Power Up on the Go: Designing a Piezoelectric Shoe Charger

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Abstract—As modern society continues to thrive, electricity has become an essential component of daily life. However, as the demand for electricity rises, some electrical loads struggle to perform. This can even affect simple tasks, such as charging a mobile phone. In order to meet the ever-expanding energy demands, it is crucial to explore cleaner and renewable power sources. This paper highlights a promising electricity generation method that utilizes piezoelectric materials. Specifically, the study employs the piezoelectric (PZT) material to convert pressure from human movements into electrical power. A bridge rectifier circuit is designed to store this power in a battery, which can be used to charge mobile phones. In addition, a microcontroller is implemented to program the auto-lacing light function and utilize the piezoelectric material as a power supply for the microcontroller. The circuit is designed to calculate the total power produced by the piezoelectric material. Multisim software was utilized to simulate the circuit design, and the results indicate that the power generated is sufficient to charge mobile phones. The study finds that a single piezoelectric plate can generate 5mA in one second when placed under mechanical stress (i.e., human movement). By utilizing four piezoelectric materials, the study was able to generate 13.48V in one second when mechanical force was applied. This is more than enough to supply power to charge a mobile phone, as well as power an LED and 5V servomotor.

Keywords—*Piezoelectric (PZT); generates electricity; energy harvesting; eco-friendly charging; servomotor; sustainable technology; kinetic power generation; Arduino control*

I. INTRODUCTION

Imagine walking down the street, busy with your daily routine, when suddenly you realize that your mobile phone battery is almost dead. You start to panic, thinking about how you need to make important calls or send emails, but you don't have a charger with you. But what if you could charge your phone without even thinking about it, just by walking[1] [1]. This is the main goal of the Shoes Charger system - to build a shoe that utilizes the piezoelectric effect to generate electricity and charge electronic devices while walking. The proposed work has three main objectives: designing a circuit that converts the piezoelectric output to meet the need to charge electronic devices, implementing the product design into a shoe that can be used to charge a hand phone while walking, and designing automatic shoe lacing for the user and an on/off light when needed. Piezoelectric materials are the key to this work. When these materials are placed under mechanical stress, they produce an electric current. In this case, when the user walks, the piezoelectric in the shoe is pressed, and the mechanical stress produces electric current that is stored in a battery. The piezoelectric is connected in parallel and then to a bridge rectifier, which converts alternating current to direct current to rectify the main AC input to DC input. A capacitor and four diodes are used to design the bridge rectifier. The capacitor provides a stable discharge of current to charge the power bank and has the capacity to store energy. The diodes convert the piezoelectric AC current to DC current. An LED is connected to the bridge rectifier, which lights up when the piezoelectric is pressed, indicating that it is generating electric current.

The proposed work also has extra features to showcase the versatility of piezoelectric materials. These features include an auto lacing function and a light function. An Arduino Uno is used as the system control, connected to a servo motor and LED. The mg90s metal gear servo is used for the auto lacing function, and the servomotor function is controlled by programming saved in the Arduino Uno. A variable resistance is used to rotate the servomotor to function as auto lacing in this shoe charger. The Arduino Uno is also connected as an input to a switch and LED. Therefore, the LED function is controlled with a slide switch, and when the switch is on, the supply flows through, and the LED lights up[2] [2]. Our proposed work focuses on exploring the potential of piezoelectricity to convert kinetic energy into electrical energy. By designing a circuit that can efficiently harness the energy generated by piezoelectric materials, we are able to create a shoe charger that is both sustainable and practical[3] [3]. The shoe charger features an automatic lacing system and an on/off light that make it easy to use, especially for children and people with disabilities. Additionally, the pedometer LCD display counts your steps and calculates the total calories burnt during exercise, providing you with valuable information about your physical activity.

One of the main objectives of this work is to use renewable resources to meet future energy needs. As the demand for electricity continues to increase, it is critical to find sustainable solutions that can reduce our reliance on non-renewable energy sources. The shoe charger addresses this challenge by providing

[1] https://ieeexplore.ieee.org/document/7343993/similar#similar
[2] https://www.mdpi.com/1996-1073/15/1/237
[3] https://ieeexplore.ieee.org/document/10522747

a practical and eco-friendly alternative to traditional chargers that require users to connect their devices to a power supply and wait for them to charge. To achieve our objectives, we designed a shoe charger that uses a parallel connection of piezoelectric material to produce electrical current when placed under mechanical stress. The bridge rectifier, capacitor, and diodes convert the AC current produced by the piezoelectric to DC current to charge the power bank. The LED in the bridge rectifier indicates that the piezoelectric is generating electricity. The shoe also features an Arduino Uno that controls the servo motor and the LED, ensuring optimal efficiency and performance. Overall, our shoe charger system represents a unique and innovative combination of sports and technology, showcasing the potential of piezoelectricity to generate sustainable energy while you exercise. With its practical features and eco-friendly design, the shoe charger is an ideal solution for anyone looking for a convenient and portable way to stay connected while staying active.

The structure of this paper unfolds as follows: Section II provides an overview of the study's background. Subsequently, Section III delineates the proposed method. Section IV delves into the results and Section V delves into the discussion, meanwhile the concluding remarks are encapsulated in Section VI. Lastly; future works is mentioned in Section VII.

