

# Footstep Power Generation System using Piezoelectric Sensor

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**Abstract** - In country like India, which is one of the largest producer and largest consumer of electricity, where in all of total consumption industrial sector consume 41.16% of electricity followed by 24.76% for residential, 17.69% for agriculture, 8.24% for commercial and 1.52% for traction. The electric power consumption is increasing exponentially. In day to day life, the utilization of power turns to be necessary for each work. The repeated application of pressure on sensor leads to development of charge and by proper circuit design this charge can be harvested and stored in battery. Energy harvesting or scavenging is the process of capturing the wasted energy sources, accumulating and storing it for later use [1]. This stored charge can be further used in other sectors. This power developed is stored in the batteries which can be used later as per the convenience. During the power surges or power shutdown this developed charge can be used for basic lights and guideways. This method of producing charge and storing it for further usage promotes ecofriendly approach towards energy generation and develops clean green energy. The power delivered in this project will not contaminate the surrounding and it also does not rely upon the climate conditions. Further in this review paper we have imparted the design and simplified concept of the model.

**Key Words:** Piezoelectric Sensor, Eco-friendly, Sustainable sources, Energy harvesting technique

## 1. INTRODUCTION

As we are aware of the increase in usage of electricity, the only solution comes out to solve this problem is to increase the applications based on renewable sources. Current sources are not enough for our needs leading us to development energy through each and every mean. An energy harvester has typically three main components; the micro-generator for converting ambient energy into electrical energy, the voltage booster to pumps up and regulate the generated voltage and storage element.[2] The main motive of this device is to developed electricity when pressure is applied platform. For better effective pressure it can be installed in stairs at respective places. Also, can be installed at entry and exit point of office, hall, etc. This device produce energy by pressure exerted on ground by human's footstep. Regarding the scope of the study that is harvesting kinetic energy of walking, the frequency of the human movement is less than 10Hz [3]. This energy develops pressure on the retractable mechanism and this electric charge developed is stored in battery which can be utilized later when needed.

## 1.1 Piezoelectricity

This piezoelectric word is derived from Greek word 'Piezein' which literally translates to squeeze or press. These materials are those which produce an electric AC current when they are placed under mechanical stress. It's a charge that accumulates in crystalline solid materials in response to application of mechanical force. Also, the unique characteristic of piezoelectric material is that its piezoelectric effect is reversible. Which means if we apply stress on them it gives current whereas if we induce current in them, they either expand or compress as per the polarity of applied source. There are numerous materials which exhibits this property. They exist both in man made and natural state. For e.g. Crystalline materials (Quartz, Topaz), Ceramic (Sodium Tungstate ( $\text{Na}_2\text{WO}_3$ ), Zinc oxide ( $\text{ZnO}$ )), Lead-free piezoceramics (Bismuth Titanate ( $\text{Bi}_4\text{Ti}_3\text{O}_{12}$ ), Bismuth ferrite ( $\text{BiFeO}_3$ )).

## 2. SYSTEM CONFIGURATION

### 2.1 Piezoelectric Sensors

This piezoelectric sensor comes in flat circular disc where the crystals are packed between lower and upper disc. Lower disc is large in diameter compared to upper. At this stage of sensor, they are packed at stable state which results in zero conduction of electricity. The upper surface here is positive anode and negative cathode. According to the terminals wire soldered. Further these terminals are to be connected to the circuit which will stabilize the AC current so that this current can be used in charging batteries and other usage.

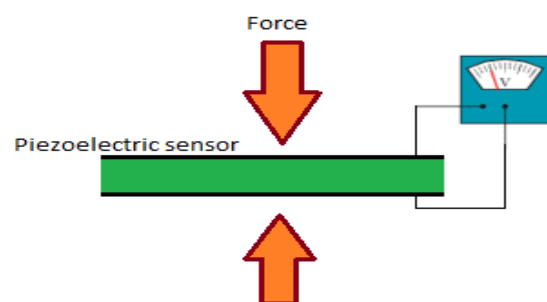


Fig 1: Piezoelectric Sensor

## 2.2 Diodes

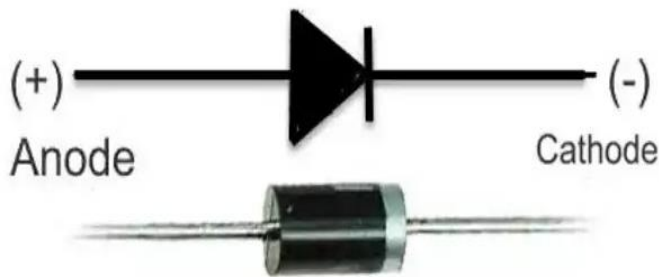


Fig 2: Diode

Diode is a semiconductor device whose intrinsic nature is to act as a one directional component for current. A diode may be thought of as an electrical counterpart of a directional valve (“check valve”) [4]. This component allows current to flow in single direction (forward direction) whereas it restricts from flowing the current in opposite direction. This property of flowing

