



Faculty of Electrical and Electronic Engineering Technology



**DEVELOPMENT OF AN AUTOMATIC WELCOMING SIGNAGE
USING PIEZOELECTRIC GENERATOR.**

RAPHAEL ANAK MUJAN

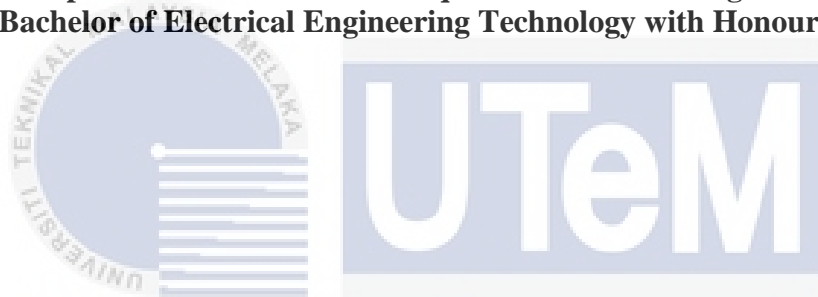
Bachelor of Electrical Engineering Technology with Honours

2021

**DEVELOPMENT OF AN AUTOMATIC WELCOMING SIGNAGE USING
PIEZOELECTRIC GENERATOR.**

RAPHAEL ANAK MUJAN

**A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electrical Engineering Technology with Honours**



Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

DECLARATION

I declare that this project report entitled “Development Of An Automatic Welcoming Signage Using Piezoelectric Generator” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature

:



Student Name

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Raphael Anak Mujan

Date

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11 January 2022

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APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology with Honours.

Signature

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Supervisor Name

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DR. AZHAN BIN AB. RAHMAN

Date

:

11 JANUARY 2022

Signature

:

Co-Supervisor

:

Name (if any)

Date

:

DEDICATION

I dedicate this final year project to my beloved parents for never ending prayers and moral support.

I would also like to dedicate it to my supervisor Dr. Azhan Bin Ab Rahman for the guidance and critical comments throughout the project.



ABSTRACT

Piezoelectric materials are those that can be used to turn environmental vibrations into electrical energy. After that, The stored energy will be used to power other gadgets. Piezoelectric power generation in microscale devices can provide an alternate power source for certain types of sensors or actuators. A piezoelectric generator is a component that converts vibrations energy into electrical energy. A milistructure of bi-morph piezoelectric material will be used in this project. This material will be used to convert vibrations in the environment into electrical energy. On the ground, a piezoelectric generator is used. where it will absord the vibration from people walking or running in order to convert to electrical energy. Human being always produce vibration when on the ground when moving, and then can use piezoelectric to produce electrical energy. This electrical energy then will be used to power electronic components such as LED or any gadgets that required electrical input power. It will transform vibration energy to electrical energy using the piezoelectric concept. In this project, the piezoelectric will convert vibration energy from people walking to an electrical energy and will light up the welcoming signage.

ABSTRAK

Bahan yang boleh digunakan untuk mengubah getaran persekitaran menjadi tenaga elektrik dikenali sebagai piezoelektrik. Selepas itu, tenaga akan disimpan dan digunakan untuk menghidupkan peranti lain. Penjanaan kuasa piezoelektrik dalam peranti skala mikro dapat menyediakan sumber kuasa alternatif untuk jenis sensor atau aktuator tertentu. Penjana piezoelektrik adalah peranti yang mengubah getaran menjadi tenaga elektrik. Mistruktur bahan piezoelektrik bi-morph akan digunakan dalam projek ini. Bahan ini akan digunakan untuk mengubah getaran di persekitaran menjadi tenaga elektrik. Penjana piezoelektrik dilaksanakan di lantai atau tanah, di mana ia akan menyerap getaran dari orang yang berjalan atau berlari untuk menukar menjadi tenaga elektrik. Manusia selalu menghasilkan getaran ketika berada di atas tanah ketika bergerak, dan dengan itu dapat digunakan untuk menghasilkan tenaga elektrik menggunakan piezoelektrik. Tenaga elektrik ini kemudian akan digunakan untuk menggerakkan komponen elektronik seperti LED atau sebarang alat yang memerlukan kuasa input elektrik. Ia akan mengubah tenaga getaran menjadi tenaga elektrik menggunakan konsep piezoelektrik. Dalam projek ini, piezoelektrik akan menukar tenaga getaran dari orang yang berjalan ke tenaga elektrik dan akan menyalakan papan tanda kedatangan.

