International Journal of Advanced Technology in Engineering and Science
Vol. No.4, Issue No. 03, March 2016
www.ijates.com
ijates
ISSN 2348 - 7550

POWER FLOOR GENERATING ENERGY BY WALKING

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ABSTRACT

In recent scenario, the demand for energy has been increasing at an alarming rate and there has been a decrease in the availability of energy resources. For sustainable development, the need of the hour is to develop more efficient, pollution free and renewable energy resources to meet the unending demands. Our paper is one such attempt to generate electrical energy from footsteps. The method being employed by us is using piezoelectric crystals. The idea is to develop a "Power Floor" which is actually a floor that can produce electricity when stepped upon. In this paper we have reviewed various concepts and methods of energy harvesting from a piezoelectric crystal.

Keywords: ***Piezoelectric material, rectifier, power generating floor, weight energy.***

I. INTRODUCTION

This paper describes about generating electrical energy by using the weight or pressure energy of human beings. It is a shocking fact that a person can generate huge amount of energy simply by walking on a floor in a normal speed. The kinetic energy of motion of a person is actually absorbed by the floor which in turn is capable of generating power. This power can be used in various applications and can be converted to different forms [8].

The process of acquiring the energy surrounding a system and converting it into usable electrical energy is termed as ambient energy harvesting [1]. In ambient energy harvesting one of the promising options for power generation is by using piezoelectric material. Vibrations from machines, mechanical stress, strain from high-pressure motors, manufacturing machines, and waste rotations can be captured and used as ambient mechanical energy sources for electricity generation [2]. Piezoelectric material can be used as a mechanism to transfer ambient vibrations into electrical energy. This energy can be stored and used to power up electrical and electronics devices. Usually this is used in energy harvesting for low power and small autonomous devices, such as wireless sensor network electronic equipments.

II. COMPARITIVE ANALYSIS

Table 1: List of Contributions by various Authors

Paper Title	Authors	Inference/Outcomes
Electrical Power Generation Using Piezoelectric Crystal[12]	Anil Kumar	Provides methods for increasing piezoelectric power. Increasing efficiency and overcoming the drawbacks
Power Harvesting Using Human Footstep Energy Generation[13]	Prabaharan, R,Jayaramaprakash ,VijayAnand	The use of piezoelectric crystal is to generate electric output from surrounding vibrations .
A Novel Approach to Recycle Energy Using Piezoelectric Crystals[14]	Arjun A.M., Ajay Sampath, Sandhya Thiyagarajan, and Arvind V	Study of existing projects
A Novel Approach to Recycle Energy Using Piezoelectric Crystals[14]	Arjun A.M., Ajay Sampath, Sandhya Thiyagarajan, and Arvind V	A famous nightclub in London exploited the principle of piezoelectricity in making its dance Floor.
Proposed Method of Foot Step Power Generation Using Piezo Electric Sensor[15]	Mr.A.Adhithan , K.Vignesh , M.Manikandan	In proposed method in addition to use the Peltier sensor.
Footstep Power Generation Using Piezo Electric Transducers[16]	Kiran Boby, Aleena Paul K, Anumol.C.V, Josnie Ann Thomas, Nimisha K.K	Hardware Implementation
Energy Harvesting via Piezoelectricity[7]	Tanvi Dikshit1 , Dhawal Shrivastava , Abhijeet Gorey , Ashish Gupta , Parag Parandkar and Sumant KatiyalA.,.Bawankar Shyam D	Study of piezo electric materials .
The Modelling of a Piezoelectric Vibration Powered Generator for	P Glynne-Jones, SP Beeby, EP James, NM White	This paper describes the modelling of a previously described inertial piezoelectric generator