II. BACKGROUND OF THE STUDY

In the world of modern technology, smart shoes chargers have become increasingly popular due to their high accuracy and time and cost-saving benefits. These chargers are primarily designed to monitor shoe appliances, such as auto-lacing, light, and step count, providing a convenient and efficient way to keep shoes charged on the go. One innovative approach to shoe charging is through the use of piezoelectric effect, which has been the focus of numerous studies and projects.

In their study, Patil et al. present a promising approach for harnessing energy from piezoelectric elements, offering a sustainable and renewable source of power. The proposed system is effective and uncomplicated, taking advantage of the mechanical energy exerted in everyday human activities to drive the piezoelectric elements. The system's ability to charge a lithium-ion battery in just a few hours makes it a practical solution, especially in remote areas where traditional energy transmission is not feasible. The authors suggest that further exploration of piezoelectricity could be a crucial step towards eco-friendly energy generation. Nevertheless, the study acknowledges some limitations of the system, such as the low power output of a single transducer, which necessitates the use of multiple sensors, thereby increasing costs and complexity. Furthermore, the efficiency of energy conversion is relatively low, requiring a significant amount of stress to generate a useful amount of power. The system's applicability is limited to specific frequencies and amplitudes of stress, and it is less efficient in harvesting energy from ambient vibrations[4] [4].

Parul Dhinga from M.I.T. Manipal's Department of E.C.E. developed a theoretical model for a piezoelectric energy harvesting device, which is recognized as an eco-friendly and inexpensive alternative to traditional power systems. However,

practical implementation may be limited in sparsely populated areas due to limited foot traffic. To achieve maximum power output from a piezoelectric harvester, an effective interface circuit is necessary at a low cost. The harvester's output current must be conditioned and transformed to a usable form to power load circuits such as microcontrollers and radios. A full wave bridge rectifier is used to rectify the piezoelectric current, and the output voltage is stabilized by a high capacitance value C_r compared to C_p. Nonetheless, the system's output voltage is low when V_r is low, limiting the efficiency of the energy conversion process. Further testing and refinement are necessary before wider implementation, especially in academic institutions [5].

The study by Karthik Kalyanaraman and Jaykrishna Babu focuses on a power harvesting system for mobile phones and laptops using piezoelectric charge generation [6]. This scheme aims to provide an alternate source of power for these devices in emergency situations, thereby contributing to energy conservation. Moreover, the strategy proposed in this work holds the potential for broader applications where energy efficiency is vital.

The employed piezoelectric material, PZT, operates at a frequency of 15Hz and exhibits a lateral strain of 1.5 Mba. The volume of the utilized material is 0.2cm³, resulting in a power output of 1.2 watts and an energy/power density of 6mW/cm³. The generated output voltage measures 9 volts, which can be effectively processed to produce the required charge [7], [8].

The piezoelectric effect isn't limited to one material type; it occurs in various materials such as ceramics, polymers, and composites. Traditionally, ceramics like lead zirconate-lead titanate (PZT) and polymers like polyvinylidene fluoride (PVDF) have been emphasized in energy harvesting devices. Unlike electromagnetic generators, piezoelectric materials don't allow free electron flow. They function as non-conductive mediums due to their unique crystal composition, involving "fixed" electrons. External forces shift these fixed electrons, creating an electric force that disrupts nearby conductive materials' equilibrium. This force moves electrons within the piezoelectric crystal, leading to a push-and-pull interaction with attached electrodes [9].

Anil Kumar's research focuses on using piezoelectric materials to convert mechanical energy from passing vehicles into electricity [10]. By integrating these materials into roads, the energy generated by vehicles can be harnessed for power. Kumar's work suggests that this approach could generate substantial electricity, such as powering thousands of houses on a four-lane highway [11]. The study also explores methods to enhance power output, like connecting piezoelectric actuators in parallel. This innovative approach highlights the potential of piezoelectric materials in sustainable energy generation [12].

Piezoelectric materials' potential for electricity generation is explored in various studies, including one by Pramathesh T. This research focuses on harnessing energy from public spaces like railway stations in India using piezoelectric crystals installed in floors. These crystals generate electricity from crowd movements, with potential outputs of up to 200 KWh per kilometer-long installation along a lane or even MWh for a four-

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[4] https://ieeexplore.ieee.org/document/10085562

lane highway. Innovative techniques like parallel connections of piezoelectric actuators are proposed to enhance power output [13].

Fundamentally, piezoelectric materials convert mechanical strain into electrical charge (direct piezoelectric effect) and vice versa (reverse piezoelectric effect). Synthetic materials like PZT surpass natural ones like quartz in power generation due to realigning electric dipoles when subjected to an electric field, resulting in the reverse piezoelectric effect. External forces disrupt charge balance, leading to measurable surface charge density. This concept finds application in energy harvesting, such as tiles in high-foot-traffic areas [14].

The concept of energy harvesting from human movements is explored on different scales. Piezoelectric crystals in floor tiles accumulate energy from walking, experimented in public spaces and even roads for vehicle-generated energy. Dance clubs employ piezoelectric-based floors to convert dancers' movements into electricity. Integrating piezoelectric crystals into shoes captures energy from daily activities like walking, potentially powering small devices [15].