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My highest appreciation goes to my parents and family members for their love, motivation, and prayer during the period of my final year project.

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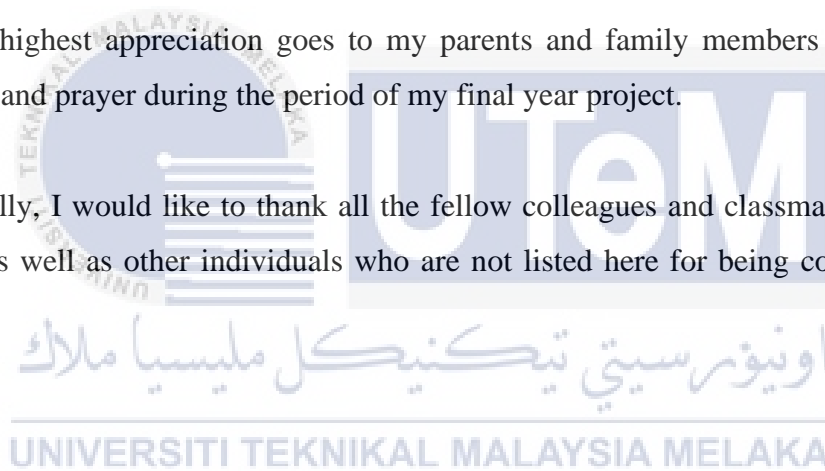


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LIST OF SYMBOLS

V	-	Volt
μ	-	Micro
W	-	Watts
Hz	-	Hertz
mm	-	millimetre
m	-	milli
kWh	-	Kilowatt-hour
s	-	Second
F	-	Farad



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LIST OF ABBREVIATIONS

<i>FTKEE</i>	-	Fakulti Teknologi Kejuruteraan Elektrik dan Elektronik
<i>MOSFET</i>	-	Metal-Oxide-Semiconductor field-effect transistor
<i>LED</i>	-	Light-emitting diode
<i>STM</i>	-	Scanning Tunneling Microscope
<i>AFM</i>	-	Atomic Force Microscope
<i>WWII</i>	-	World War 2
<i>CMOS</i>	-	Complementary Metal-Oxide-Semiconductor
<i>MEMS</i>	-	Microelectronic Mechanical Systems
<i>PEM IEH</i>	-	multimodal hybrid piezo-electromagnetic insole energy harvester
<i>NO₂</i>	-	Nitrogen Dioxide
<i>SnO₂</i>	-	Tin IV Oxide
<i>OWECs</i>	-	Oceanic Wave Energy Converters
<i>PISD</i>	-	Pipeline Inner Spherical Detector
<i>HPS</i>	-	High-pressure sodium
<i>ppb</i>	-	Parts per billion

CHAPTER 1

INTRODUCTION

1.1 Background

In Malaysia, Nonrenewable energy sources such as coal, gases, and fuels are the primary sources of electricity generation (M. S. N. Samsudin, M. M. Rahman, 2016). This source produces a large amount of carbon dioxide, which will raise greenhouse gas concentrations and cause global warming. Furthermore, the declining availability of these fuels and gases had prompted the world to seek out another source of energy. Thus, one of the alternative energies that will ensure 'green' energy is piezoelectricity (Abadi, Darlis and Suraatmadja, 2018).

