A Unique Step towards Generation of Electricity by Amputees Persons

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Abstract: sustainable green energy is needed and growing, but the supply of energy is falling short of the demand. Feet steps are one of the quickest activities in human life. Every footstep activity at the crossing space, office, retail center, lecture building, or market area generates enormous amounts of kinetic energy in pressure force terms. These human steps can be used to power some low voltage loads as an alternative energy source that has yet to be fully exploited. Enough voltage is generated to charge a battery or a mobile phone. When these small efforts are added together, they can save enough energy in our society.

In this study, a prosthetic limb shoe with piezoelectric transducers is designed and executed to generate electrical pulses by energy of the amputee footsteps (prosthetic lower limb). Lead Zirconate Titanate piezoelectric transducers were employed in this work. A piezoelectric shoe made up of 6 piezoelectric transducers product about 68.4 V AC output voltage. The average output voltage and power generated is (62.37 V, and 0.0504 watt/10 footsteps) respectively. We conclude that when this piezoelectric generator is placed with several shoes, it may generate more power, allowing us to gather this energy more efficiently. And also, in order for amputees to feel that they are not a burden on society, but rather they are an active part in building this beautiful world.

Keywords: Piezoelectric shoe, prosthetic, output voltage, DC output, AC output.

1. Introduction.

They are attempting to focus on several strategies for converting vibration energy to electric energy in this study, and discuss different forms of power harvesting techniques that will eventually provide us with electrical energy that can be used to power a variety of electronic appliances [1]. In this paper they are representing the methodology of electrical power generation using human footstep. This is about how we can generate electricity using human's waste foot energy and applications for the same [2]. This work describes a low-cost, high-performance generator based on a hybrid technique that converts mechanical vibration into electrical power using polymethyl methalcrylate and electrodeposited foil using Faraday's law of magnetic induction [3]. This paper models, describes, and investigates friction induced vibration (FIV) and its use for energy generation using a two-degree-of-freedom (2-DOF) piezoelectric linked structure [4].

The major goal of this study is to propose a versatile testing platform for characterization and evaluation of piezoelectric devices in terms of energy harvesting. The energy from mechanical vibrations, which are provided by many types of equipment and mechanical structures, is converted to electrical energy via power harvesting methods [5]. The effects of structure-property correlation on fish-skin-based sustainable energy production are examined in this paper. The designed energy harvester functions as a sensor that interacts with human body components to track physiological signals in real time [6].

The design and experimental validation of a beam-roller piezoelectric energy harvester that can scavenge energy from both sway and bi-directional vibrations are described in this work. A piezoelectric cantilever beam, a roller, and a frame make up the beam-roller harvester [7]. This paper focuses on and discusses the generation and storage of electrical energy using piezoelectric materials. This type of material can convert mechanical energy directly into electrical energy, which can then be stored using an energy harvesting technique or circuit. The conversion of energy from ambient vibration is a promising study field currently [8]. Proposing a piezoelectric generator prototype that captures mechanical vibrations energy accessible on a staircase in this context. The embarked piezoelectric transducer, which is an electromechanical converter, generates electricity through mechanical vibrations [9]. The purpose of this review is to introduce and assess the technological advancements. First, the advantages of using piezoelectric energy conversion technology are identified by comparing the three major energy conversion techniques, namely electrostatic, electromagnetic, and piezoelectric technologies, in terms of power generation capability, transmission efficiency, structural installation, and economic costs [10].

2. Materials and method

The piezoelectric is a low-cost and simple-to-use sensor that senses physical heat, pressure, and weight. The piezoelectric is 5 V, 22 mm diameter with a thickness of 0.30 mm as shown in Figure (1). The piezoelectric effect is defined as the conversion of mechanical energy (pressure) into electrical energy (Voltage). Circular piezoelectric transducers were used in this case to measure the deferent of output voltage achieved with respect to changes in various parameters and how these variations may be used to achieve the max-output voltage. When pressure is applied to the piezoelectric, charges separate, resulting in a potential difference, which eventually leads to the generation of electricity. While walking or jogging, piezoelectric can be used to capture energy as shown in figure (2).