current in single direction is called as rectification. And this is the reason why it is used to convert alternating current (AC) to direct current (DC). These diodes are used in rectification circuits where the AC current is to be converted into DC. In this device it is used as rectifier and reverse-voltage protection. Bridge-rectifier is constructed here to convert the developed AC charge into DC. Further this DC has to be more stabilize and stored in batteries. Here one diode is connected after bridge-rectifier and before the battery connection. This diode stabilizes DC charge and also controls unidirectional flow of current. The diode restricts this DC charge to flow back in circuit and stabilizes this charge.

## 2.3 Capacitor

Capacitor is one of the three basic passive circuit components of any electronic or electrical circuit [5]. It is a component with two terminal which stores charge in electric circuit. This component consists of two conductors separated by a non-conductive region. Either vacuum or an insulating material called as dielectric can be present. Plastic, paper, mica, ceramic etc. are examples of dielectric media. It builds up charge when we apply a voltage across it, and it gives up the stored charged to the circuit. As this component is connected to the voltage source, the terminal attached to the terminal of source becomes positives and the terminal attached to negative terminal becomes negatively charged. When a DC supply is connected to a resistor and capacitor, the initial current is high as the supply source transports charge from one plate of the capacitor to the other [6]. Since there is dielectric present in between the conductor inside the capacitor, no charge can be migrated from one terminal to other. The difference occurs in charging level between these two conductors present inside capacitor. This charge accumulation is not instantaneous in capacitor, gradual changes are observed.

## 2. Working

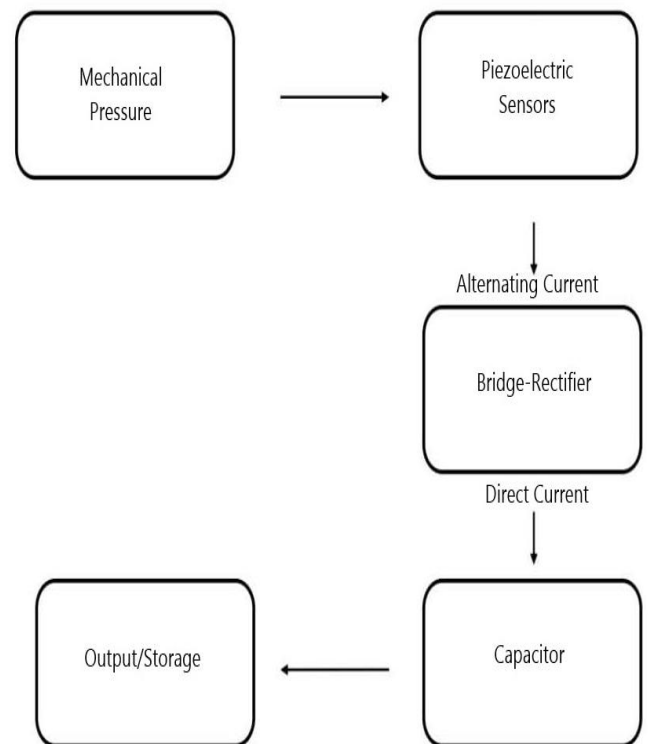


Fig 3: Block Diagram of working

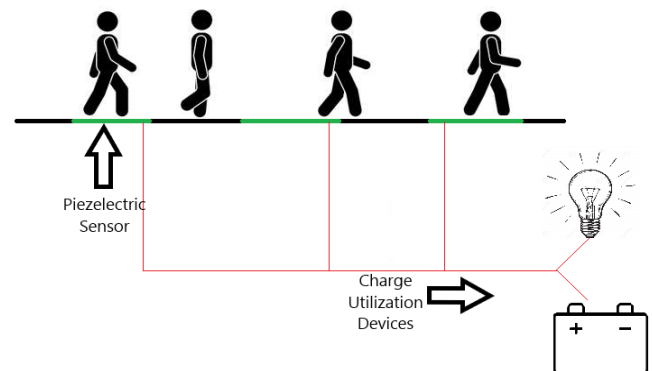


Fig 4: Working for plane platforms

There is an array of piezoelectric sensor designed, is placed under the platform which will channel the pressure developed by human activity on it. This retractable mechanism is designed in such a way that it lifts up as the weight is removed and put pressure on sensors as soon as weight is placed. As we know, the charge developed by this piezoelectric sensor is always AC. This AC charge developed by these sensors has fluctuating nature. Also, this charge varies as the weight applied on it. All humans are not of same weight, it varies from person to person. Due to this,

