Smart Shoe Electricity Generation via Piezo-electric Transducers

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Abstract*:* Smart Shoe, also referred to as intelligent wearable footwear, has become increasingly popular. In recent times, the primary concern has been the challenges associated with generating electricity, largely stemming from the excessive use of existing resources. The need for power is growing more and more with each passing day. With the continuous advancements in technology and the utilization of sophisticated methods, wearable devices have been developed to generate electricity. Our research aims to produce renewable energy from the environment without any associated costs or negative impact on the environment. This objective can be accomplished through the utilization of Smart Shoes. The intelligent footwear has the capability to generate electricity, making it a highly effective solution. Our proposed system utilizes piezoelectric transducers to convert the mechanical foot pressure exerted by humans into electrical energy. This energy can then be harnessed to charge various devices that are commonly used in our daily commercial activities, such as smartphones. This type of technology is widely used for fall detections, posture monitoring, foot progression, angle monitoring, human activity recognition and these are all rely on the intellectual ability of shoe. Wearing a 'Smart Shoe' represents a minor advancement towards a more intelligent future.

Keywords:Smartshoe, Exploitation, Sophisticated, Piezoelectrical transducers, Intelligence.

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1. INTRODUCTION

Humans can generate a lot of energy everyday by walking from one place to another place, that generated energy is being getting wasted. If it could made feasible for consumption, it would be a wonderful invention. Sources of energy is broadly categorized into two ways mainly, they are

A. Non-Exhaustible resources
B. Exhaustible resources

A. Non-Exhaustible resources

Non-Exhaustibleresources are those that are limitless and can be replenished naturally from environment. These resources do not pollute the environment by emitting harmful gases, and these are also known as clean energy resources.

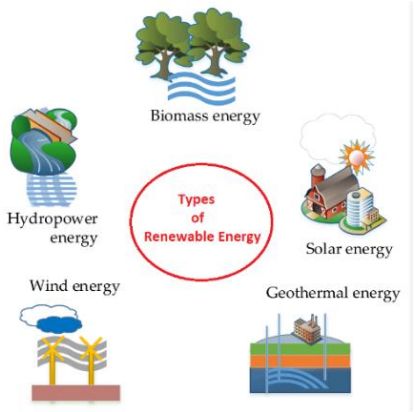

Fig.1.Non-exhaustible resources

Non-exhaustible resources such as sunshine, air, biofuel etc, are the raw resources can be transformed into cleaned energies. These energy resources can be used to generate electricity.

B. Exhaustible resources

Exhaustibleresources are those that are depleted faster than they are replenished. Furthermore, these resources contribute pollution and global warming to the environment.

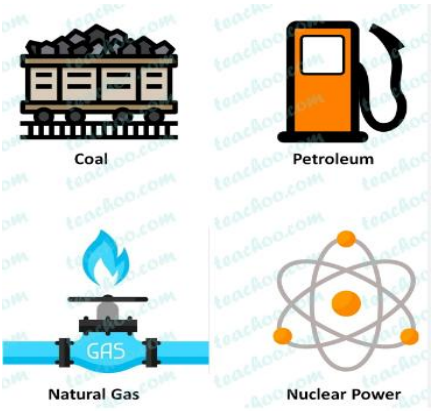

Fig.2.Exhaustible resources

Exhaustibleresources come from limited sourcessuch as nuclear power, coal and oil. At present modern era is witnessing an escalation decline in supplies of exhaustible resources, hence over there exists a requirement to establish strategies for the prudent energy consumption that places a strong emphasis on environment protection. Amongall, the innovative approach to achieve this is by Energy Production. Energy Production is often referred to as energy scavenging, it is a method of preserving little quantities of power which can be lost as heat, luminescence, fluctuation or motion. It utilizes the energy it has consumed to increase productivity and create new technology [1]. The technology behind energy harvesting is to replace small batteries in low-power electronic gadgets. Because, each battery has a limited number of functioning hours, users are unable to prevent the continuing issue of energizing or replacement of batteries. For reducing battery utilization, low power circuits have evolved over long periods of time [2].

Power banks are currently popular and can help with the issue to some extent, but they also require charging and eventually run out of power. Therefore, it is essential to develop a charger that generates electricity from renewable resources or energy from daily motion [3].Numerous studies have been done on various energy harvesting techniques, such as piezoelectric, electromagnetic, and triboelectricsources. Out of all these, piezoelectric material has the advantage using in wearing devices, because they are not impacted by ambient circumstances as they use mechanical energy to produce electricity. In order to discuss various advantages associated with electricity generation based on non-renewable sources of energy review was published using Piezoelectric transducers [4].

As wearable electrical gadgets with minimal power are becoming increasingly prevalent in our daily lives. There is an increase in necessity for the supply powers to various areas inside the person's body, i.e whenever a human applies a pressure on foot heel, our suggested technology transforms it into electrical energy which is used for charging up the devices like mobile phones and even it can be used it for domestic and commercial uses too [5].