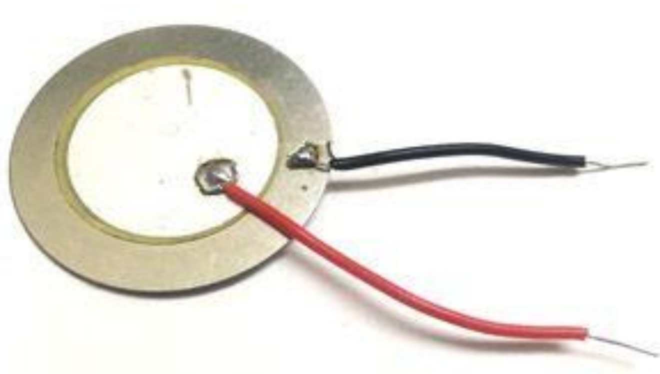

Figure 1. - Piezoelectric transducer

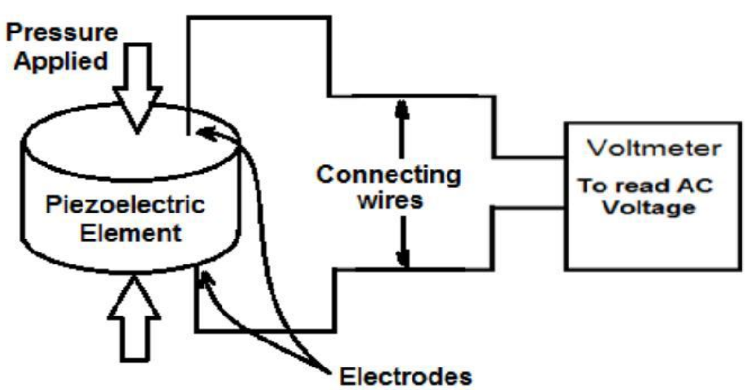

Figure 2. - Electricity generation diagram when the piezoelectric subjected to the pressure.

As illustrated in Figure (3), piezoelectric shoe circuit, the piezoelectric transducers circuit was created. The rubber was used to guarantee that pressure was distributed evenly throughout the shoe. The piezoelectric transducers were linked to grid wires in series connection. A pair of wires is connected to the rectifier circuit at the end of the connection to serve as a storage capacitor.

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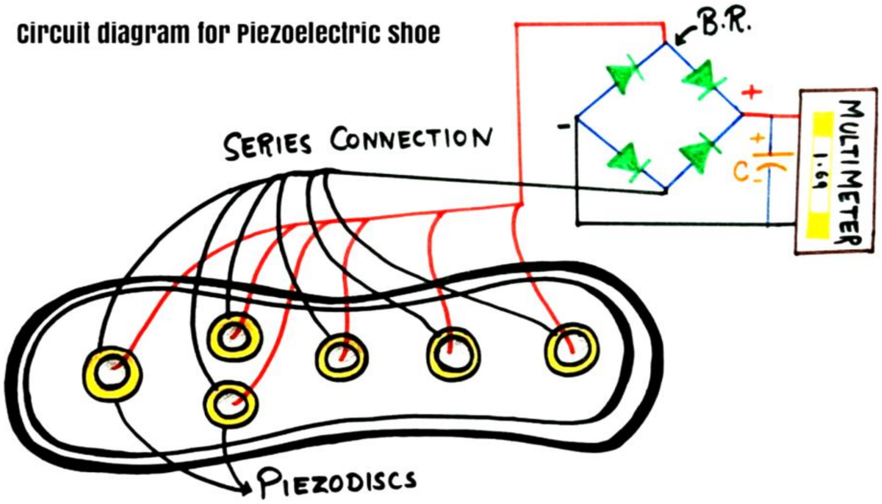

Figure 3. - piezoelectric shoes circuit

Figure 4. - Piezoelectric prosthetic limb shoe model under variations weights.