Microsystems[4]		
Energy Harvesting Strategy Using Piezoelectric Element Driven by Vibration Method]	Dong-Gun Kim, So-Nam Yun, Young-Bog Ham, Jung-Ho Park	Earlier model using mechanical techniques.
Piezoelectric Generator Harvesting Bike Vibrations Energy to Supply Portable Devices[11]	E. Minazara , D. Vasic and F. Costa	Implementation in bikes and moving Vehicles.
Power Generation Footstep[17]	Shiraz Afzal, Farrukh hafeez	Highlights the fact that the piezoelectric energy harvesting is Environment friendly.
Electricity Generation from Footsteps; A Regenerative Energy Resource[10]	Tom Jose V, Binoy Boban, Sijo M T	Rack and Pinion method
Electricity From Footsteps[18]	S.S.Taliyan, B.B. Biswas, R.K. Patil and G. P. Srivastava	Gives the idea of use in Footpath
Generation of Electrical Power through Foot steps[19]	K.Ramakrishna , Guruswamy Revana# and Venu Madhav Gopaka	Piezo ceramic analysis
Evaluation of Piezoelectric Material Properties for a Higher Power Output From Energy Harvesters With Insight Into Material Selection Using a Coupled Piezoelectric-Circuit–Finite Element Method [21]	Alice Daniels, Meiling Zhu, and Ashutosh Tiwari	Study of piezoelectric-circuit–finite element method to evaluate the power outputs of 25 different piezoelectric materials.
Energy harvesting from human and machine	P. D. Mitcheson, E. M. Yeatman, G. K. Rao, A. S.	Study of applications of motion based energy harvesting.

motion for wireless electronic devices [22]	Holmes, and T. C. Green	
Consideration of impedance matching techniques for efficient piezoelectric energy harvesting	H. Kim, S. Priya, H. Stephanou, and K. Uchino	Study and improvisation in efficiency of energy harvesting using piezoelectricity
Performance Enhancement of Piezoelectric Energy Harvesters Using Multilayer and Multistep Beam Configurations[24]	Rammohan Sriramdas, Sanketh Chiplunkar, Ramya M. Cuduvally, and Rudra Pratap	Study of polyvinylidinefluoride (PVDF) piezoelectric energy harvesters in multilayer configurations to increase the energy.
An efficient piezoelectric energy harvesting interface circuit using a bias-flip rectifier and shared inductor [25]	Y. K. Ramadass and A. P. Chandrakasan	Study of piezoelectric interfacing circuits with the help of rectifiers and shared inductor concepts
Energy scavenging with Shoe-mounted piezoelectrics[26]	Shenck, N. S. and Paradiso, J. A	Implementation and study of energy harvesting by piezoelectric crystal incorporated in shoes
Improving power output for vibration-based energy scavengers[27]	Roundy, S., Leland, E. S., Baker, J., Carleton, E., Reilly, E., Lai, E., Otis, B., Rabaey, J. M., Wright, P. K. and Sundararajan, V	Increasing efficiency of energy harvesting by vibrations by using different geometries of piezoelectric crystals.
Comparison of piezoelectric energy harvesting devices for recharging batteries[28]	Sodano, H. A., Inman, D. J. and Park, G. H.	Use of piezoelectricity in rechargeable batteries
Generation of electricity thorough PZT materials with the help footfall stress[29]	Rupendra Kumar Gohite, Madhuri Gohite	Implementation of energy generating floors using piezoelectric crystals
A Unique Step towards	Itika Tandon	Study of various implementations and uses of

Generation of Electricity via New Methodology[30]	, Alok Kumar	power floors
Electricity Generation Due to Vibration of Moving Vehicles Using Piezoelectric Effect [31]	MuktiNath Gupta, Suman and S.K.Yadav	Energy generation using pressure energy of moving vehicles
VIDYUT Generation via Walking : Analysis[32]	Monika jain, MohitDev Sharma, NitiRana, Nitish Gupta	Study of energy by walking using power floors and harvesters in shoes.
The Constituent Equations of Heterogeneous Bimorphs[33]	Smits, J., and Choi, W.	Study of piezoelectric bimorphs
Piezoelectric Energy Harvesting for Powering Micro Electromechanical Systems (MEMS)[34]	Abdul Majeed	Study of SSHI method of energy harvesting and methods of AC to DC conversion.
Advanced Piezoelectric: Materials, Devices, and Their Applications[35]	Tao Li, Jan Ma,Mohammed Es-Souni, and Peter Woias	Comparative study of various piezoelectric materials
Thin-film piezoelectric MEMS[36]	Chang-Beom Eom and Susan Trolier-McKinstry	Study about the material of the sensor.
A Review of Piezoelectric Energy Harvesting Based on Vibration[37]	Heung Soo Kim, Joo-Hyong Kim and Jaehwan Kim	Energy harvesting techniques are studied.
Piezoelectric single crystals for ultrasonic transducers in biomedical applications[38]	Qifa Zhoua , Kwok Ho Lamb , Hairong Zhengc , Weibao Qiuc , K. Kirk Shunga	Uses of the crystal in different domain is studied like as a transducer.
Generating Electricity Using Piezoelectric	Jedol Dayou , Man-Sang, C. , Dalimin, M. N. & Wang, S	Concept of energy generation is studied.

