

# HARNESSING THE ENERGY GENERATED FROM STAIRCASE USING PIEZOELECTRIC TECHNOLOGY

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**Abstract** - At present generation the rate of demand for power is increasing proportionally with a drastic increase in human population. Therefore scientists were looking for alternative way of generating electricity like solar, wind, sound etc., Efforts has been made to harness the energy which has been wasted into the electrical energy in order to power the world. One such effort is the conversion of dynamic pressure obtained from human footsteps into electrical energy by the application of piezoelectric technology. The piezoelectric materials converts dynamic pressure into electricity the power generated by piezo is DC signal with ripples hence we use rectifier and filter to get pure DC signal. Further boost converter circuit is used to step up the DC signal and through battery charger circuit, battery is charged.

**Key Words:** Piezoelectric crystals, boost converter, inverter etc.

## 1. INTRODUCTION

The piezoelectric materials are group of materials which produce electrical energy from mechanical stress and vice versa. It is for this reason that the materials are of great interest and already have applications in several areas. When we consider the global energy crisis and the future consequences associated with the continued use of natural energy resources, an alternative for electrical energy production could be extremely valuable. The issue, however, with piezoelectric materials is that the amount of energy produced is very low and, consequently, their use in large scale power generation is limited. That said, it is not unrealistic to believe that they will continue used and developed in the future. The piezoelectric effect was discovered in 1880 by Pierre and Jacques Curie. On applying mechanical stress to materials such as quartz, cane sugar, Rochelle salt and Topaz it was found that a small potential difference was generated. The pyro electric effect in which small voltages are produced when the temperature of a material is changed was already understood at this point and formed the basis of the research carried out by the Curie brothers. The discovery was first put to use during World War I, whereby their characteristics were exploited in piezoelectric ultrasonic transducers. Since then, they have been used in several situations from microphones to car airbag systems.

### 1.1 Existing system

The piezoelectric has a wide range of applications in various fields. In case of industrial applications they are used in

Engine Knock Sensors, Pressure Sensors, Sonar Equipment, Diesel Fuel Injectors, Fast Response Solenoids, Optical Adjustment, Ultrasonic Cleaning, Ultrasonic Welding, Piezoelectric Motors and Piezoelectric Relays.

In case of Medical applications they are use in Ultrasound Imaging, Ultrasonic Procedures. In case of consumer electronics Piezoelectric Printers, Piezoelectric Speakers, Piezoelectric Buzzers, Piezoelectric Humidifiers and Electronic Toothbrushes. In case of musical applications they are used in Instrument Pickups and Microphones they also have other applications such as Piezoelectric Igniters etc., In case of Defense applications the piezoelectric actuators can be used in Micro robotics.

### 1.2 Proposed system

The system serves as a medium to generate electricity using non-conventional source (force) and store, use it. The project is designed to be useful at public places like railway stations where a lot of people keep walking through all day. At such places these systems are to be placed at staircase where pressure is greater than that of the plain surface. These devices may then generate a voltage on every footstep and when mounted in series-parallel connection they will produce a sizeable amount of electricity.

### 1.3 Objective

The main objective of this project is to tap the wasted energy. The energy can neither be created nor be destroyed but can be transferred from one form to another. According to year 2013-14 the wastage of power is about 5.3 billion units. The energy in the form of light, heat, pressure, noise, dust and garbage were available in abundance which can be tapped by various techniques.

One such approach for converting the dynamic pressure obtained from staircase into potential difference is by using piezoelectric technology. The magnitude of potential difference varies according to the applied pressure which in turn is calculated by using the formula  $\text{pressure} = \text{force}/\text{area}$ .

## 2. BLOCK DIAGRAM

The input is applied to piezoelectric arrangement and the output is obtained from inverter circuit as shown in fig1.

