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Generation of Electricity Using Footstep Power

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Abstract

The primary issue of the energy crisis is the demand and supply gap. The major subject of this article is the generation of electric power from people's footsteps and the pressure applied when walking, which is frittered away. The “Foot step power production system” is a system that converts mechanical power into electrical power utilizing transducers and the pressure applied by the footstep. The power producing floor generates power, which is essentially the conversion of kinetic energy into electrical energy. Today's electricity demand is rising, and existing power generation sources are unable to meet this worldwide challenge. Although it will not be adequate to meet the world's overwhelming need for electrical energy, it will be able to modify and reduce dependency on outdated methods of generating electricity. It may be put on roadside footpaths, parks and jogging tracks, as well as many other public places, such as airports, and will have a significant influence on the electrical power generating system. When piezoelectric technology is utilized in flooring, piezoelectric transducers measure the pressure, which is then collected by a floor sensor. As a result, the pressure or mechanical stress is transformed into electrical energy, which is then stored as well as utilized as a power source. Agriculture, residential uses, city lighting, as well as an energy source for sensors in remote places are just a few of the possibilities for this power source.

Keywords: Battery; Inverter; Footstep energy; Piezoelectric; Power generation; Sensor; Transducer

Introduction

The use of various neat as well as clean energy technologies is an important method for achieving environmental sustainability. The majority of individuals spend the greatest of their lives walking. Walking also called as ambulation, and it is a basic and frequent mode of movement for humans in everyday life [1]. Walking creates touch between the human foot and the ground surface. The pressures experienced by human feet as they fall on the ground may create kinetic energy, which is a renewable source of energy. Through the use of a footstep power generator, this energy may be turned into electricity. Power may be produced in a variety of ways, and one of them, footstep energy production, can be an efficient way to generate electricity. Given the daily electricity demand and worldwide climate changes, greener power sources are urgently needed before it is too late. In furthermore, by 2022, India wants to generate 175 GW of energy from renewable sources. Considering the above-mentioned lofty goals that nations have set for cleaner fuel sources, there is a pressing need for alternative power sources that not only satisfy the demand but also meet the financial, adoption, as well as operational challenges that we face in real-time situations [2].

Implementing different renewable energy solutions is a critical step in achieving environmental sustainability. The majority of people walk for the bulk of their lives. Walking, often known as ambulation, is an essential as well as common form of human movement in everyday life. Walking brings the human foot into contact with the earth. The forces that human feet feel when they fall to the earth may provide kinetic energy, which is a sustainable energy source. A footstep power generator may turn this energy into electricity. There are many various types of footstep power generators on the market, but the bulk of them produce energy using a piezoelectric transducer. Choosing the appropriate ferroelectric material, which influences the output of conversion of kinetic energy to electricity, is one of the most difficult problems in constructing footstep power generators using piezoelectric transducers.

Because the direct piezoelectric effect (the creation of electricity when stress is applied) is reversed, materials that exhibit the piezoelectric effect (the generation of electricity when stress is applied) may also exhibit the reversed photoelectric effect (the generation of stress when an electric field is applied). Whenever physical stress is applied to a piezoelectric material, the positive and negative charge centers in the material shift, resulting in an externally applied electric. When the piezoelectric material is inverted, an external electrostatic force stretches or compresses it. The piezoelectric effect is used in applications such as sound creation and detection, high-voltage production, electronic frequency generation, microbalances, and ultra-fine optical assembly focusing. It also serves as the foundation for a variety of atomic-resolution scientific instruments such as scanning probe microscopes. The piezoelectric effect can also be used in more common applications, such as in cigarette lighters as an ignition source.

In this study, the generation of electric energy from the forces produced by a footstep on the floor is demonstrated. It will surprise you to learn how much energy may be generated by simply walking on the floor [3,4]. Each person takes tens of thousands of steps every day. Walking generates electrical energy, which is created by the people's footstep. It is true that each individual loses a significant quantity of energy during a normal stroll, which is the system's primary source of energy. This Electro-Kinetic energy floor uses the method of walking on it to transform kinetic energy into electricity. Walking on the floor generates energy that is both noiseless as well as pollution-free. This kind of energy is advantageous since it does not need any kind of fuel or power supply unit to function [5]. Every day, a large number of people walk. A person delivers energy to the road

surface through collision or vibration. By converting mechanical energy to electrical energy, this energy may be transformed [6,7]. Our kinetic energy is lost as heat energy as we walk on our feet. We generated electricity in this experiment using human-powered mechanical energy. The pressure applied by human movement will be converted into an electric current using piezoelectric material (Figure 1).