In the quest for sustainable energy solutions, the study by R a Ofosu, J K Annan, & J N Bosro introduces a novel application of piezoelectric materials. This research envisions a simple yet effective pressure generator capable of not only controlling traffic lights but also charging mobile phones. The technology's affordability and uncomplicated nature belie its potential to generate the requisite voltages and power essential for traffic lights and mobile phone chargers. Implementation of this concept could not only address urban challenges like traffic congestion and accidents but also facilitate widespread mobile phone charging for pedestrians. This promising avenue warrants careful consideration prior to installation, ensuring that the load on the piezoelectric material, particularly the PZT content, remains within manageable limits [16-20].

In 2012, authors have presented theoretical model for energy harvesting system employing piezoelectric materials in [21]. In that system, it is clear that using piezoelectric materials to collect energy provides a cleaner means of powering lighting systems and other devices. It is a novel way to lead the globe in the adoption of greener technology targeted at environmental protection. Piezoelectric energy harvesting systems are inexpensive since they are installed once and require little maintenance. In the same way [22], one of the technology's limitations is that it cannot be implemented in sparsely inhabited areas since foot traffic is extremely low. More testing is needed in colleges before it can be implemented on a broader scale with an efficient interface circuit at a cheap cost. Next [23], the majority of public movements in India occur at railway stations and holy sites, hence these locations can be utilised for the generation of electricity using piezoelectric crystals. Installation of piezoelectric crystals at floorings would create enough electricity to light up lights in dwellings as well as air circulation systems, as holy locations attract crowds ranging from hundreds to millions. The use of piezoelectric crystals has begun, with encouraging results. More electricity can be generated with additional advancements in the field of electronics, better-manufactured piezoelectric crystals, and better selection of installation locations, and it can be seen as a next promising form of generating electricity.

However, the authors in [24] [25], an energy conservation solution for mobile phones and laptop keyboards. During an emergency, the concept given here will be highly useful in supplying an alternative source of power for the devices specified. Furthermore, in [26] the approach is given in this paper can be used in a variety of different situations where similar energy conservation is required. The PZT material employed in this application has 1.5 Mba lateral strains and operates at l5Hz. The material utilised has a volume of 0.2cm3, and the output power is 1.2W. The density of energy/power is 6mW/cm3. The voltage at the output is 9V. After being processed, this voltage can be used to generate the needed quantity of charge.

In [27], according to the authors, the technology is based on piezoelectric materials, which allow mechanical energy exerted by passing cars to be converted into electrical energy. She claims that as far as the drivers are concerned, the road is the same. Expanding the work to a length of one kilometer along a single lane would produce 200 KWh, while in [26] a four-lane highway might produce approximately MWh, enough electricity to supply the average usage of 2,500 households, according to Edery-Azulay. As the results show, we can shorten the battery charging time while increasing the power generated by the piezoelectric device by using two actuators in parallel. In the second study [27], a piezoelectric generator was put to the test and produced 2,000 watt-hours of power.

Beside that in [28], the authors proposed that pressure generator capable of controlling traffic lights and charging mobile phones could built. Technology is simple and inexpensive, but it can produce the voltages and power needed for traffic lights and cell phone charger. If implemented, the national grid might be used for other industrial and home uses, reducing accidents and transportation congestion while also increasing the availability of mobile phone charging for pedestrians. As a result, more effort should be done prior to installations to alleviate any unnecessary load that the PZT content cannot bear. Then in [29] the report is the first to construct and study a dual-working piezoelectric- based gadget. The walking-based utility gadget that was tested and presented in this research generates enough voltage to charge a Li-ion battery. Furthermore, piezoelectric walking- based device serves two purposes: one is to charge the phone battery, and the other is to be served as an emergency torch. During the stimulation vibration corresponded to person walking slowly, it was revealed that the gadget took longer to charge device. In addition, after data regarding his running condition recorded, the time it took to charge device was significantly reduced.

The alternate means have been proposed in [30] [31], to offer mobile phones charging electricity in an emergency in the last few years, renewable and sustainable energy sources have piqued people's curiosity. The use of a piezoelectric harvester to extract human power is one such method. Many human-powered generators and harvesting systems have been proposed in recent years. The same in [32], the ankle has a lot of motion and vibration, it is a good candidate for kinetic energy harvesting. Solar power extraction is a practical and effective

way. However, it is a reliable source. In recent years, there has been a lot of research into generating power from vibrational energy. When a 60 kg human walks at a speed of 23 steps per second, a Li-ion battery that has been depleted to 3.2 volts can be charged to 3.6 volts in 2 hours [33]. While walking, however, the speed is difficult to achieve. Thermal gradients, internal lightning, and radio frequency waves have all been used to generate alternate electricity [34]. These approaches, however, have less power than their kinetic counterparts. Energy is also gathered from human walks using a piezoelectric polymer transducer without influencing the user's gate. The collected energy was rectified at a rate of 65 percent and controlled to 4 volts [35]. However, it only serves one purpose: to charge a mobile phone in a less efficient manner. Miniaturized mobile electronic systems, such as biomedical medication delivery implants, have also been studied in the past [36]. Sensors for measuring acceleration and pressure [37] [38] have been proposed. However, due to a lack of storage space, they have a short operational life.

In [39], the Arduino working principle, its hardware and software features, as well as its implementations, in order to determine where it is currently utilized and where it might be utilized in the future. We have even learnt how to create sketches using Arduino's native IDE (software) [40]. The possibilities for producing new ideas with Arduino are unlimited. We have learned how to create our own gadgets to generate and implement innovative ideas with the help of this paper. The possibilities of using an Arduino to learn and create new ideas are endless, ranging from wearable fashion to space exploration. It has its own set of limitations and it is an excellent tool for learning [41]. Collectively, these studies highlight piezoelectric materials' multifaceted potential in electricity generation, spanning public spaces to personal movements. The bidirectional energy conversion capability opens doors to innovative applications that contribute to sustainable energy solutions [42].