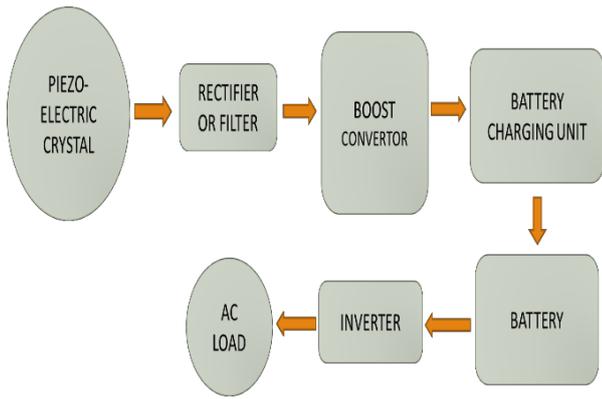


Fig 1. block diagram

Rectifier, converter, battery charging unit and inverter together forms the main circuit. The description have been given below.

**PIEZOELECTRIC ARRANGEMENT:**

Materials such as Lanthanum gallium silicate, Lead scandium tantalite, Lead zirconate titanate or any other class of materials can be used according to the working conditions and number of crystals were connected in either series or series-parallel connection to generate required potential.

**BRIDGE RECTIFIER:**

This circuit consists of Junction diode, resistors and capacitors to perform the rectification operation. Capacitors were generally used to reduce the ripple content and increase the quality of voltage.

**BOOST CONVERTER:**

A boost converter is a DC to DC power converter that steps up voltage from its input to its output. It is a class of switched-mode power supply (SMPS) containing at least two semiconductors (a diode and a transistor) and at least one energy storage element: a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors are normally added to such a converter's output and input.

**BATTERY AND BATTERY CHARGING UNIT:**

A battery charger or recharger is a device used to put energy into a secondary cell or rechargeable battery by forcing an electric current through it. Rechargeable batteries or secondary cells can be recharged by applying electrical current, which reverses the chemical reactions that occur during its use. Generally used secondary battery was lead acid battery.

**INVERTER:**

An inverter circuit is used to convert the DC power to AC

power. Inverters can be of two types True/pure sine wave inverters and quasi or modified inverters. These true pure sine wave inverters are costly while modified or quasi. Inverters are inexpensive.

**2.2 METHODOLOGY**

This system involves only simple components such as rectifier, converter, and inverter. The number of piezoelectric crystals were set up according to the magnitude of input voltage and the diameter and length of the staircase. The rectifier converts dc signal with ripples into pure dc signal. Finally converters and inverters were used to increase the magnitude of voltage and in conversion of dc to ac signal respective.

**2.3 SIMULATIONS**

The given below fig 2 is the overall simulated diagram of this overall project:

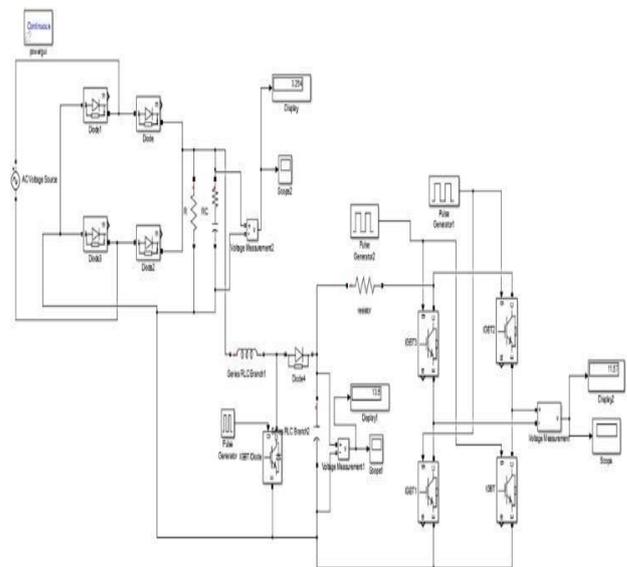


Fig2. Overall simulation diagram

The overall circuit diagram is the theoretical approach of this project. Here the initial supply is assumed to be a single constant input value (5v) for analysis purpose. The components were extracted from Simulink library and was connected respectively to form overall circuit. Initially an input of five volts AC is sent to the bridge rectifier circuit where the AC is converted to pure DC voltage. The capacitor is used to smooth the output which is in turn sent to the boost converter circuit. The boost converter boost the input voltage to desired value but reduces the current value. Thus the output obtained from the boost converter is sent to the inverter circuit where the inversion operation is performed. The inverter uses pulse width modulation technique to control the magnitude of voltage. The shape of the voltage waveform can be observed using scope. This is a simple theoretical analysis and doesn't include battery and switch unlike in the practical circuit.