Energy harvesting is a technique for generating electricity from the energy in the environment for example solar energy, wind energy, energy of the gas, vibration, flows of a liquid and many more (Elahi, Eugeni and Gaudenzi, 2018). Electromagnetism, photovoltaic thermoelectric and the four energy extraction technologies that receive the greatest attention among energy conversion technologies are piezoelectric technologies. Nevertheless, energy generated by numerous items, such as machine vibrations, motion, or any other type of mechanical energy that isn't being captured. Therefore, the source of energy is distributed and as a result wasted. Piezoelectric materials are used to collect wasted energy and convert it to electrical energy as an effective technique to make use of this energy loss. Because the amount of pressure applied is directly proportional to the electrical energy created, piezoelectric materials play a significant role. The practical use of the piezoelectric principle has the potential to make a significant impact by lowering electricity consumption costs. The use of piezoelectric materials to harvest energy from walking or running on specific area to light up a welcoming signage is a topic that truly reflects my curiosity. As the movement of busy area for example in shopping mall or in front of Fakulti Teknologi Kejuruteraan Elektrik dan Elektronik (FTKKEE) entrance, the capacity to gather this energy for the least

amount of money would be a huge step toward cleaner energy creation. and greater efficiency.

Waste vibration energy must be turned into electrical energy using a piezoelectric generator and stored in a capacitor or battery. When the piezoelectric generator fails to create any energy, the capacitor or battery serves as a backup power supply for the charger. Most of this is based on the piezoelectric principle, which is a direct effect that may transform mechanical or vibration energy into electrical energy. Any moving object would be used as the source of vibration. In conjunction with that, walking or running has been chosen as the source of vibration. When utilised correctly, piezoelectrics offer various advantages, including the fact that they produce no harmful emissions and have a high voltage and current. The circuit for this project will be designed to charge a battery and light up welcoming signage. This project prototype is built to protect against harm caused by high vibration such as footsteps, have a high efficiency in absorbing any moving things that is caused by vibrations, and be compact enough to be carried anywhere.

1.2 Problem Statement

More gasoline and gas are burned to create energy in today's fast-paced world. This is because of the growing number of population and more electricity demands around the world. These non-renewable energy sources are rapidly decreasing, and the world needs new energy options. One of the alternate energy sources is piezoelectric. Any type of vibration can be used to generate energy. One of the sources is vibration from us walking or running and the footsteps that can create vibration. This vibration is a type of energy known as motion energy. Rather than just losing this energy, piezoelectric components can be used to harvest it and transform it into electrical energy. Simple electricity has been produced using piezoelectric energy to power microelectronic devices such as metal-oxide-semiconductor field-effect transistor (MOSFET) and power electronics equipment. However, the piezoelectric yet to be used in car or device that requires high voltage. The piezoelectric can only be used for small applications due to the low voltage it produces. This project will investigate the power generated by the piezoelectric effect and create an application that can convert vibrations from walking or running into electrical energy. Piezoelectric energy also needs a lot of piezoelectric devices to generate high energy.

1.3 Project Objective

The following are the project's objectives:

- I. To develop a piezoelectric generator to generate electricity from vibration.
- II. To identify and investigate the voltage and current generated by the piezoelectric effect.
- III. To identify the piezoelectric effect.

1.4 Scope of Project

- I. To study the piezoelectric concept, characteristics, and the effect. In this project, the behaviour of the voltage and current provided by the piezoelectric element will be highlighted.
- II. Design a prototype where vibration from a footstep is sufficient to cause the piezoelectric part to generate voltage and current and light up LED signage.

1.5 Thesis organization

The thesis's outline will detail the construction of an automated welcoming signage system based on a piezoelectric generator. The project introduction, literature review, methodology, results, and discussion, as well as the project conclusion and possible recommendations, are separated into five chapters. The first chapter will introduce the piezoelectric generator, which is currently used for electric storage or generation. It also contains the project's problem statement, objectives, and scope. Then, in chapter two a more detailed research is conducted to write the literature review and background studies. The research methodology section of chapter three explains how the project was created. The results of the experiments are then summarized and addressed in Chapter four to form an analysis. Finally, chapter five brings the overall project to a close. It will summarize the thesis' key points from chapter one to chapter four. After that, a further suggestion is made for the project's improvement in preparation for future study.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A literature review is essentially a high-level overview of the project and its goals. It is also a study of the variations and similarities between different authors' points of view. Books, dissertations, journal publications, and other written content, whether physical or electronic, are used to conduct the research. The analysis provides an overview of the research field and its implementation, as well as its benefits and limitations.