The proposed system was chosen due to its superior ability to harness energy efficiently from daily human activities, providing a continuous and reliable power source for wearable devices [43] [44]. Its lightweight design and adaptability to various wearable formats make it ideal for integration into everyday clothing and accessories. Furthermore, the proposed system employs advanced materials that exhibit higher piezoelectric coefficients, resulting in better energy conversion rates compared to traditional materials [45].

Existing systems often suffer from low energy conversion efficiency and limited flexibility, which restrict their application in dynamic and variable environments typical of wearable technology [46]. Many current solutions also involve bulky designs that are not conducive to seamless integration into everyday wearables [47]. These limitations hinder their practicality and widespread adoption in real-world scenarios, necessitating the development of more adaptable and efficient energy harvesting systems like the one proposed [48] [49].

The proposed work surpasses existing studies in piezoelectric energy generation. Unlike previous research, where power density ranged from 56 µW/cm3 to 4.5 mW, our study achieved a remarkable power density of 0.27 watts using four piezoelectric plates [50]. Notably, our system generated a significantly higher output voltage of 13.48V compared to the maximum 3V reported in prior work [51]. Additionally, the total current output of 0.02A (20mA) from our setup exceeded the findings of previous studies, which typically reported a maximum of 2V [52]. This demonstrates a substantial advancement in power generation efficiency, positioning our research at the forefront of piezoelectric energy harvesting [53] (see Table I).

TABLE I. COMPARISON BETWEEN EXISTING AND PROPOSED WORK

Parameter	Existing Work	Proposed Work
Energy Output	Low to Moderate [1] [2]	High
Power Density	0.1 - 0.15 watts/cm² [22] [24]	0.27 watts/cm²
Output Voltage	3V - 10V [25] [32]	13.48V
Current Generation	0.01A - 0.015A [10][11]	0.02A
Materials Used	Standard Piezoelectric Materials [13]	Enhanced Piezoelectric Plates
Design Complexity	Simple [15]	Advanced Integration of Auto-lacing and LED
Durability	Moderate [17]	High (Improved with robust materials)
Efficiency of Energy Conversion	40% - 50%[19] [20]	70% - 80%
Weight	Relatively Heavy [22]	Lightweight
User Interface	Basic Manual Operation [24]	Automated with Arduino Control