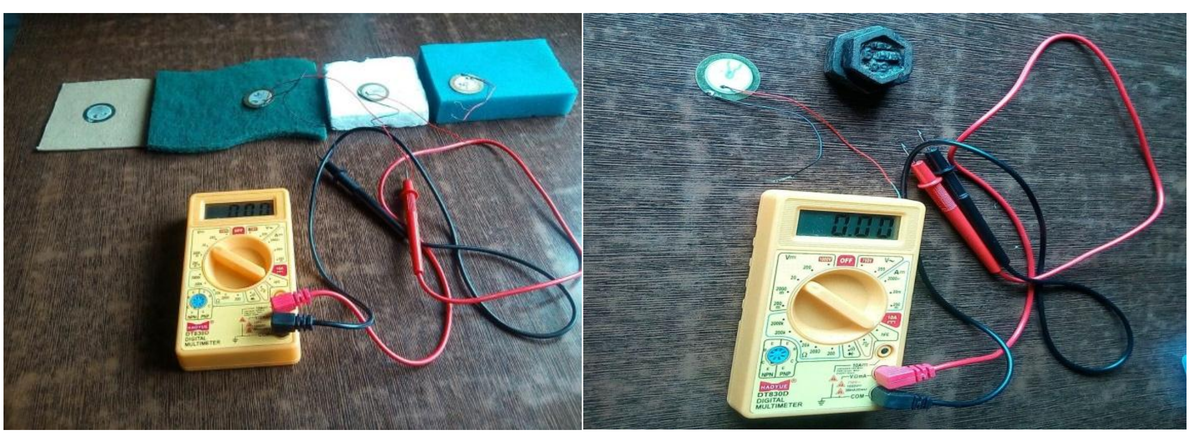

Figure 5. - measuring of piezoelectric voltage with deferent base by using deferent weights.

3. Results and dissection.

The test was performed on a 70 kg transfemoral amputee, walking wearing Piezoelectric prosthetic limb shoe for 30 seconds. Varied maximum pulses come from random different footstepping. The output voltage is the same way, the measurement of piezoelectric shoe model in this work is done by wearing the Piezoelectric prosthetic limb shoe that consisting of 6 pieces of piezoelectric transducer connected with multimeter and walking on the straight floor. The average results of output voltage and power generate for piezoelectric shoe is (62.37 V and 0.0504 watt/10 footsteps) respectively, when amputee walking by piezoelectric prosthetic limb shoe with max-voltage is (68.4 V) as shown in Figure (5).

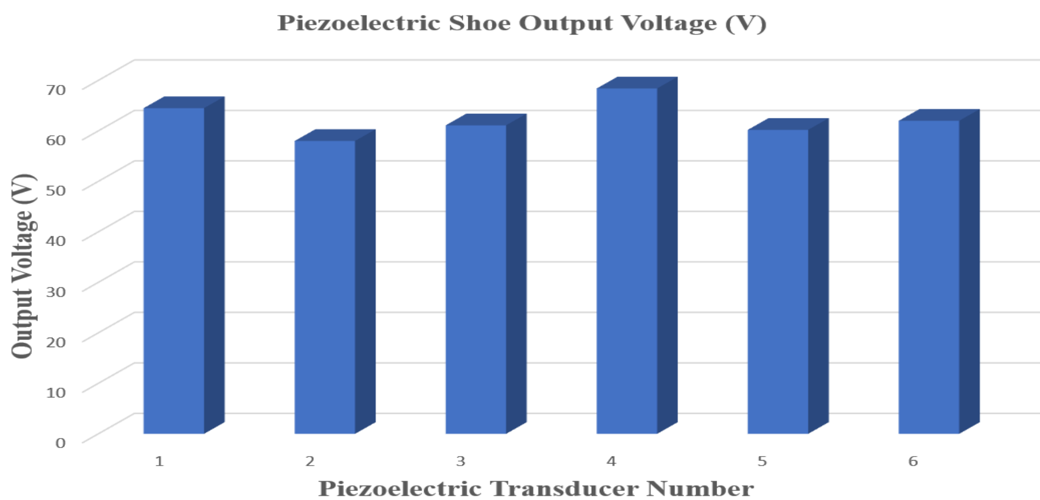

Figure 5. - Output Voltage (V) of 6 pieces piezoelectric transducer mounted under the surface of prosthetic limb shoe.