2.2 Background of piezoelectric

The ability of some materials to generate an electric charge when mechanical force is applied in figure 2.1 is known as the Piezoelectric Effect. Piezoelectric comes from the Greek words piezein, which means "to squeeze or press," and piezo, which means "push" (Uchino, 2010). The direct piezoelectric effect (the creation of electricity when stress is applied) is reversible, which means that materials that have the direct piezoelectric effect can also have the reverse piezoelectric effect (the generation of stress when an electric field is applied). When a piezoelectric material is subjected to mechanical stress, the material's positive and negative charge centers shift, producing an external electrical field. When the piezoelectric material is inverted, an external electrical field stretches or compresses it.

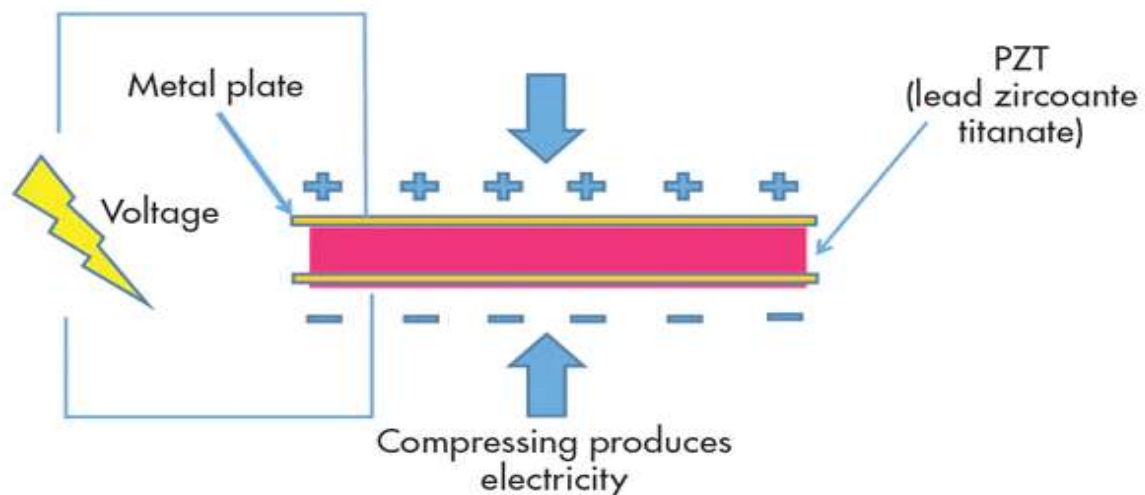


Figure 2.1: Piezoelectric is compressed to produce electricity (Carmen, 2016).

Sound creation and detection, high-voltage generation, electronic frequency generation, microbalances, and ultra-fine focusing of optical assemblies are all applications that benefit from the piezoelectric effect (Manbachi and Cobbold, 2011). It is also the backbone for a variety of atomic-resolution scientific tools like scanning probe microscopes (STM, AFM, etc). The piezoelectric effect is also employed in more daily applications, such as as an ignition source in cigarette lighters.

2.2.1 History of piezoelectric

The brothers Pierre and Jacques Curie were the first to note the direct piezoelectric effect in 1880 (Uchino, 2010). By integrating their knowledge of pyroelectricity with their understanding of crystal structures and behaviour, the Curie brothers demonstrated the first piezoelectric effect using crystals of tourmaline, quartz, topaz, cane sugar, and Rochelle salt. Quartz and Rochelle salt had the highest piezoelectricity potential at the time of their demonstration. Piezoelectricity remained a laboratory fascination over the following few decades, with more study being done to reveal the piezoelectric effect's vast potential. In figure 2.2, the sonar system, which was created in France during World War I by Paul Langevin and his colleagues, was the first practical application for piezoelectric systems. They developed an ultrasonic undersea detector consisting of a transducer and a hydrophone constructed of thin quartz crystal sandwiched between two steel plates (Uchino, 2010).

