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Power Generation by Piezoelectric Sensor by Varying the Pressure

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Abstract:- This paper investigates the use of piezoelectric transducers for power generation by varying the applied pressure. The study analyses the characteristics and performance of piezoelectric sensors under varying pressure conditions, including the effects of pressure amplitude, frequency, and duration on power generation. The research also examines the material properties and load resistance of piezoelectric transducers and their impact on power generation. The findings indicate that piezoelectric sensors can generate significant amounts of electrical power by varying the applied pressure, and their performance can be optimized through careful selection of materials and load resistance. These results have important implications for the development of self-powered systems and energy harvesting devices.

Keywords:- *Coercion, Energy conservation, Footstep, Generation, Piezoelectricity, Power.*

I. INTRODUCTION

Energy has become our most basic need as our need for energy is increasing day by day in our daily activities. This happened due to today's population growth. Currently, energy sources are not sufficient to meet demand. To resolve this issue, you will need to create other alternate sources to support the missing sources. The best way is to use renewable energy. These energies must be collected before they can be used. Energy harvesting, also known as energy scavenging, is the process of extracting or extracting energy from external sources and accumulating and storing the energy for later use. By harvesting this renewable energy, we can generate electricity without any negative impact on the environment. People's quality of life is improving due to advances in medical technology and population growth. Energy that can be generated to meet the demands of a growing population.

By harnessing human footprints, useful energy can be harvested and generated to replace non-renewable energy. This type of renewable energy is independent of climate and weather conditions. Harvest energy sources using converters to invent eco-friendly technologies. The transducers used are piezoelectric transducers. This transducer is used to sense vibrations and pressure applied to generate electricity. This piezoelectric element converts mechanical energy exerted by pressure or force into electrical energy that can be used in other small electronic devices or stored in storage compartments.

II. LITERATURE SURVEY

The piezoelectric materials have been widely used in energy harvesting applications due to their ability to convert mechanical energy into electrical energy.

- They found that the power output of piezoelectric transducers can be optimized by varying the applied pressure, and that the frequency and amplitude of the pressure also affect the power generation efficiency.

- The authors investigated the effect of load resistance on the power output of a piezoelectric transducer under varying pressure conditions. They found that the load resistance significantly affects the power generation efficiency, and that the optimal load resistance varies with the frequency of the applied pressure.

They studied the performance of piezoelectric transducers can be improved by using composite materials, such as carbon fibres.

- Reinforced polymer, which have high stiffness and low density. They found that the composite piezoelectric transducers generate higher power output than traditional ceramic-based transducers under varying pressure conditions.

The authors investigated the effect of pressure duration on the power generation efficiency of a piezoelectric transducer.

- They found that the longer pressure duration can result in higher power output, but also increases the risk of material fatigue and damage.

- The use of multiple piezoelectric transducers in parallel can significantly increase the power output under varying pressure conditions. They found that the optimal configuration of multiple transducers depends on the frequency and amplitude of the applied pressure, as well as the load resistance and impedance matching.

III. OBJECTIVE

- The objective of power generation by piezoelectric transducer by varying the pressure is to investigate the optimize the power output of piezoelectric transducers under varying pressure conditions, including the effects of pressure amplitude, frequency, and duration on power generation.
- And study the potential of piezoelectric materials as an energy harvesting technology.

