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A Review On: Design Piezoelectrical Energy Harvesting Devices

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Abstract: ***In power electronics the piezoelectric power harvesting is very important concept. The power harvesting is the process in which the harvest the energy from environmental system and convert it into electrical energy. These energy harvesting technique is one of the most reliable and efficient method. The piezoelectric materials have the ability to transform mechanical strain into electrical energy and it can convert the electrical potential into mechanical strain. There is many piezo element which gives AC output wave, which not use directly in battery charging. For convert it into DC we can use Rectifier circuit, boost converter used to step up the value of output.***
Keywords: Piezo Ceramic, Piezoelectricity, Cantilever design, Voltage form piezo ceramic, Energy Form Human foot.

I. INTRODUCTION

The technology which is generating electrical energy from ambient environment energy source is called as energy harvesting techniques. The actual concept is the process on ambient sources, which is converted natural energy into electrical form of energy. This energy provides to low power devices. The harvesting energy sources are mainly provided by light source, radio frequency, thermal sources and mechanical sources. Over the last century, the research on energy harvesting technique is very higher. Now a day, the new research product is developed in wireless technology, low power electronics, sensors which found anywhere. These advance products are used in much application such as Health monitoring, Industrial automation, Robotics and Military purpose [1]. However, these harvesting product required its own power supply which in most cases are used by the another battery. In network system the task roe replacing power supply is very expensive. These issues can be cover using the energy harvesting from natural sources.

In general on the basis of working principle we can categorize the energy harvesting methods.

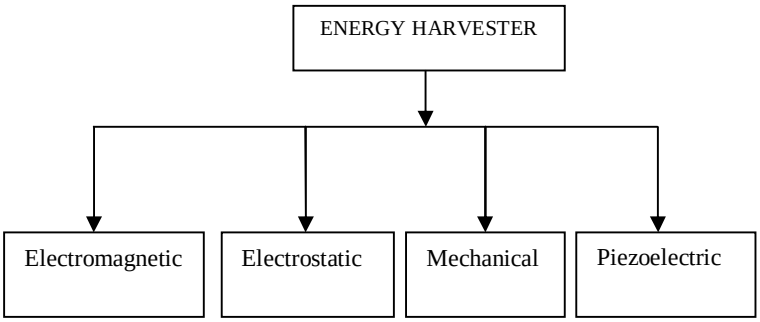


Fig.1 Type of Energy Harvesters

Among this, piezoelectric techniques is ideal techniques foe energy harvesting. Which have ability to efficiently convert mechanical strain energy into desired electrical energy and vice-versa [2], [3]. We can see the perfect material for energy harvesting. This can be convert stress energy into the electrical charge without any losses and having simple structure.

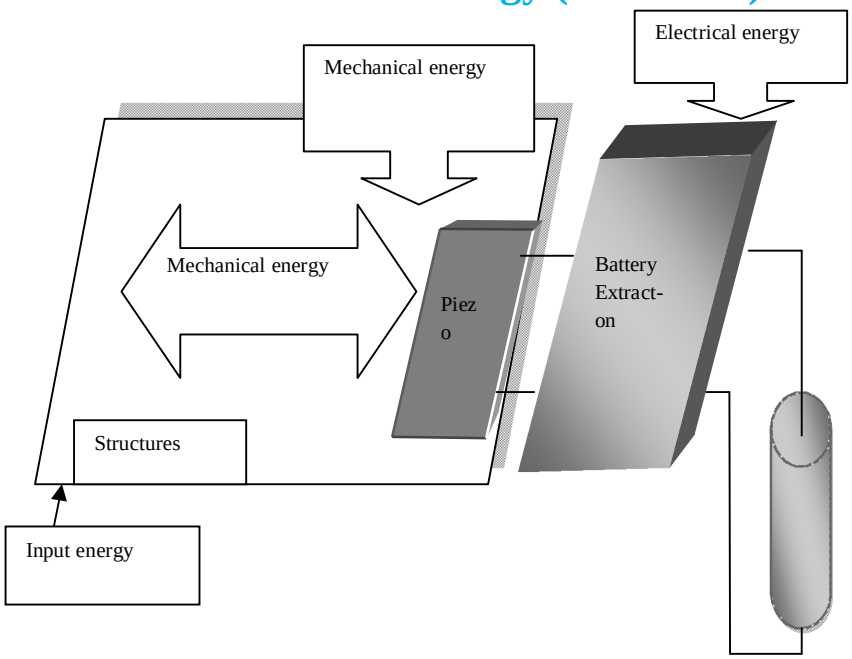


Fig.2 General Diagram of piezoelectric energy harvesters

In general, the schematic diagram for the piezoelectric energy harvesting. By using cantilever beam there is conversation of input energy into mechanical energy, by using piezoelectric material electromechanical conversation and electrical energy transfer.