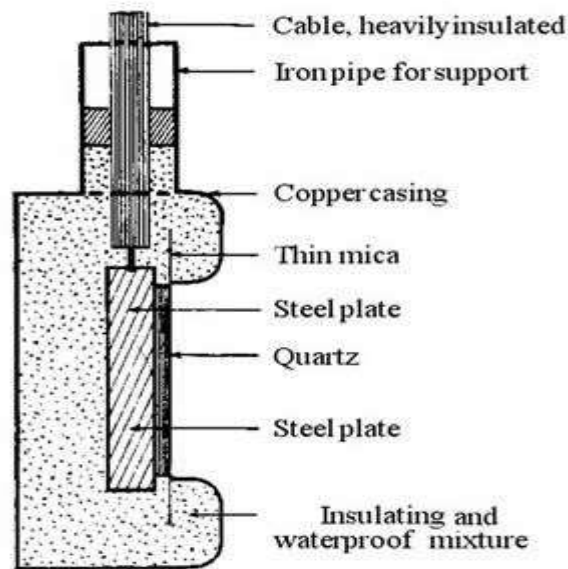


Figure 2.2: Cross sectional view of first ultrasonic detector by Paul Langevin (Cyprien, 2019).

This early use of piezoelectricity in sonar inspired an interest in piezoelectric devices all across the world. For the next few decades, new piezoelectric materials and uses were investigated and established. During WWII, scientists in the United States, Russia, and Japan developed ferroelectrics, a new class of man-made materials with piezoelectric constants several times higher than natural piezoelectric materials. Despite the fact that quartz crystals were the first commercially exploited piezoelectric material and are currently utilised in sonar detecting applications, scientists sought out other materials. Because of this extensive research, two materials with extremely particular characteristics suitable for specific applications were developed: barium titanate and lead zirconate titanate (Uchino, 2010).

2.2.2 Piezoelectric materials

When mechanically deformed, some materials, such as ferroelectrics, exhibit polarisation changes because their crystal structure lacks a centre of symmetry (strain). When mechanical strains are applied to piezoelectric materials, they produce electricity. The type of material used in piezoelectric energy harvesting has a big impact on how well it works. As a result, a wide variety of materials have been investigated for piezoelectric energy harvesting, including inorganic, organic, and composite materials. Many natural and man-made materials show piezoelectric properties in varying degrees. Berlinite (structurally identical to quartz), cane sugar, quartz, Rochelle salt, topaz, tourmaline, and bone are some naturally occurring piezoelectric minerals shown in figure 2.3. (The apatite crystals in dry bone give it some piezoelectric qualities, and the piezoelectric effect is assumed to operate as a biological force sensor). Man-made piezoelectric materials include barium titanate and lead zirconate titanate, as seen in figure 2.4.

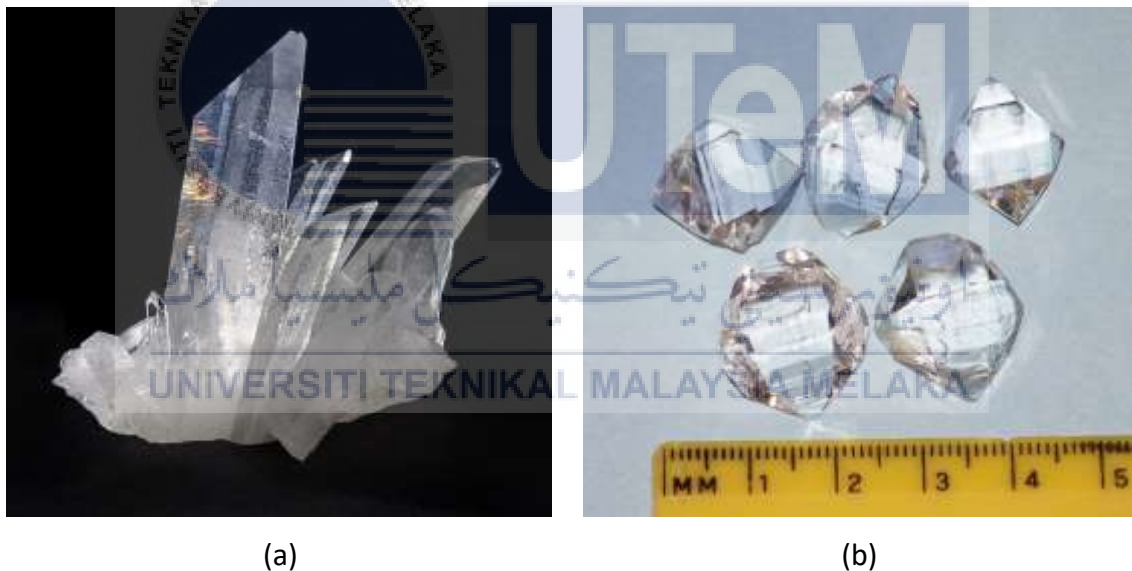


Figure 2.3: Example of natural piezoelectric material: (a) Quartz (JJ Harrison, 2009) and (b) Berlinite (DMGualtieri, 2012)