3.1. pressure applied in case (different weights) curve.

As the amount of pressure applied in case (different weights) increases, so does the output voltage generated, as shown in Figure (6).

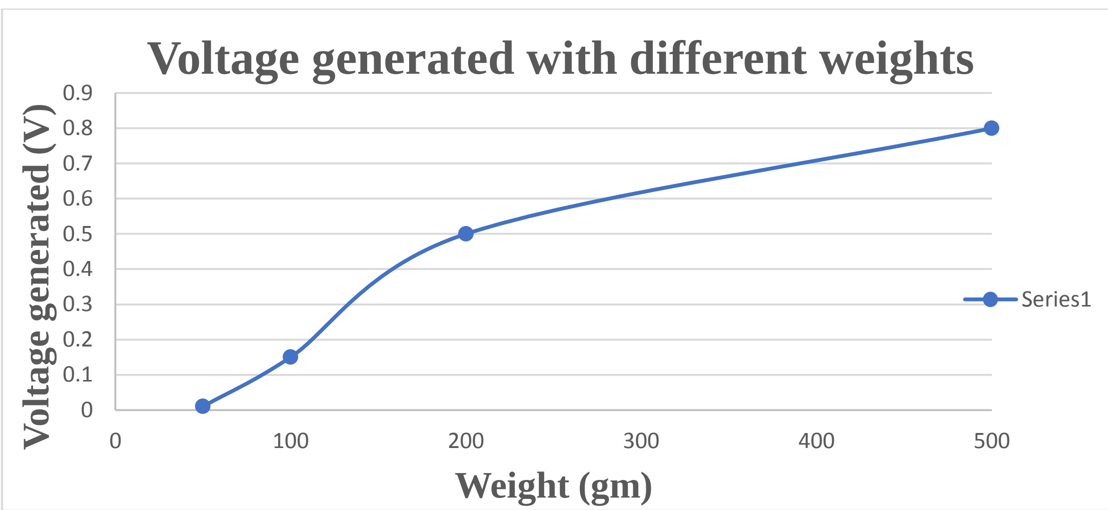

Figure 6: deferent output voltage with deferent weights.

3.2. The output voltage of the piezoelectric with different materials.

The output voltage of the piezoelectric with different materials are increasing as the elasticity and material thickness used as a base increase, as shown in Figure (7).

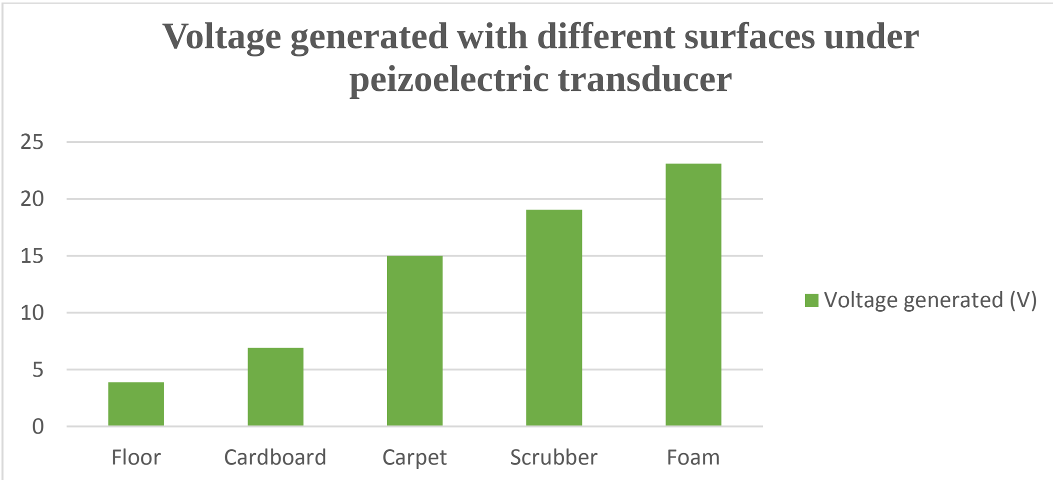

Figure 7. - deferent output voltage with deferent base materials.