II. PIEZO-ELECTRICITY

In 1880, the Pierre and Jacques was discovered piezoelectric effect. They found that if we applied mechanical stress on the piezo crystal they produce electrical energy. The piezoelectric effect can be divided into two parts which are

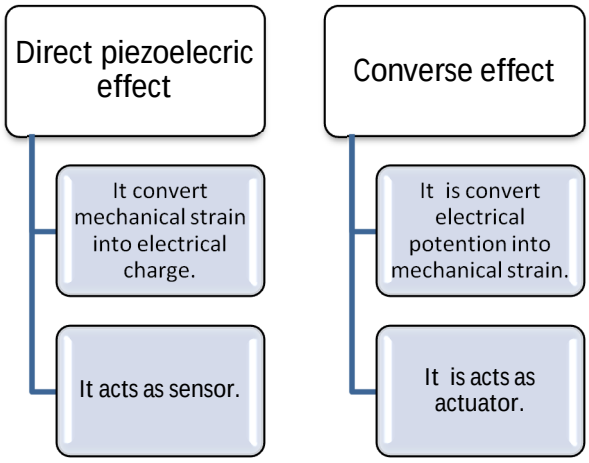
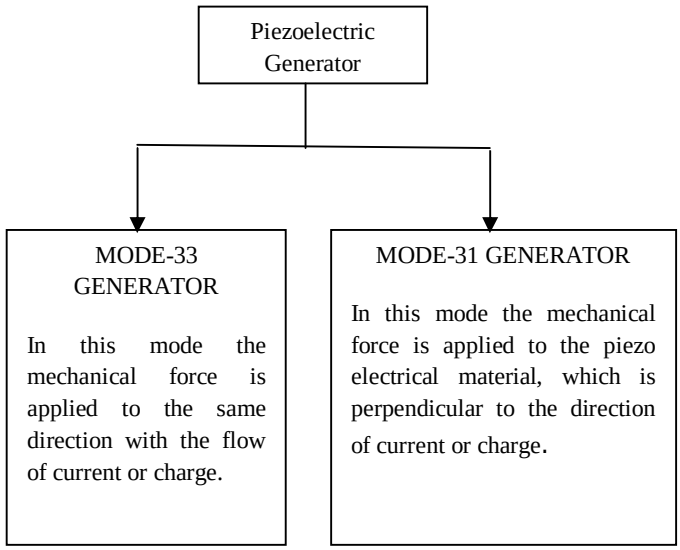


Fig.3 Types of piezoelectric effect.

The numbers of researchers gives significant attention to produce piezoelectric materials in the conversion of mechanical vibration into electrical energy. In piezoelectric power generation the PZT, PVDF and Micro–fiber composite (MFC) are commonly used [4]. The piezoelectric generator are classified as bellow-



The mathematical equation for the mechanical and electrical behavior of piezoelectric material is given as follows [5]:

$$S = s^E T + d_t E \quad (1) \qquad D = d_t T + €^T E \quad (2)$$

Where S – Mechanical strain

T – Applied Mechanical stress

E – Electric field

D – Electric Displacement

S^E - Matrix of elasticity under conditions of constant electric field

€ - Permittivity of matrix

III. OVERTAKE VOLTAGE FROM PIEZO CERAMIC

The most important stage in piezoelectric energy harvesting device is generate voltage from piezoceramic material. The acquisition is process in which piezoelectric material is subjected to vibrations and stress applied it to convert it into voltage. The piezoceramic material is placed on a cantilever beam which is excited by using shaker. This shaker gives electrical energy from the mechanical strain which is applied to the piezoceramic material [6] [7]. This electrical energy is absorbed by using DAQ unit. This obtaining electrical energy is further gives to energy harvesting device for many application.

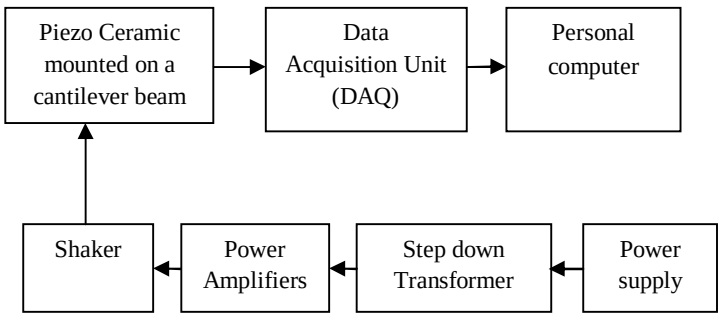


Fig.4 Block diagram for overtake voltage from piezoceramic material.