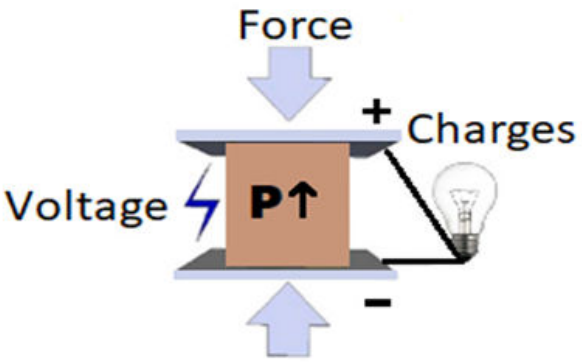

Figure 1: The above figure illustrate the how the power is generate by applying pressure on piezoelectric material.

Because almost all-important objects are powered by electricity, contemporary technology requires a massive quantity of electricity to run its many activities. Because electricity is the most precious resource, it is critical that any unused energy be recovered. Walking is the most prevalent human action that transfers energy to the surface in the form of vibrations. Using the piezoelectric effect, this squandered energy may be converted into electrical energy. Piezoelectric footstep power generation has a wide range of applications. Bioenergy from the Sterling plant, solar, as well as wind turbines are among the non-conventional energy sources utilized. When all of these non-conventional energy sources are compare to footstep electrical electricity production through a piezoelectric sensor, however, footstep electrical electricity production is less costly, cheaper, and more reliable [9].

Materials with piezoelectric properties

There are a wide range of natural and man-made materials with piezoelectric characteristics. Natural occur piezoelectric material include berlinite (which is physically comparable to quartz), quartz, topaz, Rochelle salt, cane sugar, tourmaline, as well as bone. Barium titanate as well as lead zirconate titanate is examples of man-made piezoelectric materials. In recent years, there has been a drive to create lead-free piezoelectric materials in response to growing environmental issues about the toxicity of lead-containing gadgets and the European Union's RoHS regulation. This effort to create new lead-free piezoelectric materials has yielded a wide range of innovative and ecologically acceptable piezoelectric materials so far.

Literature Review

Chun Kit Ang explained the growth of a foot-steps power generator in changing kinetic energy into electricity [10]. Kinetic energy is one of the non-conventional energy sources. A significant amount of study was done to see if it was possible to transform kinetic energy into electricity. Nonetheless, the majority of prior studies focused on the selections of appropriate materials as well as the intricate design of power generators. By putting mechanical footsteps power generators on the rearmost foot area, this study proposes a simple and low-cost method to improve the performance and efficiency of kinetic energy to electricity energy conversions. M. Aman explained the Power Generation from Piezoelectric Footstep Technique. The major subject of this article is the generation of electric power from people's footsteps and the pressure applied when walking, which is frittered away. The primary issue of the energy crisis is the demand and supply mismatch. The “Foot step power production system is a system that converts mechanical energy into electrical energy utilizing transducers and the pressure produced by the footstep. The power producing floor generates power, which is essentially the conversion of kinetic energy into electrical energy. Today's electricity demand is rising, and existing power generation sources are unable to meet this worldwide challenge [9].

Sarat Kumar Sahoo discussed about the foot step power generation. Creating electrical energy in this project using a non-traditional way of just stepping on the footprints. At this time, non-conventional energy systems are desperately needed. Steps-based energy generating does not require any fuel input to create power. In this study, we just use a rack and pinion arrangement, as well as an alternator and a chain drive mechanism, to generate power. The mechanism consists of rack as well as pinion, chain drives, alternator, and battery for proper operation in converting Force into electrical energy. We've spoken about how it can be used in a variety of different ways. B. Swetha, et al. discussed in their study on footstep power generation system. In today's world, the need for non-conventional energy has risen in tandem with the rise in power demand. Renewable-energy source, like solar as well as wind, are employed to meet this human need for electricity. However, these sources are insufficient, and energy waste is growing *via* a variety of ways. To solve this problem, we plan to harness the energy generated by human mobility by installing piezoelectric sensors in the flooring, particularly in densely inhabited regions. These sensors detect and transform the pressure of footfall into electrical energy [8]. This will not pollute the environment, and changes in climatic circumstances will have no impact:

- What is the need of footstep energy?
- How the footstep energy will be converted into electrical energy?
- How it will overcome the power demand?