3.3. The output voltage foot tapping.

The output voltage increases when foot tapping increased, as shown in figure (8).

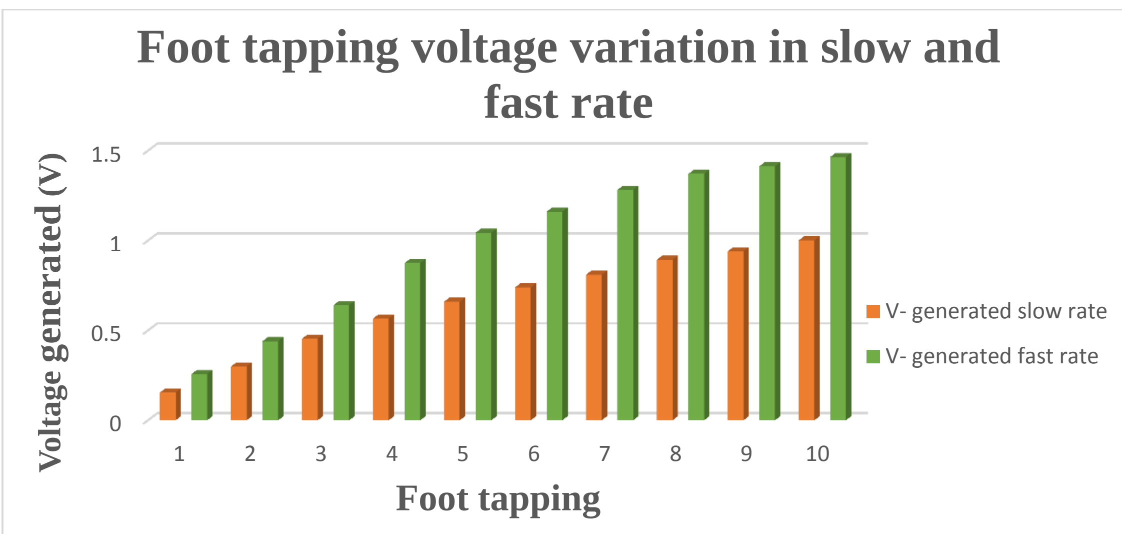

Figure 8. -Variation output voltage for foot tapping rate.