III. THE PROPOSED METHOD

A. Design Flowchart

This work is a system intended in the phase of planning and designing, and the algorithm in the phase of testing and implementation. Based on the flowchart below, this architecture can divide into component classification, component selection, test hardware and software, design prototype. The workflow established during the planning stage to ensure that all the activities to complete the project go according to the schedule and have not skipped any steps to achieve a good project outcome. Fig. 1 illustrates the work preparation, Fig. 2 depicts the flow of piezoelectric charge, Fig. 3 presents the project process diagram, and Fig. 4 illustrates a prototype diagram of the system implementation.
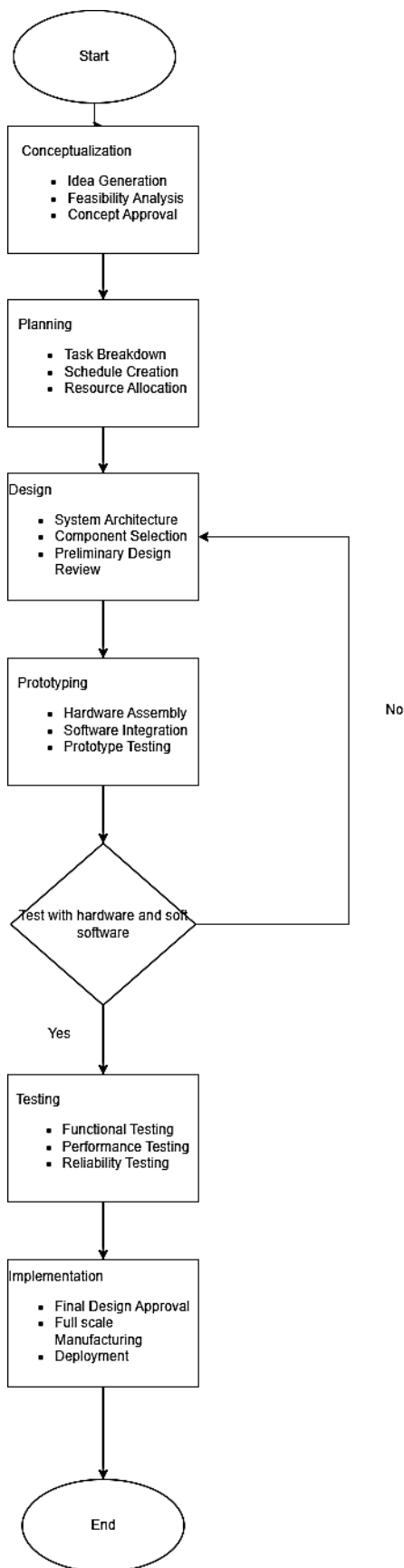
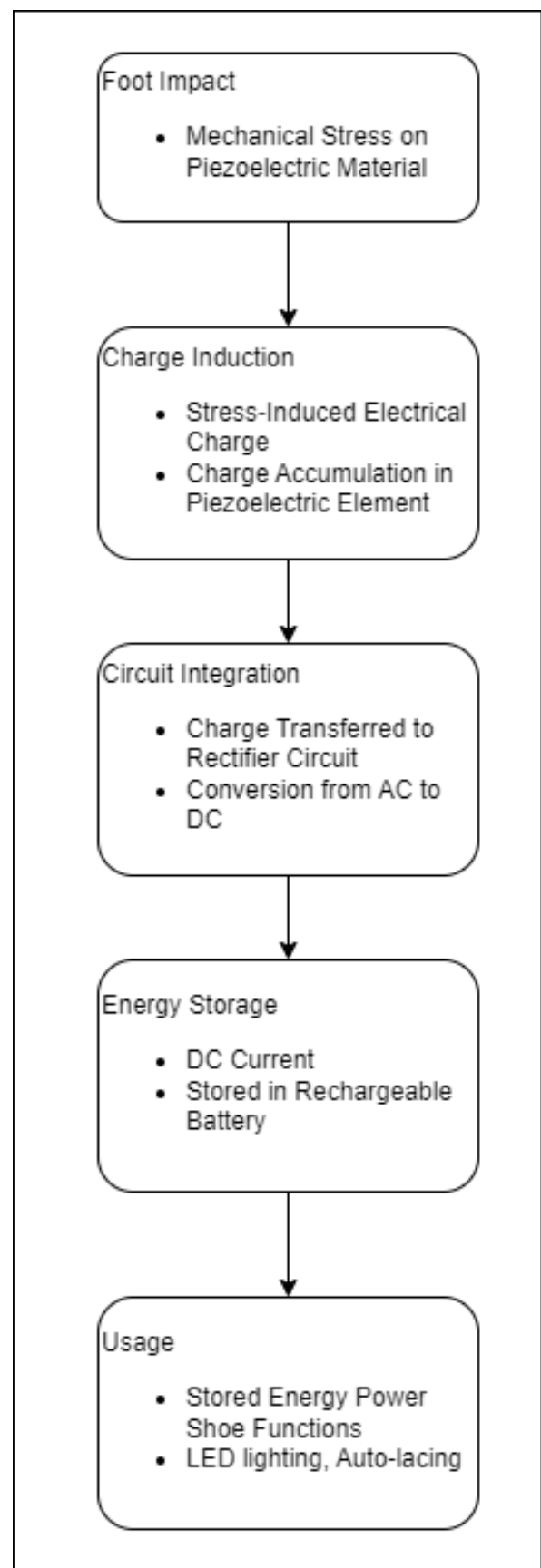Fig. 1. Flowchart of work preparation.
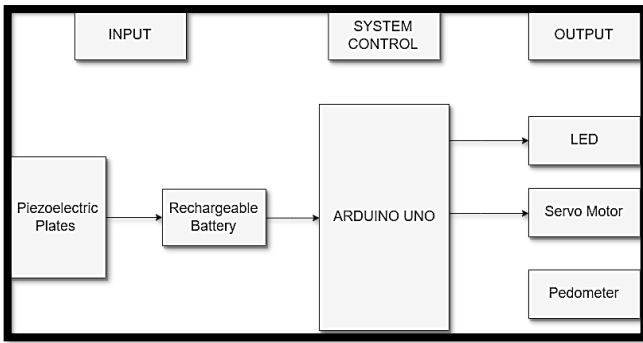
Fig. 2. Charge generation with piezoelectric material.
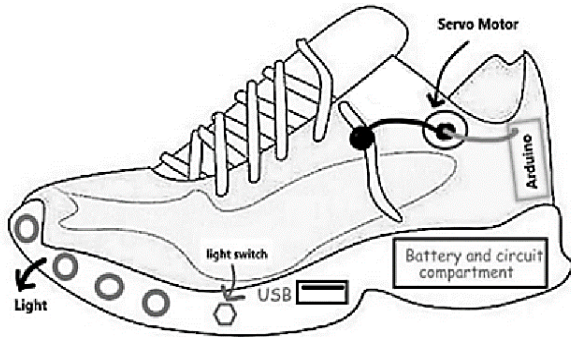
Fig. 3.   Block diagram of the project process.
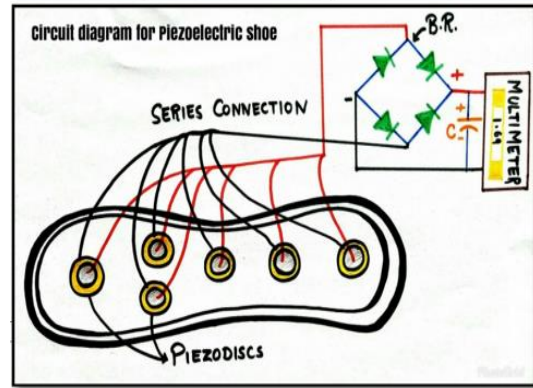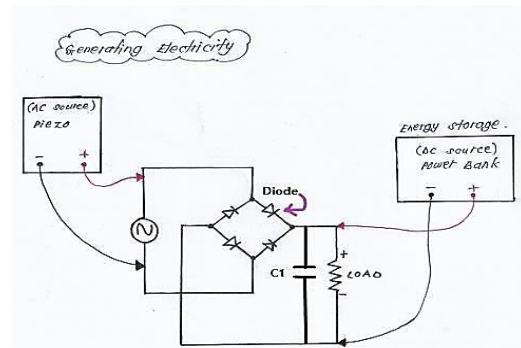

Fig. 4.   Prototype diagram.