2. LITERATURE REVIEW

Power generation techniques comes in a variety of forms. According to historical research and analysis, power generation via shoes has gone through several stages of development. In this part, some of the related research's findings are discussed.

Md. Azhar proposed a mechanism for "Foot step energy generation using Rack and pinion technology". Since the intended system draws its energy from Non-renewable sources, in this research they have employed 500mA power supply, Bridge rectifiers, step down transformer even though it is necessary for generating power. The main flaw in this method is using Rack and Pinion technology, which is cost-effective process [6].

Amitshah, Samir Basak,Joydev Ghosh proposed "Footstep Power Generation for urban area". In this study the authors used magnetic method, Dc and Ac supplies which delivers 95 volts and 50mA power supply to induce an emf into the coils, based on Faradays law of electromagnetic induction, electricity is generated in this approach. This methodology is complex because it uses magnetic technologies, which have a shorter life span, and heavy components, which are of high cost [7].

Ajay yadav, vivekkumar Yadav, Rajat kumarimplemented "Generation of Power via Step". In this research authors stated that the designed equipment is simple and converts energy with pollution free. But the disadvantage involved in this approach is that they have used large materials like D.C Generator, Mild steel, Ball Bearings, shafts for electricity generation which includes high cost [8].

Shiraz Afzal, Farrukh Hafeez designed a technology named "Footstep Power Generation". The purpose of this paper is to generate electricity when people walk on the floor. In this research producing electricity is a challenging process which includes Dc Generator, Gear box shaft, Dc motor (Electronic motor) [9].

From the above all research papers, we state that the above-mentioned findings all are dependent on only one energy i.e Human energy. But each research has certain limitations so to overcome those we suggested a new technology for electricity generation using smart shoe based on piezoelectric transducers.

The article's flow is as follows: In this first section various methodologies for power generation are presented. The second section discusses the suggested method for electricity generation.The Design and working principle for producing electricity via piezoelectric transducers is presented in third section. The fourth section compares performance evaluation to previous methods. The article's conclusion is presented in fifth section.

3. PROPOSED METHODOLOGY

The use of power and its production is one of the issues in today's world. Even though there are numerous Non-exhaustible and Exhaustible resources available today, despite our best efforts to meet our energy demands. The proposed technology introduces power generation by non-conventional energy, which produces electricity without any input. The basic idea behind the system is to convert any unused energy from nearby systems into electrical energy. This type of system can be used whenever people are frequently moving around, such as in homes, schools, and colleges etc.

In this project, by using one of the resources as human population we generate energy by means of running or walking. Whenever a person wears a shoe for walking and apply mechanical pressure on heel it is transformed into electrical energy, here the piezoelectric sensorscontrols the whole operation. Piezo refers to the process by which a material becomes electrically polarized in response to mechanical tension. The produced energy can be saved and it is used for home purposes. Our suggested technology intension is to charge the electronic gadgets like mobile phones [10]. The proposed system block diagram can be shown in below.

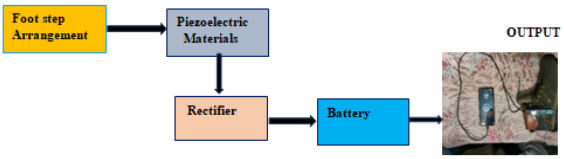

Fig.3. Block diagram of smart shoe arrangement

The block diagram consists of Footstep arrangement, Piezoelectric materials, Bridge rectifier, Battery and Load (Output).

A. COMPONENTS DESCRIPTION

The following are the list of components that we have used for this project, which gives usable form of energy (electrical energy) for domestic purposes.

1. Piezoelectric transducers
2. Diodes
3. Battery
4. USB connector
5. Shoe
6. Mobile phone
7. Connecting wires

1) Piezoelectric transducers

A piezoelectric transducer is an apparatus that transforms mechanical stress or pressure into electrical energy or the other way around. The phenomena of electrical charge creation in some materials as a result of mechanical stress is referred to

as the “Piezoelectric phenomenon”.

Fig.4. Piezoelectric transducer

2) Diodes:

A diode is a two-terminal electrical component that permits one-way current flow. i.e. from anode to cathode. It has been noted that the feature of the diode and the energy harvested are found to be closely related. Low reverse leakage current diodes are preferrable for the high source impedance scenario. Low forward voltage drop diodes are advantageous for low source impedance cases.

Fig.5.Diode

3) Battery

In this proposed system we preferred Li-ion battery, it is a type of rechargeable battery. These batteries are frequently found in portable electronics, electric cars, and non-exhaustible systems due to their energy density. They can be charged multiple times without losing capacity and have a relatively low self-discharge rate. Li-ions migrate from the anode to cathode during charging, and they move in the other direction during discharge.

Fig.6.Battery

4) USB Connector

USB cables are known as universal Serial Bus cables. It's a cable with two connectors at each end. It is a Universal plug. It is used to connect two devices and transfer data and power. It is now extremely popular due to its global compatibility.

Fig.7.USB Connector

5)Connecting wires

A Connecting wire, also known as a jumper cable, and it is a bunch of electrical wires in cord with a terminal at each end.

