RESEARCH ARTICLE OPEN ACCESS

Power Generation Using Piezoelectric Transducer

[1]Chandan Kumar Dubey, [2]Prateek Sharma, [3]Tanu Chouhan, [4]Manju Gurjar
[1](Asst. Prof., Department of Electronics & Communication Engineering, Poornima Group of Institutions, Jaipur, India)
[2](B.Tech., VIII Sem., Department of Electronics and Communication Engineering, Poornima Group of Institutions, Jaipur, India)
[3](B.Tech., VIII Sem., Department of Electronics and Communication Engineering, Poornima Group of Institutions, Jaipur, India)
[4](B.Tech., VIII Sem., Department of Electronics and Communication Engineering, Poornima Group of Institutions, Jaipur, India)

ABSTRACT
The most basic need of today's world is energy which is non-renewable source of energy available on earth. The need is increasing day by day, to overcome this there is requirement of energy harvesting. This paper attempts to show how man has been utilizing and optimizing kinetic energy. Current work also illustrates the working principle of piezoelectric crystal and various sources of vibration for the crystal. "The idea of energy harvesting is applicable to sensors as well as transducers that are placed and operated on some entities for a long time to replace the sensor module batteries. Such sensors are commonly called self-powered sensors." Embarked piezoelectric transducer, which is an electromechanical converter, undergoes mechanical vibrations therefore produce electricity. This power source has many applications as in agriculture, home application and street lighting and as energy source for sensors in remote locations.
Keywords– Transducer, piezo electric crystal, diode.

I. INTRODUCTION

Recently energy harvesting become more popular and one of the popular technique is generation of energy from surroundings. This technique is commonly called as Energy Harvesting. Some traditional energy harvesting schemes are solar farms, wind farms, tidal energy utilizing farms, geothermal energy farms and many more[3]. The energy harvesting source of electrical energy can be used for autonomous feeding of remote applications ,electronics low power devices and wireless sensors. The energy harvesting devices generates electric energy using some energy conversion method .Therefore energy harvesting devices here considered do not consume any fuel or substance. When viewed on a large scale, energy harvesting schemes can be categorized as shown in Table 1[4-6].

Type of Energy Harvesting	**Energy Source**	**Solution**	**Ultimate Goal**
Macro	Renewable sources like solar, wind, tidal	Energy Management solutions.	Reduce oil dependency.
Micro	Small scale sources like vibration, motion, heat etc.	Ultra-low-power solutions.	Driving low energy consuming devices.

Table 1: Types of Energy Harvesting Schemes.

II. RESEARCH ELABORATIONS

A. STUDY OF PIEZO MATERIALS

The conversion of mechanical energy into electrical one is generally achieved by converters commonly called as dynamo. But there are other physical phenomena including piezoelectricity that can also convert mechanical movements into electricity.

The piezoelectric effect exists in two domains, the first is the direct piezoelectric effect that describes the material's ability to transform mechanical strain into electrical charge, the second form is the converse effect, which is the ability to convert an applied electrical potential into mechanical strain[2].

Piezoelectric ceramics belong to the group of ferroelectric materials. Ferroelectric materials are crystals which are polar without an electric field being applied. The piezoelectric effect is common in piezo ceramics like PbTiO3, PbZrO3,

PVDF and PZT. The main component of the project is the piezoelectric material. The proper choice of the piezo material is of prime importance. For this, an analysis on the two most commonly available piezoelectric material - PZT and PVDF, to determine the most suitable material was done. The criterion for selection was better output voltage for various pressures applied. In order to understand the output corresponding to the various forces applied. For this the Piezo transducer material under test is placed on a Piezo force sensor. Voltmeters are connected across both of them for measuring voltages and an ammeter is connected to measure the current. As varying forces are applied on the Piezo material, different voltage readings corresponding to the force is produced[4-5].

Figure 1: Piezoelectric crystal.

B. Study Of Connections

Next to determine the kind of connection that gives appreciable voltage and current necessary, six PZT are connected in series first, followed by the parallel connections of all the series connected crystals. The series connection results in the addition of the current while the parallel connections results in the adding up of the voltage. The arrangement of piezoelectric crystal made in our project is shown below in figure 2.

Figure 2: Array Arrangement.

C. WORKING OF PROJECT

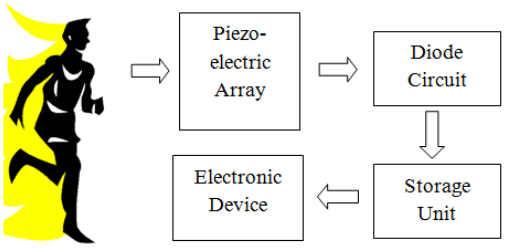

Figure 3: Block Diagram of working of Project.

Piezo-electric crystal array: The piezoelectric crystal when exposed to the pressure by the foots of individual then it generates energy[2]. The energy produced by the crystal is directly propotional to the intensity of the force. The current and voltages which are in the range micro amperes and micro volt adds up to form the values of milli amperes and milli volt[6].

