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# MICRO POWER GENERATION USING PIEZOELECTRIC TRANSDUCER IN FOOTWEAR

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## ABSTRACT

The aim of this paper is to built a smart shoe which is equipped with power generating capability while wearing this footwear during walking and running. Because, low power consumption electronic devices have been increased rapidly in our day to day life. So, We try to develop a Piezoelectric transducer based power generation through footwear. That can produce pressure during walking or running and it convert mechanical energy into electrical energy to charge the electronic devices. Bridge rectifier was used to convert the AC voltage output from the piezoelectric transducers into DC voltage. Then it will be boost up by the dc-dc Boost converter to charge the electronic devices through Li-ion battery by using a switch. Here, a round piezoelectric disc with diameter of 3.5cm was used. Finally, the produced mean output voltage of standard 12V to charge the electronic devices such as mobile, smartwatch etc., It was a renewable source of energy and it was also a green energy.

**Keywords:** Piezoelectric, Dc-Dc Boost Converter, Renewable Source

## 1. INTRODUCTION

In today's world, power demand is becoming a serious issue with the increasing of power consumption from the constantly growing population and the rapid growth of the newer technologies such as the usage of electric train, electric vehicles like Electric Scooters, Cars etc., These are become our basic needs in our life. So, we try to fulfill our basic needs of electricity through power generation by own. Piezoelectric uses crystalline structures like Quartz, Topaz, Berlinite (AlPO4), Lead Titanate (PbTiO3) etc in it. It is made up of Lead Zirconate Titanate (PZT). They can

generate electric charge when the plate of its crystal disc is compressed or any external force is applied on them. There are two types of structures available as piezoelectric generators one is round and square type of piezoelectric transducers.

## 2. LITERATURE REVIEW

The study conducted by Patel, (2010), has discussed the capacity of piezoelectric in electrical energy harvesting. He defined a previous comparative study by Starner, (1996) showed 5 Watt of electrical power generation by 52 kg person at a brisk walking pace using a PVDF (polyvinylidene fluoride) power harvesting device integrated in a footwear. Asano et al. (2020)

In June 2021, a topic of 'Onmarche Piezoelectric Tiles' was uploaded in ResearchGate by the authors from Bahcesehir University Istanbul, Turkey. In this research, they installed a piezoelectric transducer on the floor tiles to generate electricity. Chaudhary & Azad (2020)

In Dec 2022, a topic of 'Power Generation Using Piezoelectric Transducers' was published in IEEE by the authors from Amrita School of Engineering, Bengaluru, India. Yin et al. (2021)

## 3. OBJECTIVE

The Core objective of this paper is to design a shoe to charge our portable electronic devices through energy produced by own during walking or running. In Army, uninterruptedly powering up a soldier's wearable electronic gadgets such as communication devices used in military operations and also be used to tracking the soldier's location in remote areas. In Nature, to generate energy without damaging the environment and generate power as a renewable energy like solar energy, wind energy etc. Cho et al. (2016), Uchino & Ishii (2010)

## 4. FUNCTIONING METHODOLOGY

**Figure 1**

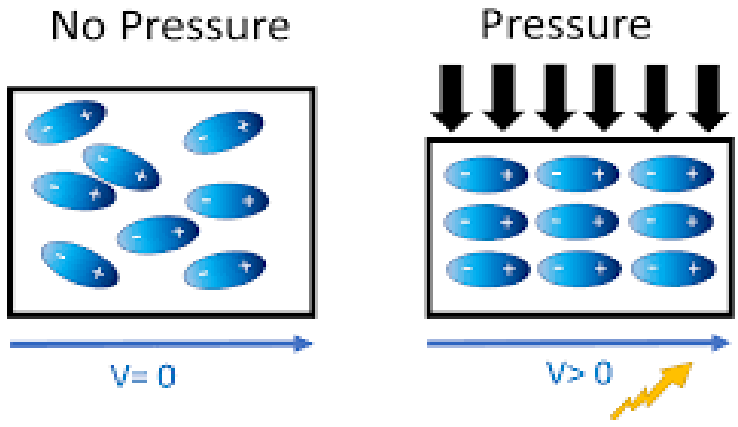


**Figure 1** Functioning of Piezo Crystal

The functioning methodology of a Piezoelectric Transducer is based on the principle that when a pressure is applied on a piezoelectric crystal as a mechanical force, a voltage is produced across its faces due to the movement of electron atoms on the crystal disc is shown in the Figure 1. Thus, mechanical phenomena was converted into electrical energy as an AC output. Gatto & Frontoni (2014)