(a)



(b)

Figure 2.4: Type of man-made piezoelectric material: (a) Barium titanate (Materials scientist, 2009) (b) Lead zirconate titanate (Piceramic, 2021)

2.2.3 Advantages and disadvantages of piezoelectric

The benefits of piezoelectric energy harvesting are numerous (Covaci and Gontean, 2020). It has high energy and power density. It also has simple structure and good scalability. It is easy to suit and mount in high-density electronic devices due to its small dimensions. Then piezoelectric also does not require the use of an external voltage source. When a force is applied to a piezoelectric material, it produces a voltage. External power is not required for piezoelectric materials. Piezoelectric and hybrid materials can be combined to provide a wide range of voltages. Piezoelectric transducers are available in a variety of forms. Most piezoelectric materials can be designed in a variety of shapes and sizes, making them extremely useful in a variety of applications and fields. Energy collecting structures can simply incorporate piezoelectric transducers. Curie temperatures are high in many piezoelectric materials (the temperature at which piezoelectricity is lost in materials).

Considering their many benefits, piezoelectric energy harvesting technologies have a few limitations (Covaci and Gontean, 2020). One of the downside is when compared to other harvesting techniques, such as thermoelectric, the power harvested is modest. Piezo materials create very little electric charges despite being self-creating, demanding the need of a high impedance connection to connect them to an electrical interface. Rectification, maximum power extraction, and output voltage regulation are all requirements for piezoelectric harvesters. Piezoelectric energy harvesters are not necessarily suited for use

with low voltage CMOS processes because of the high voltage they produce and the little current they produce.

2.2.4 Application of piezoelectric

Piezoelectric igniter - This is probably the most well-known and widely used piezoelectric application. A spring-loaded hammer is pushed and released using a button or trigger, which strikes a rod-shaped piezoelectric ceramic in a piezoelectric igniter. The abrupt mechanical shock to the piezoelectric ceramic causes a rapid spike in voltage, which is high enough to jump a huge spark gap and ignite flame. For example, in figure 2.5, the piezoelectric is used to ignite flame on butane lighter (APC, 2015).



Figure 2.5: Using piezoelectric to ignite flame on butane lighter (Ellis, 2017)

Microelectronic Mechanical Systems (MEMS) - As more integrated capabilities are needed in smaller packages, such as mobile phones and tablet computers, MEMS devices have become more popular. MEMS systems have the benefit of being able to incorporate gyroscopes, accelerometers, and inertial measurement devices into chip-sized packages. Piezoelectric actuators and sensors are often used to achieve this feat (APC, 2015).

Tennis racket – In figure 2.6, piezoelectric fibres are integrated a microcontroller in the grip and a microcontroller in the neck of a tennis racket, in an uncommon application for piezoelectricity. When a tennis player hits the ball, the racquet frame absorbs and generates an electric output that is amplified, reversed, and sent back into the fibres. This is a method of causing disruptive interference and dampening structural vibrations (APC, 2015).

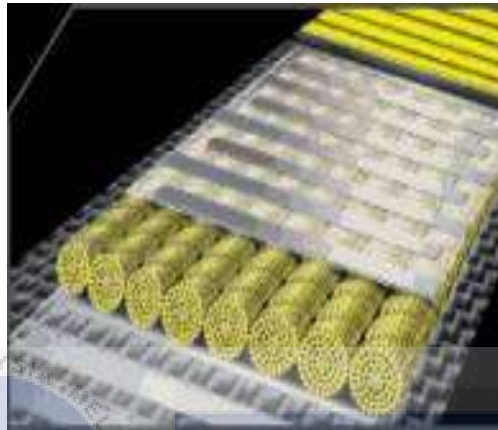


Figure 2.6: Piezoelectric fibre bundles in racket frame (D.ruh, 2021)