3.4. Output voltage capacitor of the prototype under two cases as shown in figures (9 and 10).

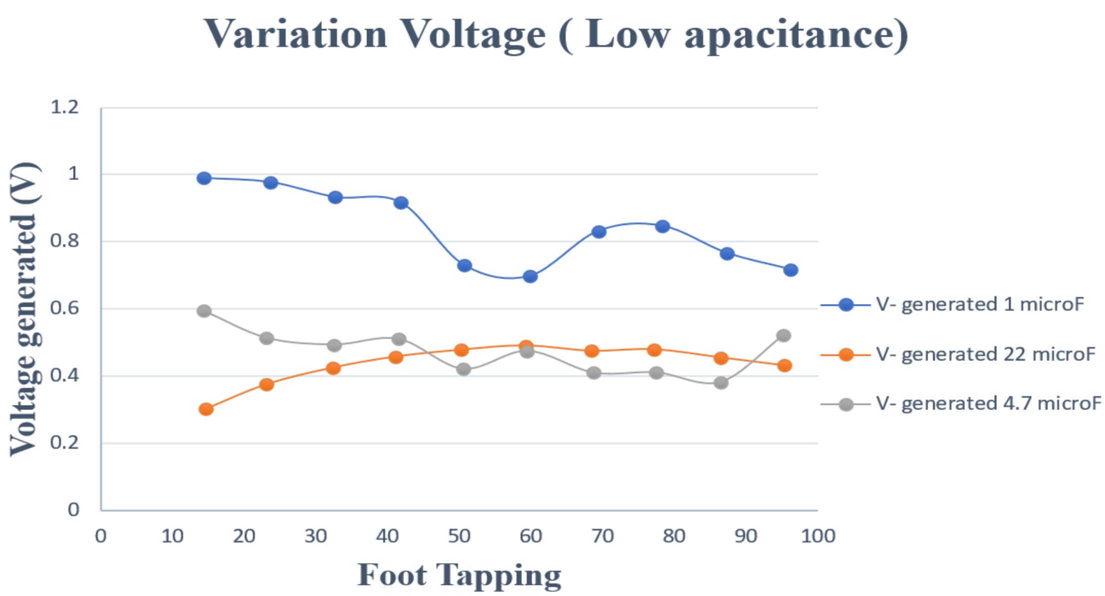

Figure 9. - Variation output voltage with application low capacitance

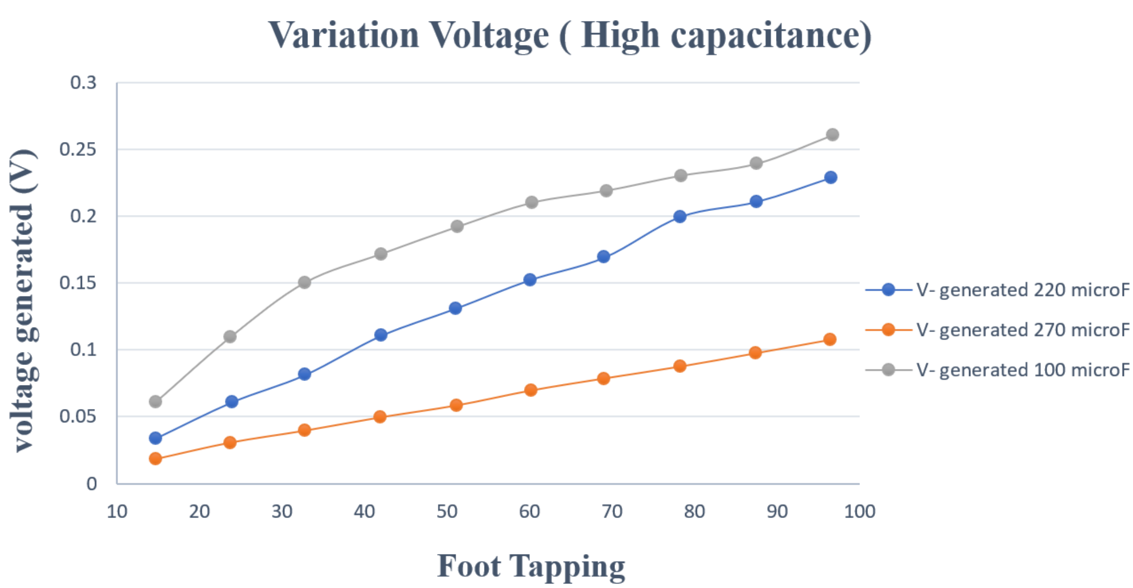

Figure 10. - Variation output voltage with application high capacitance.

Conclusion.

1. We conclude from this research prosthetic those piezoelectric transducers have the potential to be used as a green energy harvester from human footsteps. When human 70 kg weight wearing piezoelectric prosthetic limb shoe and walking, the 7-piece piezoelectric transducers can generate average power 0.0504 watt/10 footsteps, and AC output voltage up to (68.4 V) as shown in Figure (5).

2. The output voltage of the piezoelectric with different materials are increasing as the elasticity and material thickness used as a base increase, as shown in Figure (7).

3. When the number of foot tapping increasing in one location, the output amount generated increases as shown in figure (8).

4. When used the small capacitance capacitor, occur an erratic output is produced, but larger capacitance capacitors produce a far more stable output. As shown in figures (9 and 10).

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