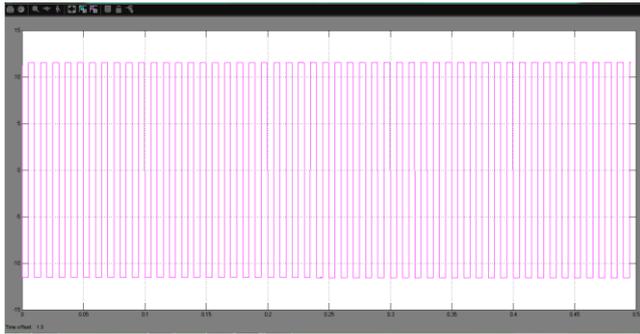


Fig 3.output waveform

In the above overall circuit the magnitude of resultant output voltage is 11.57 v as shown in fig3.

## 2.4 HARDWARE IMPLEMENTATION

The fig 4 given below is the overall component diagram of the project.

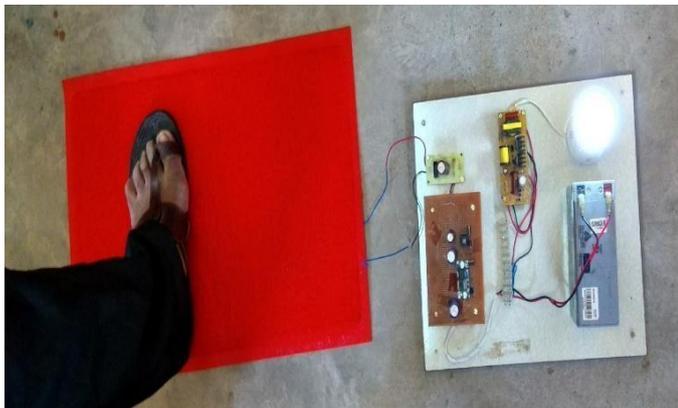


Fig 4. Practical output of overall hardware

This is one of the reliable method to generate electricity. This project could be efficient in large scale. This project consist of piezoelectric crystals connected in either series or parallel or series-parallel. This crystals were properly embedded in substrate and provided with proper safety arrangements. The outer surface of is covered by a proper plastic or sponge mat. This project could be applied to both domestic and industrial applications. Initially the piezoelectric mat which is been prepared is fixed at the staircase of places such as schools, railway stations, collages etc.

Due to the movement of people on the staircase a dynamic pressure is applied on the piezoelectric mat which is converted to voltage. The magnitude of voltage created depends on the magnitude of applied voltage. An AC voltage with DC ripples which is created from the piezoelectric crystal is applied to the bridge rectifier circuit.

The output from the bridge rectifier circuit is which is a pure DC is applied to the boost converter circuit. Boost converter simply steps up the DC voltage but reduces the current. Thus the boosted voltage obtained from the converter is applied to the battery charging unit the battery

thus gets charged. The output from the battery is connected to inverter through switch.

The switch present between the battery and inverter helps in decreasing the discharge rate of inverter. The inverter converts the direct EMF obtained from battery into alternating EMF which can be stepped up using step up transformer and can be used to run the light loads.

## 3. CONCLUSIONS

Thus the above project has its own advantage and disadvantage. Some of the advantage of this project are alternative small scale renewable resource to run light load, dexterous, reliable and efficient provided with right technological support and protective measures. But the disadvantages of this project are that the piezoelectric crystal which was used in daily life such as quartz was inefficient and unreliable. Also the current output obtained from the quartz crystal is very low. We have crystals which produce optimum voltage and current which were costly and uneconomical for underdeveloped and developing nations. Yet still by proper design and innovative engineering work were can make this project a highly efficient one for large scale applications.

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