2.3 Literature review

Work presented by (Iqbal *et al.*, 2020) show that researchers are increasingly interested in capturing power from ambient environmental sources through embedded systems as a substitute for batteries as wearable microelectronics grow more popular and their size and power requirements drop. As a result, this paper presents that PEM-IEH is a multimodal hybrid piezo-electromagnetic insole energy harvester that recovers biomechanical energy lost in the environment during everyday walking. The hybrid system consists of two piezo-ceramic wafer plates, two magnets, and two wound coils. The engineered harvester has been simulated, built, and tested in the field. As shown in figure 2.7, to harvest biomechanical energy from walking, running, and jogging, the PEM-IEH was installed into the sole of a commercial shoe.

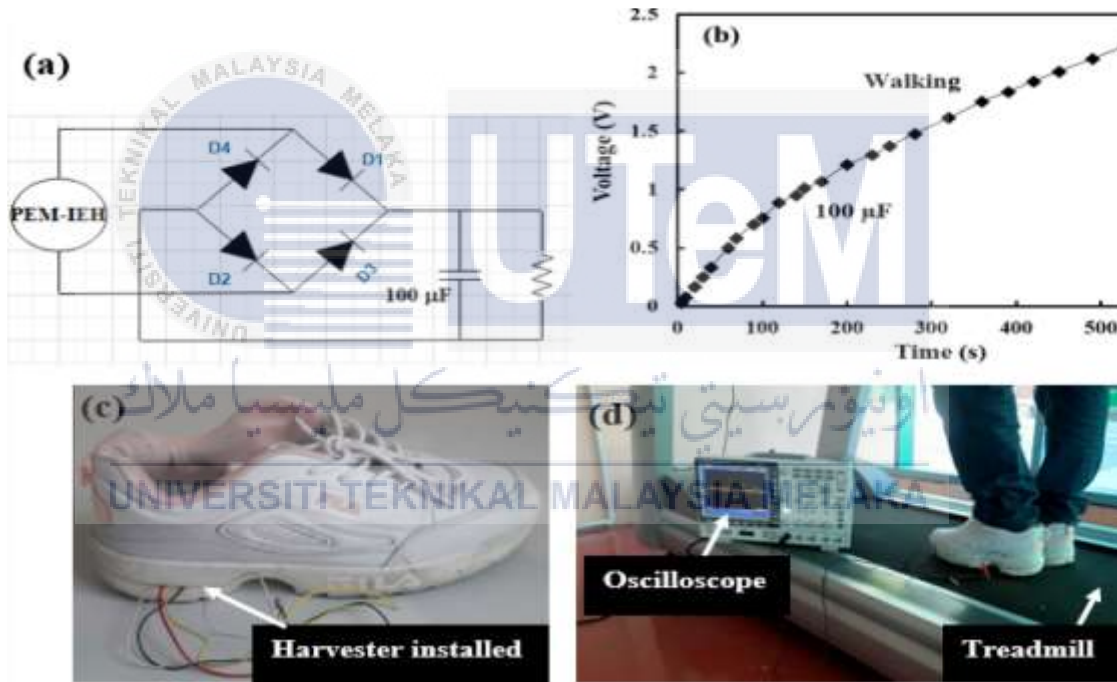


Figure 2.7: PEM-IEH is incorporated into the heel portion of the shoe's sole. (a) A full-bridge diode rectifier is attached to the harvester for DC output storage into the capacitor. (b) Capacitor is charged when walking. (c) Shoe is self-powered (d) Shoes is tested on treadmill.

Same goes for previous work by (Sikka, 2019), this paper proposed a piezoelectric based wireless charger. Therefore, the article can be said to demonstrate the design and implementation of an energy collection scheme that converts energy produced by human movement into a usable form that can charge any battery wirelessly. The configuration of

the unit system is shown in Figure 2.8. The built-in bank in the transmitter-receiver receives the electric signal from the piezo and transmits it to the storage device, where the mobile phone is charged during the movement of the shoe.