each time different person steps a different amount of charge is developed. To stabilize fluctuating charge and convert it into DC a diode and separate bridge-rectifier is attached respectively.

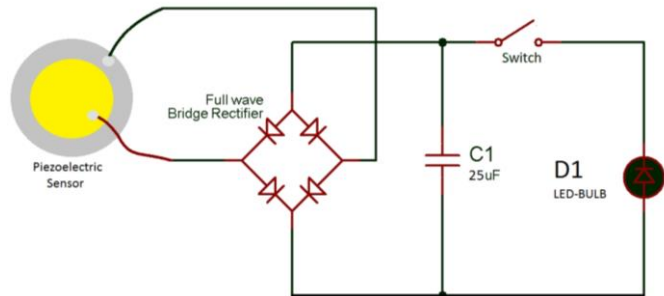


Fig 5: Circuit Diagram

Bridge-rectifier used to here to rectify the current, which is to convert AC to DC. This DC current later flows through diode via capacitor. This diode restricts the reverse flow of current as these ends are connected external batteries or any electricity storage device. This whole circuit is designed in such a way that all the piezoelectric sensors which are set in array are connected to the entry point of this circuit. Any of the sensor experience pressure on itself and develop a charge, this charge goes through the circuit and gets stored into the storage device connected at exit point.

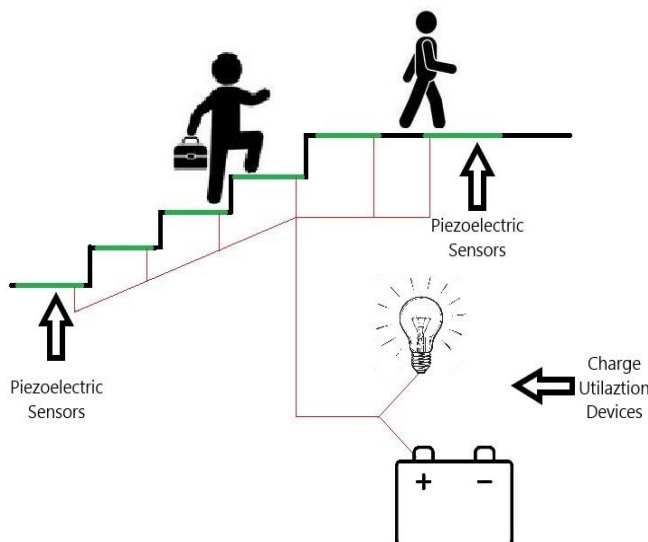


Fig 5: Working for inclined Platforms (stairs)

### 3. CALCULATIONS

Power developed varies with different amount of pressure developed while stepping on a sensor.

For this the experimental results are found as follows,

- Minimum voltage observed = 0.03 V
- Maximum voltage observed = 1.02 V

Since weight is a factor which varies from person to person, let's consider the standard weight of about 50kg respectively.

So, the calculations for standard weight is as follows,

To increase 1V of charge we need about 800 steps,

For increment of about 12V in battery,

$$\begin{aligned} \text{Steps needed} &= 12 \times 800 \\ &= 9600 \end{aligned}$$

So, 9600 steps are required for development of 12V.

### 4. ADVANTAGES

- \* Promotes use of green energy.
- \* No harm to any being.
- \* No emission of toxic materials.
- \* Easy to handle.
- \* Easy to access.
- \* No 24/7 monitoring required.
- \* Can be easily installed.

### 5. CONCLUSIONS

An effective and eco-friendly way to generate electricity by utilizing the neglected mechanical forces created by human activity is presented in this review. This piezoelectric platform is capable of producing electricity enough for basic usage. Also, can be used to develop and store the charge for later usage for basic purposes during power cutoff. There are numerous locations where it can be placed as it suits every indoor and outdoor environment where human movements happen. This system requires basic knowledge for maintenance and with such simple device we can harness energy which can be useful in public as well as private sectors.

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