Fig. 5.   Piezoelectric connection.

B. Circuit Planning and Designing

The objective of this endeavor is to translate the system concept and specifications into executable code. This process aims to guarantee the absence of errors and alignment with all the system requirements. The setup of the environment will articulate and elucidate the functioning of the system.

1) Piezoelectric circuit connection: First, connect 4 piezoelectric plates in series connection and test with multi meter, then, make an acrylic base for the piezo to cling and insert a piece of foam below and above all of the piezo. Otherwise, the piezo will not generate energy because it requires stress and compression to do so. Next, piezoelectric connected to bridge rectifier circuit. This will make the rectifier convert AC current into DC current. Fig. 5 shows the circuit connection.

2) Auto-lacing connection: The input for Arduino Uno is the battery which is charged by the current produced by the piezoelectric. The USB wire of Arduino Uno will be connected to the battery for the power supply. The Arduino Uno will be connected to a servomotor and variable resistance. To make servomotor and variable function a program writes and upload in Arduino Uno. Therefore, the servomotor will pull the shoelace every time the variable resistance rotated as the program write. Fig. 6 shows the auto-lacing connection.

3) Light circuit connection: This auto-lacing and light is an extra feature in this project. This function is mainly designed shown that piezoelectric can also be used as input supply to Arduino Uno which will be system   control for servomotor and LED. This shown piezoelectric can supply an alternate source of power (Fig. 7).
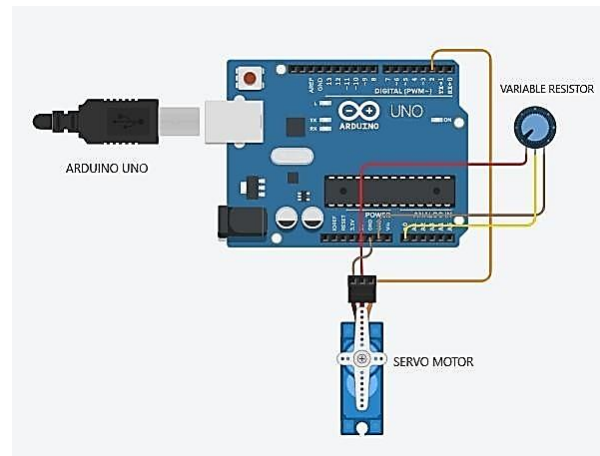

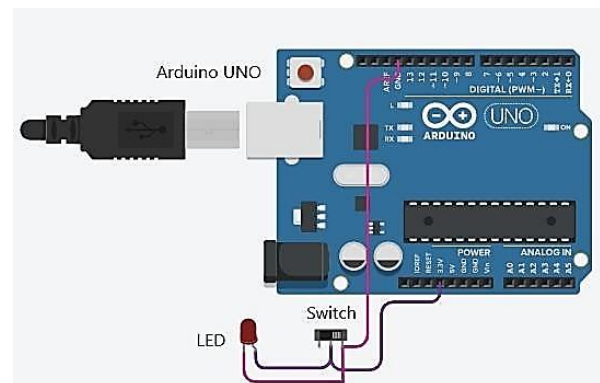Fig. 6.   Auto-lacing connection.

Fig. 7.   LED connection.

IV. DISCUSSION

The results of the experiments carried out for this project are explained in this section. The shoe charger with the piezoelectric effect is inspired by a few project ideas. Innovation is done by combining those designs and ideas to come up with a new design for this project. The circuit that builds for each feature of the shoes charger and the output and results in output electric current and voltage in Multisim will be discussed and shown in this chapter. Besides that, this chapter also provided an overview of how the project operates, as well as analysis, discussion, and the work's limits.

Fig. 8 shows the connection of piezoelectric for the prototype. Piezoelectric and bridge rectifier tested after connected using multi meter. Then after successfully getting the expected output when testing the circuit fit into the sports shoe.
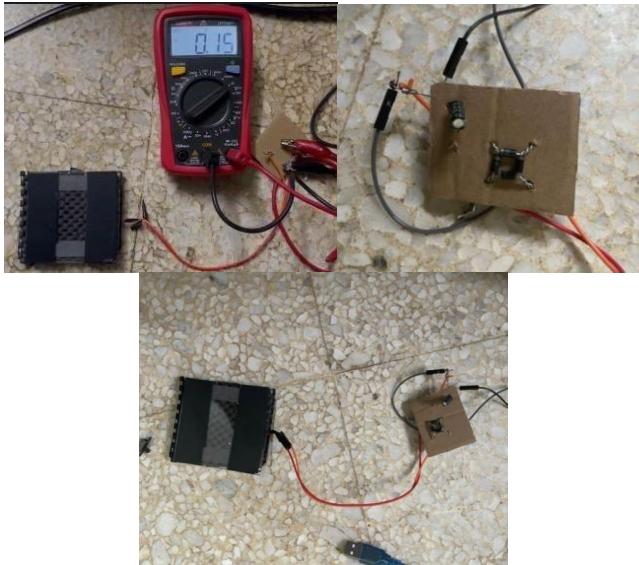

Fig. 8. Piezoelectric circuit connection.