The block diagrams for over taking voltage from piezoceramic material are shown. It is made of shaker, which is vibrated the

piezoceramic material and actuated by accelerometer. These accelerometers connect as input to the shaker which is vibrates the cantilever beam. This provided the mechanical strain to the ceramic material. This further converts it into electrical energy and the data from ceramic material. The use of transformer which is step down the voltage of power supplies 230 V AC to 110 V DC. This step down AC output of transformer is gives to power amplifier which is gives the amplified output signal. This is fed to the shakers. These signals are used to generate vibrations to the cantilever beam. Due to vibrations the shaker is excites the beam and thus stress is applied. This are used to produce energy. This further gives to DAQ unit.

IV. ENERGY FROM HUMAN FOOT STEP

The piezoelectric crystals are most important method for obtaining the energy from surrounding [8]. It is small scale energy sources. The piezoelement are going to vibration. They produce very small amount of voltage. Due to vibrations, piezoelement generates the electrical voltage which in the form of AC. After the AC voltage are passing through rectifier circuit. This converts it into DC. This DC voltage is applied to boost converter.

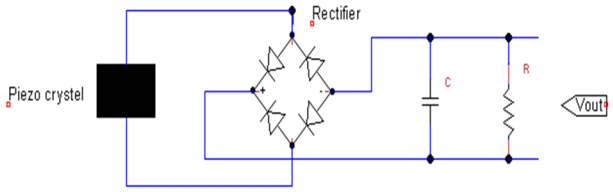


Fig.5 AC to DC harvesting circuit

The boost convertor is power converter. This gives the high DC output for low input voltage. It contains at least two semiconductor switches and at least one energy storage element. Here use of capacitor, which is reduce the output Voltage ripple.

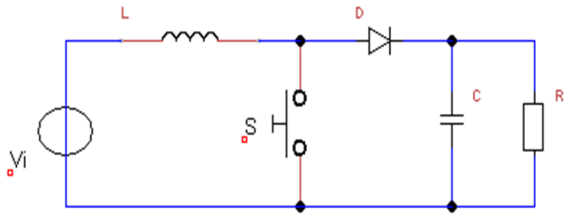


Fig.6 boost converter

The boost converter has two mode of operation.

MODE1: In this mode switch S is closed due to this increasing current of inductor. In this mode the current through inductor never become zero.

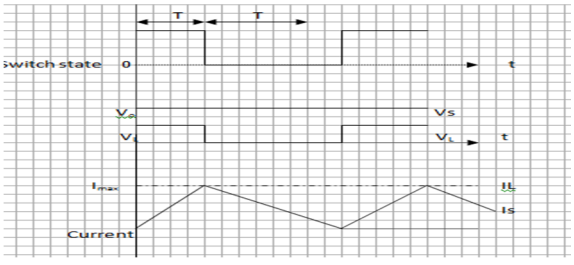


Fig.7 shows the waveform in mode 1 operation

MODE 2:

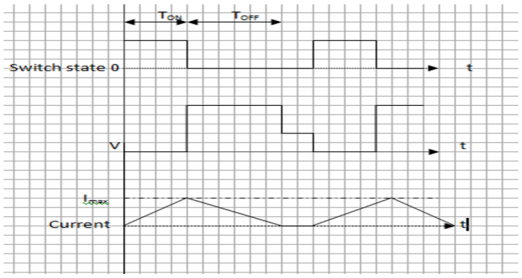


Fig.8 shows the waveform in mode 2 operation

In this mode, the switch S is open. There is only one path to flow the inductor current (I_L) through diode D, capacitor C and load R. Which is gives the transforming energy through capacitor C [9]. In this mode, inductor current falls to zero.

TABLE I. COMPARISON BETWEEN VARIOUS PIEZOELECTRIC MATERIALS

Material / ***Parameters***	**PVDF**	**PZT-5H**	**PMN-0.33Pt**
Capacitance(C)	1.936nF	$0.548\mu F$	0.564nF
Charge(Q)	199.7×10^{-12}C	52.39×10^{-9}C	39.17×10^{-9}C
Voltage(V)	2.099×10^{-8}J	5.815×10^{-76}J	3.3×10^{-5}J

V. CONCLUSION

The main purpose of this paper is to harvest the energy from various natural sources. If we continuously stressing the piezo crystal for three hours which produce voltage which is enough to charge a mobile battery. This rechargeable battery made of nanotechnology which has high efficiency. By using boost converter we can improves the voltage effectively and by enhancing the current we can improve the power.