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IV. METHODOLOGY

A. Experimental

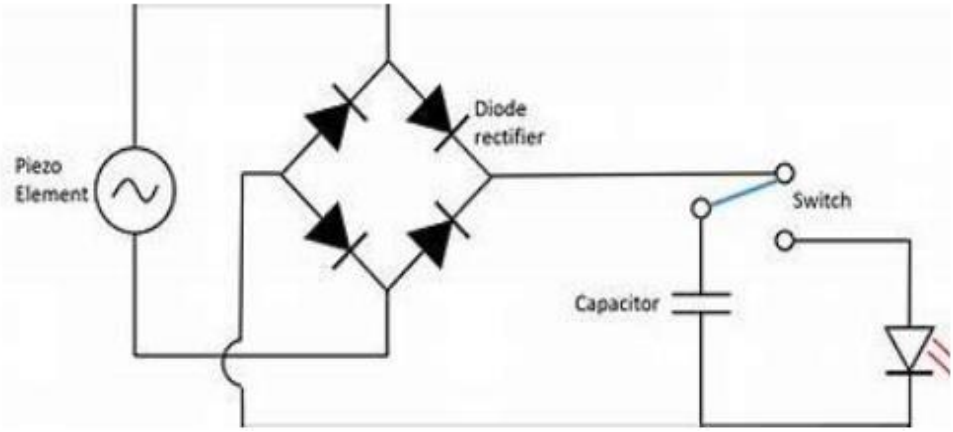

Fig. 1: Experimental Setup

B. Simulation

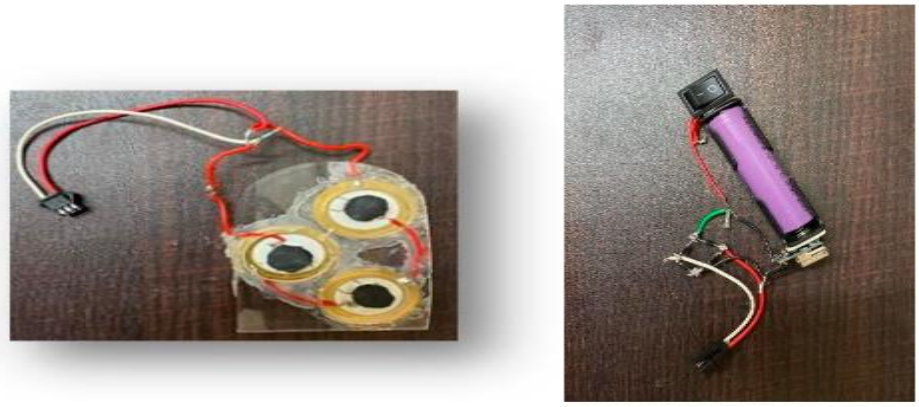

Fig. 2: Actual Circuit Diagram

For the Piezoelectric sole, an acrylic sheet dimension 100cm x 64cm is taken. The thickness of the acrylic sheet is 2 mm. To implement and protect the piezo-electric sensors a sheet acrylic sheet is placed in the shoes. As the power output from a single piezo film was extremely low, a combination of a few Piezo films is investigated. Two possible connections were tested - parallel and series connections. The parallel connection did not show a significant increase in the voltage output. With a series connection, additional piezo-film results in an increase of voltage output but not in linear proportion.

The system consists of an acrylic sheet that depresses slightly under the pressure of human steps and which will depress the mechanical setup placed immediately after it inside the system. This consists of an immovable bottom platform and a compressible top platform. The piezoelectric material converts the pressure applied to it into electrical energy. The output dc voltage is then stored in a rechargeable battery. The battery charger is connected to the power bank charging model to alternate or pass the current the battery is getting charged. In a similar way, the mobile charger is also connected to the outside surface of the battery. The 3.7V power supply is given to the power bank charging model and bridge e rectifier with the mobile charger we can charge mobiles also this generates electricity.

V. COMPONENTS USED

A. Piezoelectric Sensors

A sensor is referred to as a piezoelectric sensor when it operates on this basis. If a material is subjected to mechanical stress, a process known as piezoelectricity occurs, which causes electricity to be produced. A piezoelectric sensor is one that uses the piezoelectric effect to sense changes in acceleration, strain, pressure, and force by turning them into electrical charge. The amount of stress applied to the substrates of the powerful piezoelectric crystal determines how much piezoelectricity is generated.

These gadgets, sometimes known as energy harvesters, can be employed in situations when batteries are impractical and outside power is not accessible. The piezoelectric sensors require an external source because of their self-generating nature and extremely high frequency response. It is simple to use as they have small dimensions and a large measuring range.

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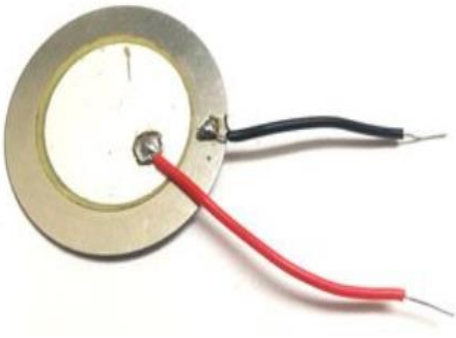

Fig. 3: Piezoelectric Transducer

- ***Sensitivity S:*** *Ratio of change in output signal* Δy *to the signal that caused the change* Δx. $\boldsymbol{S = \Delta y/\Delta x}$.

Table 4.2 Specification of Piezoelectric Transducer

1	Impedance value	≤500Ω
2	Strain sensitivity	5V/με
3	Operating Temperature	-20°C to +60°C

B. Bridge Rectifier

AC (Alternating Current) is transformed into DC (Direct Current) using the rectifier circuit. Half-wave, full-wave, and bridge rectifiers are the three basic types of rectifiers. All of these rectifiers have the same primary purpose, which is to convert current, however they do not do so effectively while doing so. Both the bridge rectifier and the centre tapped full wave rectifier are effective converters. One often seen component of electronic power sources is a bridge rectifier circuit. In order to power the numerous electronic fundamental components from the available AC mains supply, many electronic circuits require a rectified DC power source. In comparison to a rectifier with a three-wire input from a transformer with a center-tapped secondary winding, a bridge rectifier offers full-wave rectification from a two wire AC input, which results in a cheaper cost and weight.