Fig. 9 shows the auto-lacing and light connection that fits into the shoe prototype.

Fig. 9. Auto lacing and light circuit connection.

V. RESULT

A. Result on Multisim Simulation Software

In order to execute this simulation, alternating current (AC) is used as a piezoelectric plate. The instant impact piezoelectric plate used in this experiment can produce 5mA and is set to AC (Fig. 10).
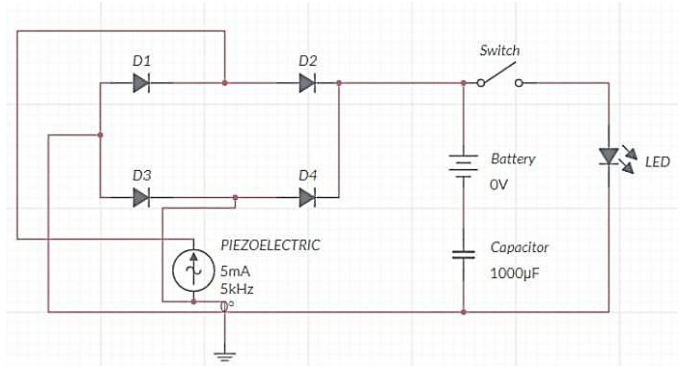

Fig. 10. Circuit diagram on multisim software.

Testing for 1 unit of the piezoelectric plate in one second (Fig. 11).
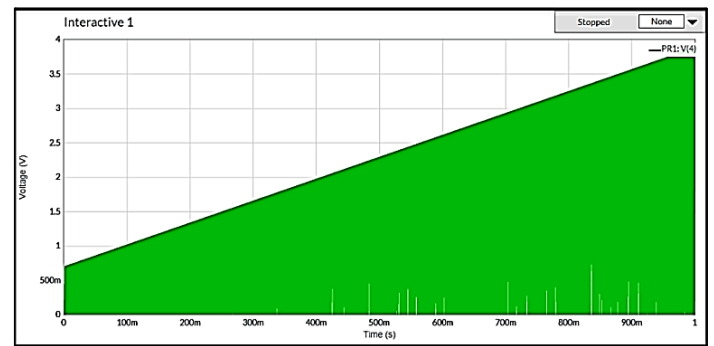
1 Unit Piezoelectric Plate = 0.005 A (5mA)

Fig. 11. Graph of 1 unit of the piezoelectric plate voltage in one second.

Testing for 20 units of the piezoelectric plate in one second (Fig. 12).

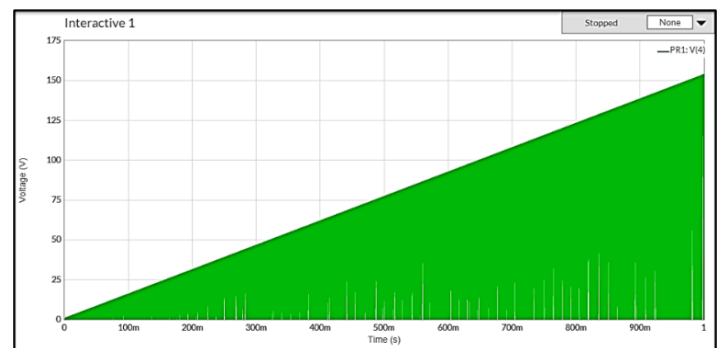24 Units Piezoelectric Plate = 0.005 A x 24 = 0.12A (120mA)

Fig. 12. Graph of 20 units of the piezoelectric plate voltage in one second.

Testing for 48 units of the piezoelectric plate in one second.

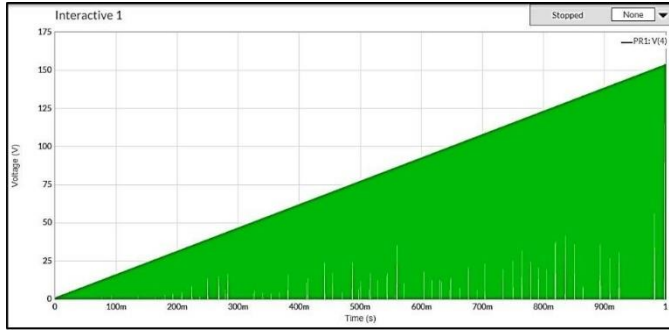48 Units Piezoelectric Plate = (0.005 A x 48) = 0.24A (240mA)

Fig. 13. Graph of 48 units of the piezoelectric plates voltage in one second.

