteries. There are two main types of inverter. The output of a modified sine wave inverter is similar to a square-wave output except that the output goes to zero volts for a time before switching positive or negative. It is simple and low cost and is compatible with most electronic devices, except for sensitive or specialized equipment, for example certain laser printers. A pure sine wave inverter produces a nearly perfect sine wave output (<3% total harmonic distortion) that is essentially the same as utility-supplied grid power. Thus it is compatible with all AC electronic devices. This is the type used in grid-tie inverters. Its design is more complex, and costs 5 or 10 times more per unit power. The electrical inverter is a high-power electronic oscillator. It is so named because early mechanical AC to DC converters was made to work in reverse, and thus was "inverted", to convert DC to AC. The inverter performs the opposite function of a rectifier.

2.5 Bulb:

A bulb is a short stem with fleshy leaves or leaf bases. The leaves often function as food storage organs during dormancy. A bulb's leaf bases generally do not support leaves, but contain food reserves to enable the plant to survive adverse conditions. The leaf bases may resemble scales, or they may overlap and surround the center of the bulb as with the onion. A modified stem forms the base of the bulb, and plant growth occurs from this basal plate. Roots emerge from the underside of the base, and new stems and leaves from the upper side. Other types of storage organs (such as corms, rhizomes, and tubers) are sometimes erroneously referred to as bulbs. The correct term for plants that form underground storage organs, including bulbs as well as tubers and corms, is geophytes. Some epiphytic orchids (family Orchidaceae) form above-ground storage organs called pseudo bulbs that superficially resemble bulbs.

III. CONSTRUCTION

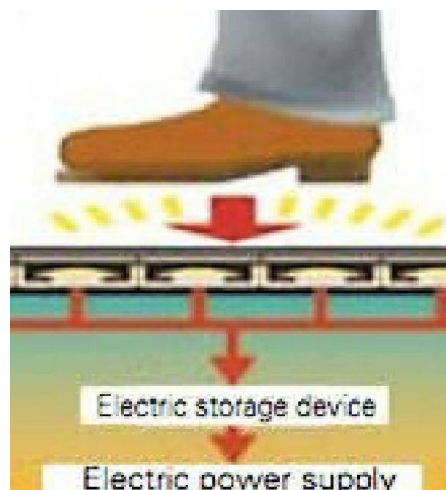


Fig.3.1 Foot Steps design at steps

Whenever force is applied on piezo electric crystals that force is converted to Electrical energy is used to drive DC loads. And that minute voltage which is stored in the Lead Acid battery. The battery is connected to the inverter.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018

This inverter is used to convert the 12 Volt D.C to the 230Volt A.C. This 230 Volt A.C voltage is used to activate the loads. We are using conventional battery charging unit also for giving supply to the circuitry.

IV. WORKING

- In this foot step power generation project is designed to convert foot step, walking and running energy into electrical energy.
- It is used to generate electricity from by walking or running on foot step.
- Foot step power generation system basically converts force energy of foot into electrical energy by using piezoelectric sensor.
- Piezoelectric sensor is transducer which converts force energy into electrical energy
- It consists of large number of Piezoelectric sensors connected in series. Kinetic energy of series connected transducers is converted into electrical energy.
- Voltages generated by piezoelectric sensors are feed to circuit elements to get proper output.
- Output energy is stored in batteries.
- The voltage generated by series of sensors is stored in Lead Acid batteries.
- This voltage can be used to drive either DC or AC loads.
- For AC loads, pure sine wave inverter circuit is used.
- Inverter converts dc voltages stored in lead acid batteries in 220 volt AC. AC voltage can be used to drive AC loads.
- User can use any type of inverter according to his/her requirement like pure sine wave inverter, square wave inverter and modified sine wave inverter.
- Rating of battery charger also depends on amount of power generation from foot step

V. RESULTS

5.1 METHOD OF IMPLEMENTATION

The "Crowd would work something like this A responsive sub-flooring system would be placed under, say, the platform of a subway terminal. The blocks that make up the system would depress slightly under the force of human footsteps. As the blocks slipped against each other, they would generate power in the form of an electric current.

The electric current could be used, among other things, to light up signs about the energy created by the pedestrians, the creators say. People should understand the direct relationship between their movement and the energy produced," said co-creator Thaddeus Jusczyk.