## 5. BLOCK DIAGRAM

**Figure 2**

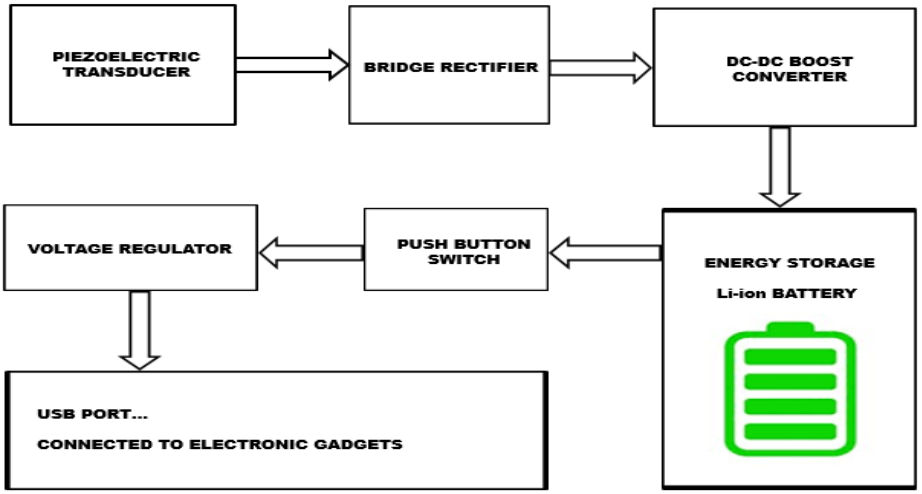


**Figure 2** Block Diagram

In that Figure 2 describes the diagrammatic representation of our proposed work. It consists of the piezoelectric transducer, bridge rectifier, DC- DC boost converter then Li-ion battery for energy storage. And it has the push button switch, voltage regulator and the USB port for charging the electronic gadgets. Hong et al. (2013)

## 6. COMPONENTS REQUIRED

**Figure 3**

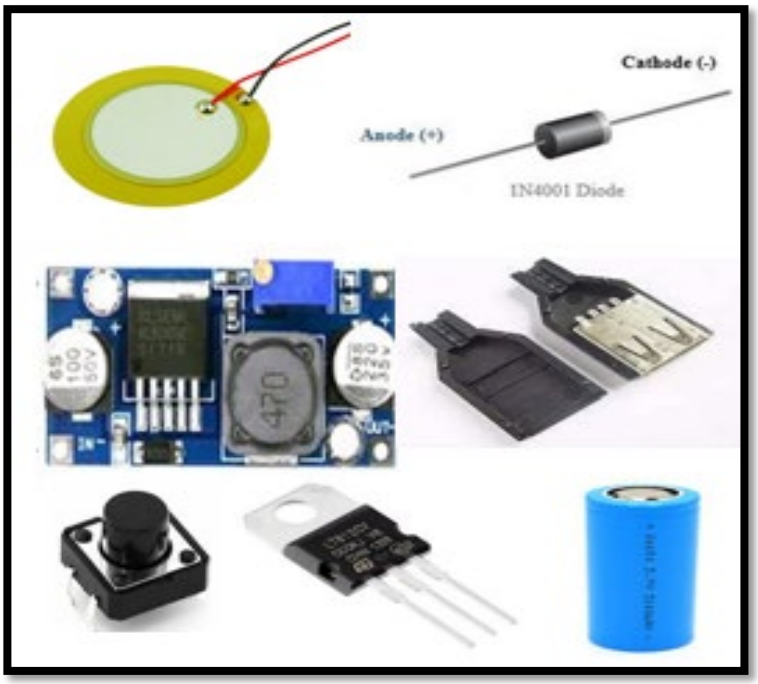


**Figure 3** Components Image

The Figure 3 shows the picture view of the components used for our work.

**Piezoelectric Disc**: Round shaped 3.5cm diameter sized four piezoelectric transducer discs were used on each shoe.

**Diode**: Here, four 1N4001 diodes are used to built a bridge rectifier circuit to convert AC to DC voltage on each shoe.

**DC-DC Boost converter**: One DC-DC Boost converter with the adjustable output voltage of the 5 to 35 v which is fitted on the bottom of each shoe.