Electricity Using Piezoelectric Material[39]		
Research on application of piezoelectric material in smart structures[40]	Jinhao QUI,Hongli JI	Piezoelectric crystal various applications are studied.
Energy Harvesting using Piezoelectric Materials[41]	Parul Dhingra, Jhilam Biswas, Anjushree Prasad, Sukanya S. Meher	Energy harvesting methods are studied.
Eco-Friendly Electricity Generator Using Scintillating Piezo[42]	Pratibha Arun, Divyesh Mehta	Eliminating pollution techniques are studied.
Principle and Experimental Study of Human Energy Harvesting Through Piezoelectric Ceramic[43]	Jiacun Sun	Piezoelectric crstal generating electricity methods.
Piezoelectric Energy Harvesting Solutions[44]	Renato Caliò , Udaya Bhaskar Rongala , Domenico Camboni , Mario Milazzo , Cesare Stefanini , Gianluca de Petris and Calogero Maria Oddo 1	Various methods of energy harvesting are studied.
Piezoelectric Energy Utilization in Industries[45]	Ayush Gupta, Anshul Prabhakar, Anubhava Guptak, Ashutosh Patel, Vikas Singh Bhadoria	Industrial application of the crystal are studied.
Piezoelectric Charger Energy Harnessing Technique[46]	Arun kumar Gangwar, Farheen Chishti	Energy harnessing techniques are studied.
Piezoelectric Energy Harvesting Devices: An Alternative Energy Source for Wireless Sensors[47]	Action Nechibvute,Albert Chawanda and Pearson Luhanga	Wireless energy generation is studied.
Piezoelectric Energy Harvesting[48]	Brenda Ou	Energy harvesting is studied.
Piezoelectric Ceramics	T.L. Jordan, Z. Ounaies	Properties of piezoelectric ceramic is studied.

Characterization[49]		
Properties of Piezoelectric Ceramics in the Solid-Solution Series Lead Titanate-Lead Zirconate-Lead Oxide: Tin Oxide and Lead Titanate-Lead Hafnate [50]	B. Iaffe/ R. S. Roth, and S. Marzullo	Properties of piezoelectric ceramic is studied

III. PROPOSED METHOD

After detailed analysis, we propose the method of piezoelectric crystals to be used in implementing a Power Floor .Let us first have a brief description

about piezoelectric crystals. Piezoelectric crystals are special type of crystals which when subjected to pressure produce AC voltage. Also, they exhibit a vice versa phenomenon where when these crystals are subjected to external voltage, they produce mechanical vibrations. The voltage is generated because of formation of dipoles in the material. Equal and opposite charges are deposited on opposite surfaces as shown in figure 3. This leads to a potential difference between the surfaces which is tapped as electrical energy.

IV. IMPLEMENTATION

4.1 Method using series parallel combination

Piezoelectric crystal is taken for the experiment along with the LED. TheLED has two terminals. These two terminals are connected to the terminals of the piezoelectric crystal. Piezoelectric crystals are connected in parallel through diodes. This assembly is fixed beneath a doormat. The measured values of voltage from one crystal when subjected to force is 3 volts and the current is 70 mA.The glowing LED indicates that the crystal is working properly crystals in series and 10 such series are put in parallel, the power output is increased manifold.10 volts voltage and 1.2A current are indicated[7].

4.2 Using Bridge Rectifier

Bridge rectifier can also be used to convert ac into dc.A Capacitor can be used to store electrical energy as shown in fig.1. A controller is given in feedback so as to manage the supply to charge a battery.

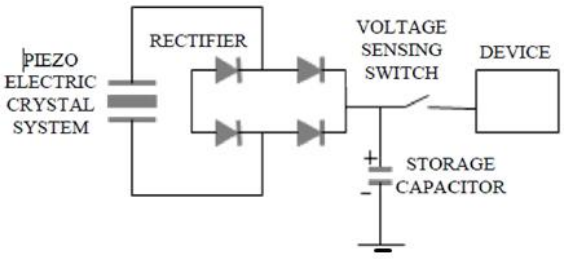

Figure 1 AC to DC conversion

4.3 SSHI Method

Fig 2 shows the SSHI synchronized switch harvesting on inductor method[8].This method involves an inductor connected in parallel with a piezoelectric crystal. The inductor is connected when the displacement in the crystal due to stress is maximum. The switching of the inductor causes the inversion of the piezoelectric generator voltage.