Diode Circuit: The unidirectional property of diode is utilized in our project. To oppose the reverse flow of direction of current the diode is used.The diode prevents the flow of current from the battery to the piezoelectric array[3].

Storage Unit: It is basically a power bag which stores the charge generated by the piezoelectric and charge the other portable electronic devices.We uses the lithium- Ion Battery battery of 6V and 4.5Ah with max charging of 1.35A.

Electronic Device: The battery when gets charged can be used with the portable electronic device like charger, led lamps etc.[6]

Figure 4: Charging of battery with crystal array.

III. MAXIMUMTHEORETICAL VOLTAGE GENERATED

When a force is applied on piezo material, a charge is generated across it. Thus, it can be assumed to be an ideal capacitor. Thus, all equations governing capacitors can be applied to it. In this project, on one tile, we connect 6 piezo in series. 5 such series connections are connected in parallel. Thus when 6 piezoelectric discs are

connected in series, its equivalent capacitance becomes as given in eq-1.

$1/C_{eq} = 1/C_1 + 1/C_2 + 1/C_3 + 1/C_4 + 1/C_5$ – eq.1

$Q=CV$ –eq.2

Putting eq.2 in eq.1, we get

$V_{eq}/Q = V_1/Q + V_2/Q + V_3/Q + V_4/Q + V_5/Q$ –eq.3

Hence, the net voltage generated in series connection is the sum of individual voltages generated across each piezoelectric disc.

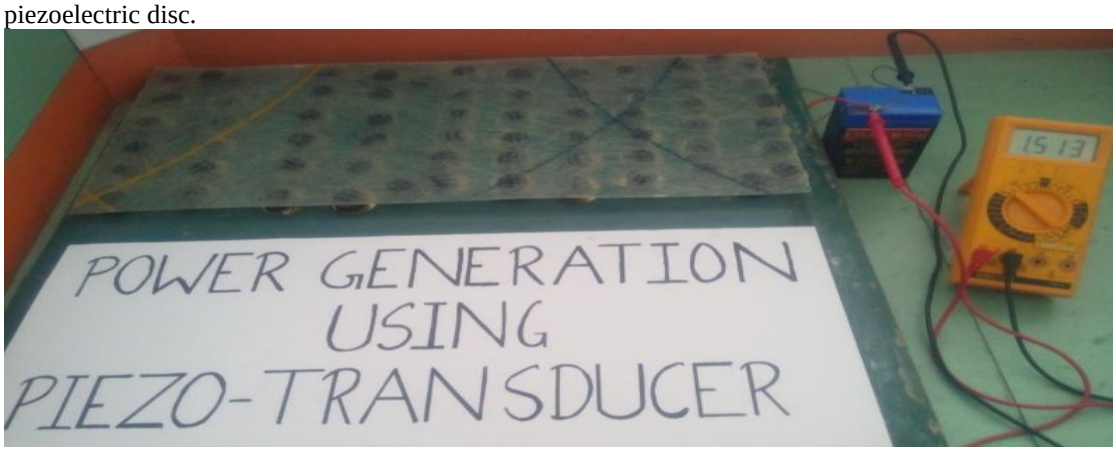

Figure 5: Actual view of our project.

IV. CONCLUSION

A piezo crystal capable of generating 1volt has been devised. The weight applied on the crystal and corresponding voltage generated is studied and they are found to have linear relation. It is especially suited for implementation in crowded areas. This can be used in street lighting without use of long power lines. It can also be used as charging ports, lighting of pavement side buildings.

REFERENCES

[1]. Anil Kumar, "Electrical Power Generation Using Piezoelectric Crystal", International Journal of Scientific & Engineering Research, Volume 2, Issue 5, May 2011.

[2]. J. John Livingston and M. Hemalatha, "Charging an Electronic Gadget using Piezo-electricity", Indian Journal of Science and Technology, Vol 7(7), pages 945–948, July 2014.

[3]. Md.Saiful Islam, Syed Khalid Rahman and Jakeya sultana Jyoti, "Generation of Electricity Using Road Transport Pressure", International Journal of Engineering Science and Innovative Technology (IJESIT) Volume 2, Issue 3, May 2013.

[4]. Phagna Esha Singh, Siddhakar Bhumi and Rami Monika, "Real Time Battery Charging System by Human Walking", International Journal of Innovative Research in Science, Engineering and Technology, Volume 4, Issue 2, February 2015.

[5]. M R Sarker1, Sawal H Md Ali, M Othman, and Shabiul Islam, "Designing a Battery-Less Piezoelectric based Energy Harvesting Interface Circuit with 300 mV Startup Voltage", 3rd ISESCO International Workshop and Conference On Nanotechnology 2012.

[6]. Ms. Kamble Sushama Baburao, "Development of Energy Harvesting Source from Piezoelectric Shoe", Proc. of the Second Intl. Conf. on Advances in Computer, Electronics and Electrical Engineering, CEEE 2013.