Methodology

Design

This paper study about the generation of electrical power by using foot step power. The foot power of human being which is generally waste power by using this foot step power electricity will be generated. It uses piezoelectric effect which converts mechanical power into electrical power. Basically, it is types of transducers which convert one form of energy into another form. The complete set-up consists of different arrangements as well as electrical and electronics devices. The foot step energy is absorbed by foot step arrangement after that this absorb energy is fed to the Piezoelectric material which convert foot step power into electrical power.

The force of moving cars or the weight of persons walking on them may both exert pressure. The result is in the form of a variable. To convert variable voltage to linear voltage, a bridge rectifier (Full wave converter) circuit is used. This output voltage is filtered out using an AC filter and stored in a rechargeable battery. To convert DC to AC,

an inverter is needed voltage into AC voltage, by using this AC voltage Load is operated. The complete arrangement shown in Figure 2.

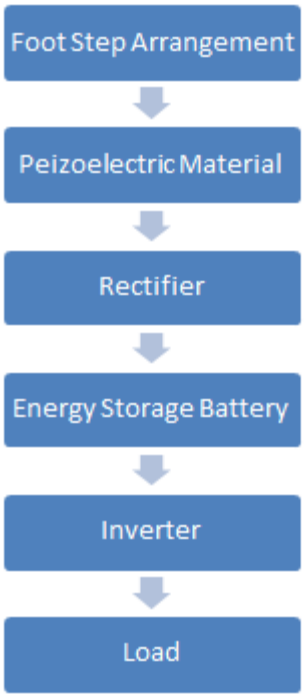

Figure 2: The above Figure shows the complete block diagram of electricity generation using footstep power.

Instrument

In this research paper following components is used to generate electricity by converting footstep energy into electrical energy.

- Piezoelectric Sensor
- Inverter
- Battery
- Rectifier
- Voltage regulator
- Footstep body
- Capacitor

Piezoelectric sensor: Piezoelectric Detector is a device that measure change in the pressure as well as acceleration, temperature, strain, and force by changing them all too electrical energy *via* the piezoelectric effects. It is a powerful tool that may be used to assess a variety of factors. They are utilized in a variety of sectors for quality assurance, process control, and research and development. It's essentially a sensor that transforms kinetic energy to electrical energy. To produce greater electrical power, a number of sensors should be linked in series. Once a piezoelectric materials is stressed T, it generates polarization P, which is a linear function of T: P=dT. The connection between electrical displacement D and electric field strength E for a dielectric material is D=E. The piezoelectric sensors are very durable and have a very high natural frequency. Electromagnetic fields and other radiations have no effect on these phenomena.

Inverter: An inverter is a device which transforms direct current into alternating current. Transformers, switching, as well as control circuit are used. Inverters are frequently used to convert dc electricity from solar panels and batteries into AC power. The inverter is a static device that can transform one kind of electrical power into another. However, since it is unable to produce electrical power, the inverter is classified as a converter rather than a generator. Inverters are divided into three categories:

- Sine-wave inverter.
- Modified sine-wave inverter.
- Inverter with Square-wave.

Battery: A rechargeable battery, also known as a store battery, secondary cell, or accumulator, is an electrical battery that may be charged using an electrical circuit. When there isn't any A.C. electricity, the battery comes in handy. The charge that is produced by the circuit is stored in the battery. The voltage is stored in D.C form.

Rectifier: A rectifier is a device that converts alternating current into direct current. It is made up of one or more diodes and allows a current to travel in just one direction through it. Rectifications are the procedure of turning AC into DC. The rectifier's purpose is to change AC electricity to DC power. Rectifiers are found in virtually all electrical and electronic apparatus's power supply. In this project, bridge rectifier is used to convert A.C power to D.C power. Bridge (rectifier) has good stability and full wave-rectification is shown in Figure 3.

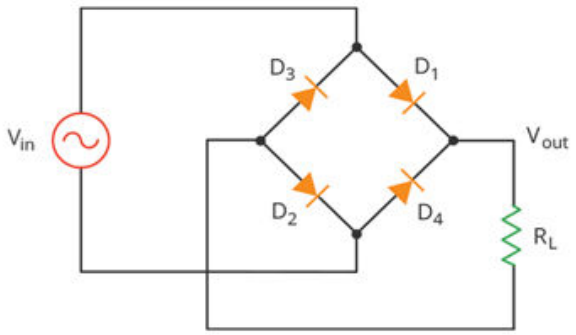

Figure 3: Illustrate the block diagram of full wave rectifier which convert full wave of AC into purely D.C.