Fig.8. Connecting wires

4. DESIGN AND WORKING PRINCIPLE OF ELECTRICITY GENERATION VIA PIEZOELECTRIC TRANSDUCERS

4.1) Design process

Step1

The major purpose of producing electricity through shoes is by moving wearers around the places. The circuit is initially made using a Polyvinyl Chloride (PVC) sheet that is cut to the exact measurement and shape of the insole. The sheet's thickness must range from 2 to 5mm. After that, the PVC sheet must be traced around the piezoelectric discs. The below figure represents the insole part of the shoe using PVC sheet.

Fig.9. Trace of piezoelectric disks on PVC sheet

Step2

The following step is to drill holes in the shaded area of the PVC sheet. To cut the holes cleanly, we have used a hand rotary tool.

Fig.10. PVC sheet after grinding holes

Step3

The next procedure involves parallel soldering of all the piezo elements. Solder them in a series manner since this arrangement will needs more current than voltage.

Fig.11. PVC sheet after soldering

Step4

Next step is to build a bridge rectifier on PVC sheet. A piezoelectric element produces alternating current when mechanical force is applied to it (AC). A bridge diode is required to filter and transform alternating electricity into direct current.

Fig.12. Bridge diode on PVC

Step5

Final step is to insert that sole part in the shoe and make all necessary connections, which leads to form the shoe (Smart shoe).

Fig.13.Smart shoe

4.2) Working principle

This proposed system, that we designed works on the principle of Piezoelectric effect.

A. Piezoelectric effect

The capacity of piezoelectric materials to produce an electric field in reaction to mechanical stress exerted is known as the piezoelectric effect.

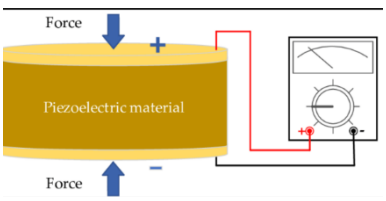

Fig.14. Working principle

C. Circuit diagram:The circuit diagram for smart shoe is shown in below figure.

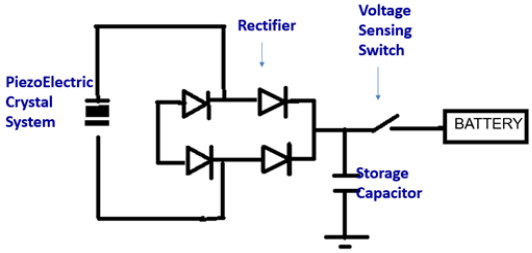

Fig.15.Circuit diagram

When we step on the surface of the floor, by compressing a piezoelectric material that is fixed beneath the floor, our kinetic energy separates the positive and negative charges in an organized way. Our footfall produces vibrations, which acts as input for transducer. The transducer transforms any physical quantity into electrical quantity, hence at the input alternating current is produced. The bridge rectifier used here converts alternating current (AC) into pulsating (DC) direct current, the capacitor is used to remove all AC components if present, and then the dc current is preserved in battery. Later the stored energy or current is used to charge the electronic gadgets like mobile phones by using voltage sensing switch.

5. OBSERVATIONS AND RESULTS

5.1) Observations

The observed values for the person's weight and the related voltage generated are displayed in the below table.

Table1**:** Weight vs Voltage generated

S. No	**Approximation of sensors weight (in kgs)**	**Approximation of generated voltage (in volts)**
1	50	7
2	60	9
3	70	11
4	75	13

In our study, we have examined the person weighing 60 kgs to produce electricity, and 9 volts voltage is generated. The outcome is shown in the graph below.

A) Weight vs Voltage graph:

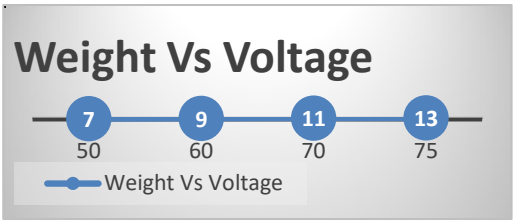

Fig.16. Weight vs Voltage graph

6. RESULTS

Step1: The person is ready to insert a foot in foot insole

Fig.17. Foot insole

Step2:The person applied a mechanical pressure on foot heel. The corresponding voltage is generated via piezoelectric transducers.

Fig.18. Applied Mechanical Pressure

The generated voltage is stored in a battery for further usage (to charge gadgets like smart phones)

Step 3:Finally, the stored energy is used to charge the mobile phone, which is shown below.

Fig.19. Output image.

7. CONCLUSION

The “Smart shoe electricity via Piezoelectrictransducers” project has been successfully planned and built. It is determined that the output results are satisfactory. This concept refers to the discussion of non-renewable energy sources among many available resources. Our proposed system is one of the cheapest methods, which generates electricity by using human footsteps as energy source, and it does not affect environment. Basing on the volume, and traffic patterns each step may create milliwatts of power each day when it is executed. The generated power may be applied to variety of uses (intended to charge smart phones).

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