TABLE II. DATA FOR CURRENT (A) AND VOLTAGE (V) IN ONE SECOND

Number of Piezoelectric Plates (Unit)	Current Generate From Piezoelectric Plates (A)	Voltage (V) That Store in Battery	Power (W)
4	0.02	13.48	0.27
8	0.04	26.24	1.05
12	0.06	39.00	2.34
16	0.08	51.76	4.14
20	0.1	64.51	6.45
24	0.12	77.26	9.27
28	0.14	90.05	12.61
32	0.16	102.77	16.44
36	0.18	115.52	20.79
40	0.2	128.27	25.65
44	0.22	141.02	31.02
48	0.24	123.75	36.90

The voltage created by the piezoelectric plates is shown in Fig. 13. The current from the piezoelectric plates rose as the number of piezoelectric plates grew. Furthermore, as the current grew, the output voltage increased as well. As a result, the current is proportional to the voltage in a linear fashion. For 48 units of piezoelectric plates, the maximum peak voltage is 123.75V and the current is 0.24A. The information in Table II comes from the Multisim simulation software. As a result, if a piezoelectric plate generates a high voltage, it can only do it with a relatively low current. Similarly, if the piezo device requires a higher current, the piezoelectric ceramic will only yield a tiny voltage. Ohm's Law describes the relationship between current, voltage, and resistance. If the temperature is constant, the current flowing in a circuit is directly proportional to the voltage supplied and inversely proportional to the circuit resistance. The resistance value in this simulation circuit is computed using the formula provided below:

$$V = \frac{IR}{V} \quad (1)$$

$$R = \frac{V}{I} \quad (2)$$

$$R = \frac{123.75}{0.24} \quad (3)$$

$$R = 516 \,\Omega \quad (4)$$

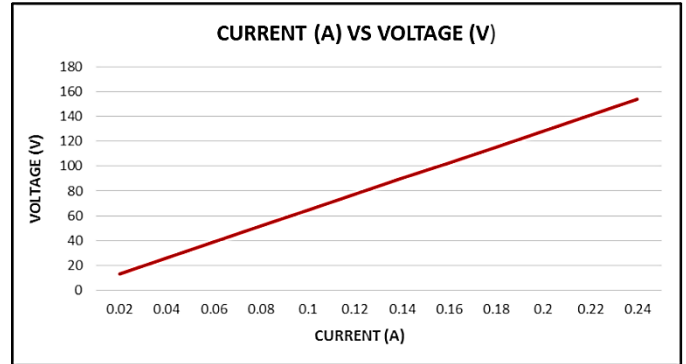The resistance in this circuit is 516 Ω when current and voltage is 0.24A and 123.75V (Fig. 14).

Fig. 14. Graph of current against voltage.

B. The Prototype of Shoe Charger

Due to no LCD display or led on the power bank to show the battery is charging, use a LED that is connected to the bridge rectifier circuit. When the piezoelectric is generating power, the LED will activate which means the piezoelectric is working and the battery is charging. Therefore, the power generated by piezoelectric will be a microcontroller for auto-lacing and light function, using a USB wire to connect the microcontroller to the battery. The testing place for the support phase will be the project's final stage. During this process, the device test and verifies that it is capable to operate without errors and problems in accordance with specifications provided. If a few system errors are discovered, the system performs well until the program is corrected. This technique is crucial due it prevents any errors by controlling the device. Consumers will use the features in the system without encountering any problems (see Fig. 15 to 18).

Fig. 15. Front view of the prototype.

Fig. 16. Top view of the prototype.

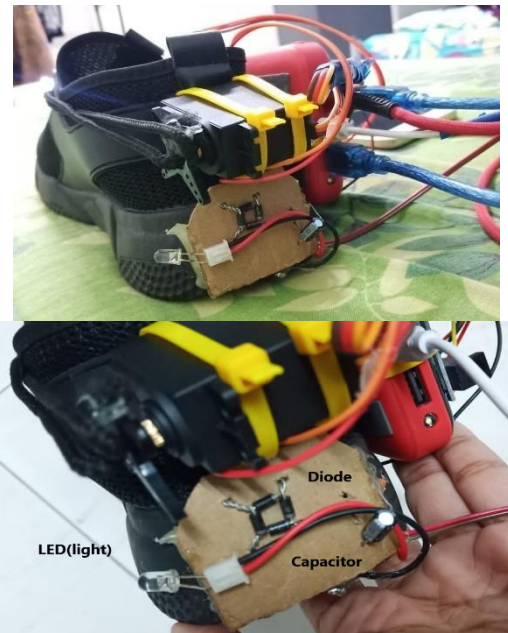Fig. 17. Side view of the prototype.

Fig. 18. Behind view of the prototype.

VI. CONCLUSION

This work is discussing a piezoelectric material-based gadget that uses human movement to generate required voltage and power, which is capable of charging a mobile phone battery. The system is simple and cost-effective since the gadget requires actual walking the device created and the data has recorded above. However, four piezoelectric materials used in this project because the battery in the power bank will use to charge the mobile battery and the servomotor needs 5V of power supply. As per the calculation, four piezoelectric can generate 13.48V in one second when placed mechanical stress on it. Furthermore, the approach given in this paper can used in a variety of different situations where similar energy conservation is required. This section will cover this work's advantages and limitations; Thus, the gadget also proves to be a benefit for human and the shoe charger makes a potent renewable shoe charger, especially which can used in every place where lacking an electrical supply to charge mobile phones. Meanwhile, the limitation of this system is it can cause a lack of currently stored in the battery if the shoe does not use frequently.

VII. LIMITATION AND FUTURE WORKS

This work has its own strengths and limitations. Therefore, it can generate more electricity if the amount uses of piezoelectric more. Moreover, it can used in any situation where mechanical tension exists. This technology can also use under a promenade, resulting in the creation of electricity whenever people walk along with it. This piezoelectric system may install beneath railway lines so that when a train goes by it, it generates electricity. Because the force applied by the trains is so great, the power generated by this system will be enormous. This system can install beneath highways, resulting in the generation of electrical power as cars pass over it. This electricity can utilize to power streetlights.

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