VI. FUTURE SCOPE

There is a huge demand for energy. For developing energy, the piezoelectric energy harvesting is best suitable and very efficient method. The piezoceramic material converts the applied stress into electrical energy and stored in rechargeable battery.

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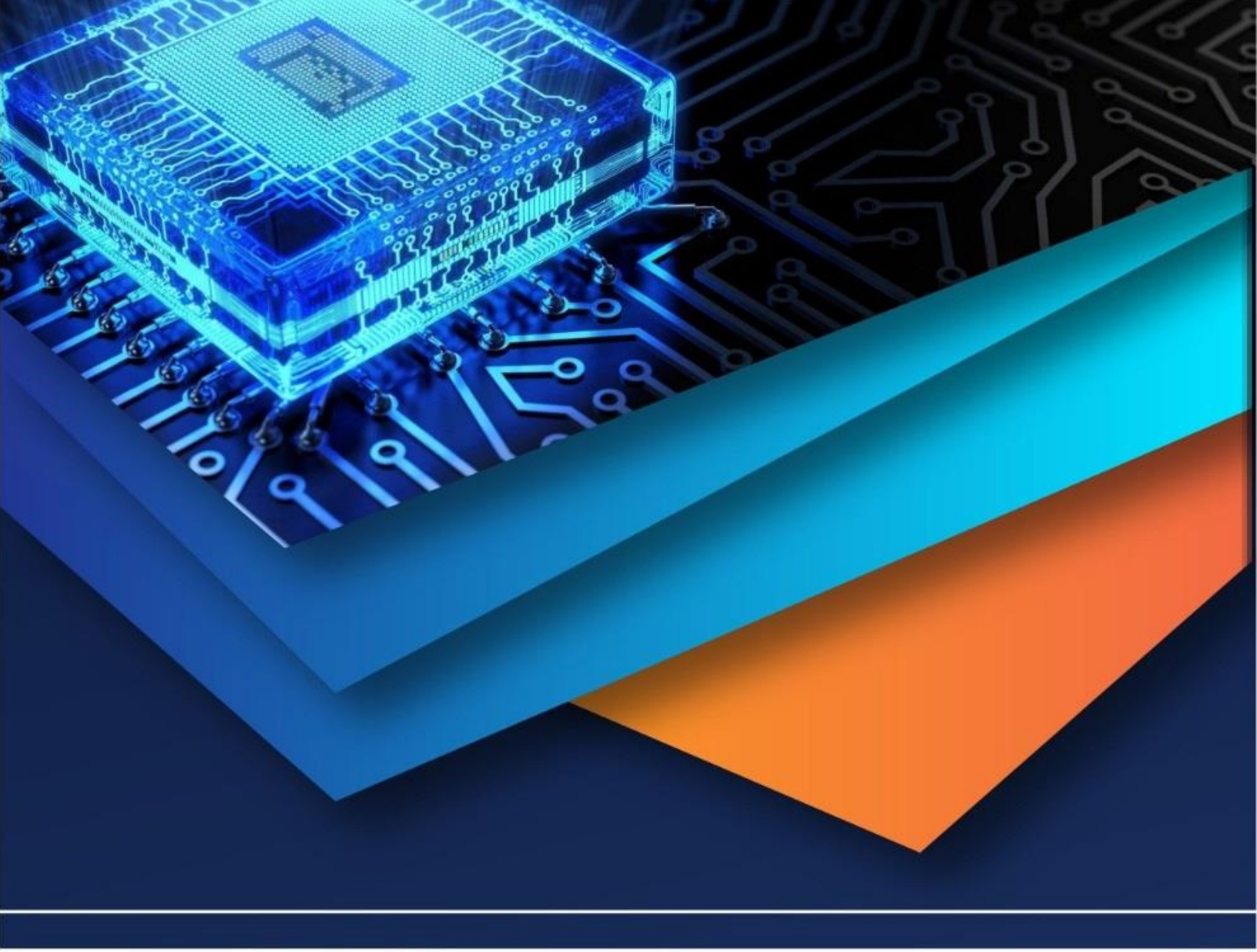

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