Voltage regulator: A Voltage Regulator (VR) is just an electrical or electronic device that generates Irrespective of input voltage or load conditions; it maintains a consistent output voltage. Voltage regulators keep power distribution voltages within a range that other electrical components can handle. Depending on the design, it may control both AC and DC voltages. It protects protective gadgets from harm by acting as a shield.

Capacitor: A capacitors is an electrical energy storing device that runs in an electrostatic field. It's a two-terminal passive electrical component. Capacitors serve an even more essential function as filters, filtering the A.C signal, since the electric energy stored in them keeps the information alive after a brief lack of power. The capacitive filter is used in this project to smooth the D.C output and eliminate ripples from the rectifier's output.

Data collection

The footstep energy generator generates power and this power is store in energy storage device. The out-put of the generators is fed to the battery by using rectifier and energy stored in the battery. Further the storage energy of battery will be converted into A.C by the help of inverter. Load is connected to the inverter, and the complete arrangement shown in Table 1.

No of footsteps	Duration of lighting a 100 w, 230 w bulb (s)	Total energy	Energy/step (j)
250	6	600	2.4
500	12	1200	2.4
750	18	1800	2.4
1000	25	2500	2.4

Table 1: This table illustrate the duration of lighting, the bulbs for number of footsteps and corresponding energy store by energy generator.

Data analysis

A cost analysis is performed as well as compared to solar energy in order to accomplish the goal. The following is a cost analysis arrangement, as shown in Table 2: Furthermore, the piezoelectric electricity generated is compared to solar energy, which is presently developing as an alternative renewable energy source that is also widely marketed.

Parameters	Unit	Value
Overall cost one piezoelectric tile	(Rs)	12,511
Average steps per day	Nos.	7000
Total hits assuming 3 hits per person ina house	Nos.	21,000
Energy per step	Joules	5 J × 4 nos of piezoelectric crystals=20 J
Total energy per day (J)	Joules	420,000 J
Total energy per day (kWh)	kWh	0.11664 kWh
Total energy per year	kWh	42.573 kWh
Durability	Years	15 years

Table 2: This table illustrates the total value of piezoelectric tile as well as output in India.

Discussion

The output of the piezoelectric material under discussion was investigated to see how it relates to the various pressures and strains applied to it. The voltages created across the piezoelectric materials and the quantity of current flowing through them is measured using voltmeters and ammeters, respectively. The energy can be stored in the capacitor by charging it, and the capacitor can then be discharged when needed. This circuit's energy harvesting capacity, on the other hand, isn't particularly impressive. After the bridge rectifier step, a DC-to-DC converter can be used to address this difficulty. The installation of a DC-DC converter resulted in a seven-fold improvement in energy harvesting. A switching device is located in parallel with the piezoelectric element. In a twelve V battery, the DC voltage will be stored. There is only one battery utilized. An inverter converts the twelve V DC batteries into AC electricity. A voltage of about 40 V may be generated by a single piezoelectric tile. Depending on the power needs, the tiles are linked in series or parallel. The conversion of mechanical energy into electrical energy is used to arrange electrical equipment. The electrical system is well-designed to efficiently convert mechanical energy to electrical energy.

Conclusion

One of the renewable energy approaches is the transformation of kinetic energy from human foot steps into the electricity energy. The possibility of producing electricity using a basic rack and pinion system was proven in this study. Furthermore, this study recommended that the mechanical foot-step power generator be placed in the rear foot region to create larger output power with greater efficiency. One of the renewable energy strategies for generating electricity is the change of kinetic energy into electricity energy. The possibility of producing electricity with a basic mechanism was proven in this study.

The Advanced Foot Step Power Generation Using Piezo Sensor has been successfully tested and deployed, and it is the most cost-effective and accessible energy solution available to the general public. This may be utilized for a variety of purposes in rural locations where power is scarce or non-existent. Because India is a developing country

with a large population, energy management is a major problem. It is vital to the places, all tracks where footsteps are used to create non-conventional energy such as electricity, that there is no need for any type of power from the mains. This technology makes advantage of the waste energy generated by humans when walking. Footsteps provide a constant and renewable supply of energy. As a result, it will be concluded that this technique can show to be a reliable method of producing electricity from human footsteps.

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