5.2 RESULT ANALYSIS:

While the Crowd Farm wouldn't work in the home (a single human step generates only enough power to light 15 LED lights for one second), it could really draw some power from a crowd producing thousands of steps. And also it is found that for charging a battery of 6 volts 1.2 ampere hours it requires approximately 600 steps over the plate. The generated voltage from a piezoelectric material can be calculated from the following equation.

$$V = S_v * P * D$$

Where

V = Piezoelectric generated voltage (Volts)

S_v = Voltage sensitivity of the material (Volt *meters / Newton)

P = Pressure (N/m²)

D = thickness of material (meters)

Voltage sensitivity values are provided with the material when received from the manufacturer

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018

Table: 5.1 Comparison of theoretical and practical results

S. No	Weight in kgs	Theoretic al voltage in volts	Practical voltage in Volts
1	50	30	8
2	60	35	13
3	70	40	17
4	80	47	20

From the above tabular form it can be seen that the values of theoretical and practical values have large error this is because of the following reasons the plate designed is not formed with single piece it is formed by embedding circular discs in a 3*8 matrix with totally 24 discs each are separated by a finite space and for testing practical output it is seen that the pressure applied at two points of the persons foot hence the error between theoretical and practical values is large.

VI. CONCLUSION

The work “Electrical Power Generation through foot steps” has been successfully tested and implemented which is the best economical, affordable energy solution to common people. This can be used for many applications in rural areas where power availability is less or totally absent. India is a developing country where energy management is a big challenge for huge population. By using this project we can drive both A.C. as well as D.C loads according to the force we applied on the piezoelectric sensor. Man has needed and used energy at an increasing rate for his sustenance and well being ever since he came on the earth a few million years ago. Due to this a lot of energy resources have been exhausted and wasted. Proposal for the utilization of waste energy of foot power with human locomotion is very much relevant and important for highly populated countries like India and China in future. And this can be implemented with little advancements which reduce the total cost and also reliability is increased.

We can connect a backup supply from grid so that in case of shortage of power we can charge the battery from the grid and next option is integrating the system with solar system and form a hybrid system such that the cost storage equipment is reduced and pure clean energy is produced with a high reliability.

REFERENCES

- [1]. Shenck, N. and Paradiso, J. 2001. “Energy Scavenging with Shoe- Mounted Piezo electrics”, IEEE Micro, 21(3):30–42.1
- [2]. Niu P, Chapman P, Riemer R and Zhang X, 2004 “Evaluation of motions and actuation methods for biomechanical energy harvesting”, Proc. IEEE 35th Annual Power Electronics Specialists Conf. (Aachen) pp 2100–2106.
- [3]. Kymissis, J., Kendall, C., Paradiso, J., Gershenfeld, N., 1998, “Parasitic Power Harvesting in Shoes,” Second IEEE International Conference on Wearable Computing, pp. 132-139.
- [4]. Ottman, G.K., Hofmann, H., Bhatt A. C., Lesieutre, G. A., 2002, “Adaptive Piezoelectric Energy
- [5]. Harvesting Circuit for Wireless, Remote Power Supply,” IEEE Transactions on Power Electronics, Vol.17,NO.5.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018

BIOGRAPHY



V. SUNIL KUMAR, Associate Professor in EEE, completed B.Tech in Electrical & Electronics Engineering from Syed Hashim College of Science and Technology Affiliated to JNTU Hyderabad and M.Tech in Electrical Power Systems from B.S.A.Crescent Engineering College affiliated to Anna University, Chennai. He is working as Associate Professor in St. Martin's Engineering College, Dhullapally, Secunderabad, Telangana. His Area of interest includes Power Systems, FACTS Devices and Renewable Energy Systems. He is the life time member in Indian Society for Technical Education (ISTE).



T.V. Sai Kalyani, completed M.Tech at G.Narayanamma Institute of Technology & Sciences for Women, Autonomous Under JNTUH, Telangana, India. She received her B.Tech. degree from Geethanjali College of Engineering And Technology, JNTUH, Keesara, TELANGANA. Currently she is working as Assistant Professor in the Department of EEE at St.Martin's Engineering College, Dhulapally, Secunderabad, Telangana. Her interests include in the areas of Power Electronics and Drives and Renewable energy sources.



CH. SRINIVAS is currently working as an associate professor in St.Martin's Engineering College, Dhulapally, Secunderabad Telangana. He received B.Tech degree from Dr.Paul Raj Engineering College, Bhadrachalam, Telangana. He obtained his M.Tech degree from Osmania University College Campus, Telangana. His interested areas are Electrical Machines and Power Electronics. He has over 08 years experience in teaching and he published 07 papers in various International journals. He is the life time member in ISTE and IAENG