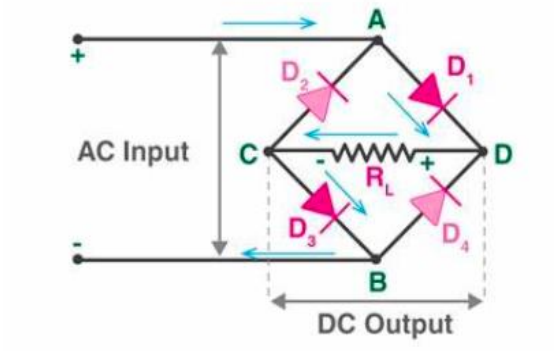

Fig. 4: Bridge Rectifier

C. Li-Ion Battery

A battery is a collection of electrochemical cells that are individually connected or separately connected and housed in a single device for the purpose of storing power. An electrical battery is made up of electrochemical cells that transform chemical energy that has been stored into electrical energy. uses for battery standby power. Larger batteries offer backup power for vehicles or computer data centres; these batteries are utilised in electric vehicles.

Fig. 5: Lithium-ion Battery

D. Power Bank Charging Module.

The 5V Step-Up Power Module Lithium Battery Charging Protection Board or the Power bank module contains a single chip that has multiple applications. This module is widely used as a power bank application, as it can provide large load currents and large discharge currents up to 1A, which is ideal for device charging. The module has onboard LEDs to indicate charging and discharging.

VI. WORKING

A. Piezoelectric effect

They also use piezoelectric crystals. The piezoelectric crystal exhibits the piezoelectric effect. This piezoelectric effect has two properties. The first one is the direct piezoelectric effect which means that the material has the ability to convert mechanical strain into electrical charge. The second one is the converse effect, in which the applied electrical potential is converted into mechanical strain energy. That means material used as a power harvesting medium.

B. Power Harvesting by Using Human Footsteps-

In this paper use of piezoelectric crystal is to generate electric output from surrounding vibration. Piezoelectric materials have crystalline structures. They can convert mechanical energy into electrical energy. The produced electrical energy from piezoelectric crystal is very low in the order of 2-3 volts and is stored in a battery to charge the controller since it is not possible to charge a 12v with less time battery through crystal output. To increase the voltage, the boost converter circuit is used. The level of voltage ranges from 1-7V and it is stored in a 3.7V battery.

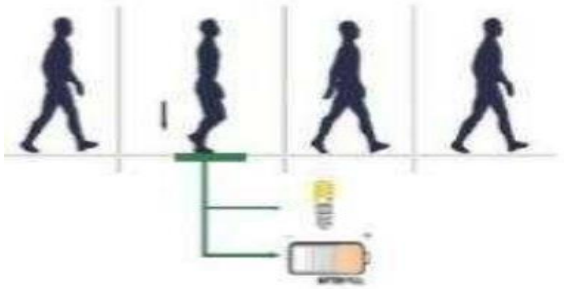

Fig. 6:

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VII. RESULT AND DISCUSSION

Since the power that piezo sensors produce changes depending on the step, get 200 steps of minimum voltage=0.25 V 5 to 7 volts maximum per step

Consider the steps of a single person who weighs 70 kg. If an average pressure of 70 kg is applied, the average computation is:

The battery's 1 V charge is increased over the course of 800 steps.

To raise the battery's voltage by 10 V. (10 x 800) steps totaled equals 8000 steps. Since this experiment is being carried out while wearing ordinary shoes, the sound of footfall can be used as a source if, on average, two steps are taken for every second. Time needed for 8000 steps is equal to 8000/(60), or 66 minutes.

(Approximately)

Table 1: Actual Result

WEIGHT	STEPS	VOLTAGE AND CURRENT
70	**200**	**0.25V**
54	200	0.19
86	200	0.28

Fig. 7: Actual Model

VIII. FUTURE ASPECTS

In the future, we may apply this idea to speed bumps on highways when there are too many cars on the road at once, increasing the input torque and final output of the generator. If we apply this principle to the road, we can create effective electrical power that is beneficial for big projects.

- *Merits:*

Power generation is simply walking on the step.

- Power is also generated by running or exercising.
- No need for fuel input.
- This is a non-conventional system.
- Maintenance cost is low
- Light in weight.
- Easy to carry.
- Simple in construction.

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