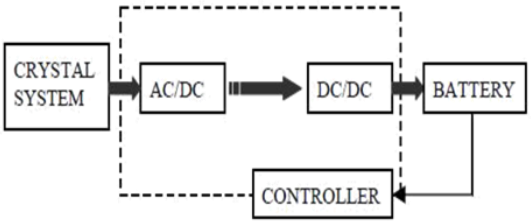

Figure 2 SSHI Method

4.4 Super Capacitor

In this method, piezoelectric-driven self-charging supercapacitor power cell (SCSPC) using MnO2 nanowires as positive and negative electrodes is fabricated in order to convert mechanical motion or stress into electrical energy. This assembly can be directly used as a power source. This system is a self-charging system. The SCSPC can be charged up to 100 mV in about 300 seconds under foot pressure of a normal weighing person. Refer Figure 3

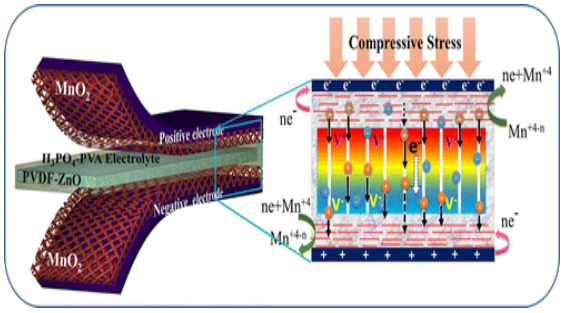

Figure 3 Super Capacitor

V. CURRENT PROJECTS

The concept of power floor is being used in a few places to generate energy and to supply energy to remote areas. Two of them are listed as below.

1) In Rio de Janeiro, Brazil, the company installed 200 power tiles floor in a football pitch. When thePlayers run on the pitch, the energy generated can light for up to 10 hours on a full battery, creating the world's first ever people-powered football pitch.

2) The recycled rubber power floor called "PaveGen" harvests kinetic energy incident on them.They deliver small amount of electricityto nearby devices and circuits as batteries, lights, wireless sensors etc. These power floorscan also store energy for three to four days using a battery. However the output obtained is not very large, hence, it can be used only for small range operations such as those mentioned above.

VI. CONCLUSION

This method of electricity generation can prove to be the biggest boon in future.From footfalls to climbing stairs, to opening doors, the cities of the future will look at ways of tapping energy from all the mechanical energy we expend going about our daily lives.

6.1 Advantages

This method has a lot of advantages.

1) It is highly economic. The cost of one piezoelectric crystal, is between 11-16 Rupees only and hence it is a cost effective method.

2) This method is pollution free and utilizes waste energy as there is no combustion or waste generation involved.

3) This system can be employed to recover from energy crisis and for supplying energy to remote location also. This method will also enableus to store electricity which can be used in case of power shortages and for running various machines.

Thus, as compared to other methods this is the best possible alternative.

6.2 Disadvantages

However, this method also has a few disadvantages. Major disadvantage is that it cannot be used as a primary energy source in places where continuous supply is required. This is because of the fact that energy is generated only when there is motion on the floor. Storing charge is also quite cumbersome. The conversion from AC to DC involves rectifier. The diodes used are temperature sensitive and can even be destroyed at high temperatures. Thus, there is high maintenance cost involved with this method.

VII. FUTURE SCOPE

- This idea can be implemented in the floors of crowded places as footpaths, railway platforms etc.
- Also these floors will be useful if they are implemented in gyms in tread mills and other machines.
- Other useful places where this idea may be implemented is dance floors.
- Stairs can be also used for production of energy by mere walking.
- This method can also be used for security purposes and in various alarm systems.
- This principle can also be employed in construction of inverters which can be used in case of power cuts.

VII. ACKNOWLEDGEMENT

We would also like to thank Prof. O.N. Pandey (Head of Department, Instrumentation and Control Department) of JSSATE, Noida for always supporting us and encouraging us to do better. We would also like to convey our sincere thanks to the entire faculty of ICE department for being so supportive and guiding us.

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