**Battery**: 3.7v, 3000mAh battery was connected in the circuit to store the power on each shoe.

**Voltage Regulator**: LM7812 model voltage regulator was used to produce the constant 12v output to charge the load.

**Push Button**: Mini clicky On/Off push button switch was used between the battery and the voltage regulator.

**USB Port**: Female type USB Port with the specification of USB 2.0 which is used to connect the load as electronic devices through it.

## 7. CIRCUIT DIAGRAM

**Figure 4**

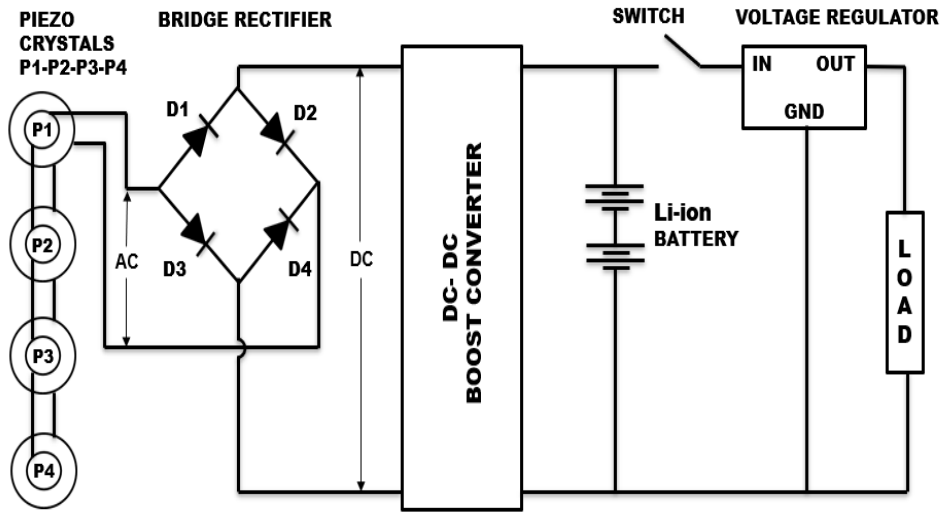


**Figure 4** Circuit Diagram

The above Figure 4 is the circuit diagram of our proposed work. It consists of the parallel connected four piezo crystals P1, P2, P3 and P4. The AC output from the piezo was connected to the bridge rectifier circuit consists of four diodes D1, D2, D3 and D4 are used to construct this bridge rectifier. After crossing the rectifier, the power will be converted into DC and then the output from the bridge rectifier was connected to the DC- DC Boost converter to boost up the power. Then the boost up power was given to the energy storage device such as Li-ion battery. Finally, load was connected by using USB port through the voltage regulator with the control of push button switch. Jeong et al. (2019), Kim et al. (2021)

## 8. TESTING CIRCUIT

**Figure 5**


**Figure 5** Testing Circuit

The Figure 5 shows the piezoelectric transducer generates the AC voltage which was varying depends on the pressure given on the piezoelectric transducer. Thus, piezoelectric transducers are arranged in parallel connection to each other because we need more current then voltage. Here, the testing circuit generates the output of more than 7.36V as an AC output before the usage of the dc-dc boost converter circuit. Moro & Benasciutti (2010), Saha et al. (2014)

## 9. RESULT

**Figure 6**

**Figure 6** Piezo Footwear

The outcome of our proposed work was to make a successfully completed portable micro energy generated shoe using piezoelectric transducers installed on it. The product style is made simple, robust, and compact design for using as a normal footwear feeling. Mechanism management is easy because of human motion due to walking or running to made pressure as mechanical force applied to it, and use of USB port to charge the devices with 12V constant power output by this technique on each shoe. And it also charging the Li-ion battery for future use, and it is very helpful for the long-term utilization of the power from the battery. The result of piezo based footwear which is shown in the Figure 6. Shenck et al. (2001).

## 10. CONCLUSION

The idea of energy harvesting from piezoelectric disc is a good source of clean and green renewable energy. In this work, we have illustrated the design of piezoelectric based energy harvesting from the human walk and then use it to power up wearable electronic devices. We generated electrical power as non-conventional method of energy generation by simply walking or running with footwear and charge the mobile through USB port with the output of 12 v DC power and also store the power on battery inside the shoe. Here, we achieve that the self-generation of power without the usage of any type of external source required. However, this all depended on how much pressure that was applied onto the piezoelectric elements through walking.

## CONFLICT OF INTERESTS

None.

## ACKNOWLEDGMENTS

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