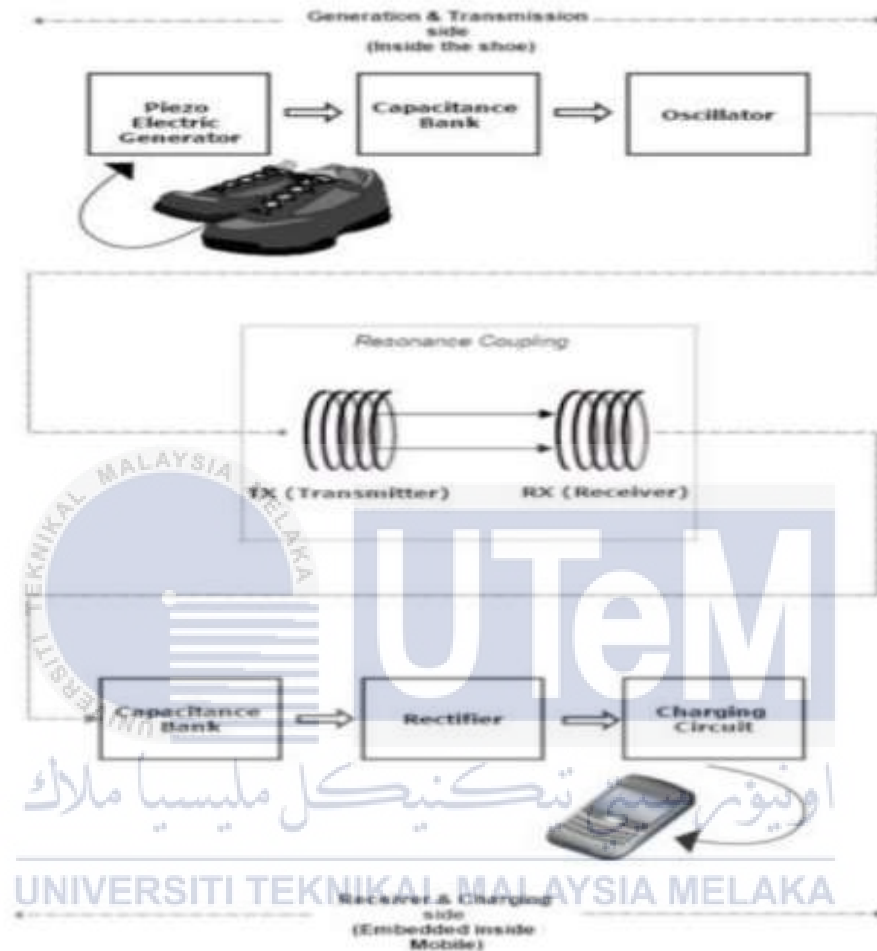


Figure 2.8: Piezoelectric wireless power transfer mobile charging technology block diagram.

Same research of piezoelectric generation from footstep is a work presented by (Elhalwagy, Ghoneem and Elhadidi, 2017). The research examines how take full advantage of piezoelectric energy harvesting floors in interior spaces of buildings, considering the varying weights of various consumption factors and integrating diverse piezoelectric technology capabilities. This research demonstrates how to reconcile and harmonise the tough requirements of use factors with the application possibilities using a proposed strategy to enhance the acceptance of piezoelectric energy harvesting floor implementations.

Based on article by (Xu *et al.*, 2018) titled application of piezoelectric transducer in energy harvesting in pavement. Mechanical energy can be found all over the place in nature, and vehicle-generated road vibration energy is not only harmful to the road surface, it is however difficult to gather. Using the piezoelectric material's electromechanical conversion characteristics, gather vibration energy from vehicles on the road and develop a piezoelectric transducer kit box for traffic lights, signs, and other applications. Experiments with piezoelectric boxes have been performed in pavement, as shown in figure 2.9, to demonstrate the effectiveness of this device. Transmission of a long distance can be cut to save money, and electrical losses can be maximised.



Figure 2.9: The mix piezoelectric box SEM after assembling.

Article by (Nyamayoka, Zhang and Xia, 2018) also a project on piezoelectric generation by vehicle about a development plan of an embedded piezoelectric generator system for street light electrification was conducted on the highway. This research presents a feasibility analysis of creating electric power using piezoelectric materials implanted in a highway's asphalt layer, as seen in figure 2.10. Because of its high traffic volume, the Pumulani Plaza tollgate station on the N1 highway in Pretoria was chosen for this analysis.

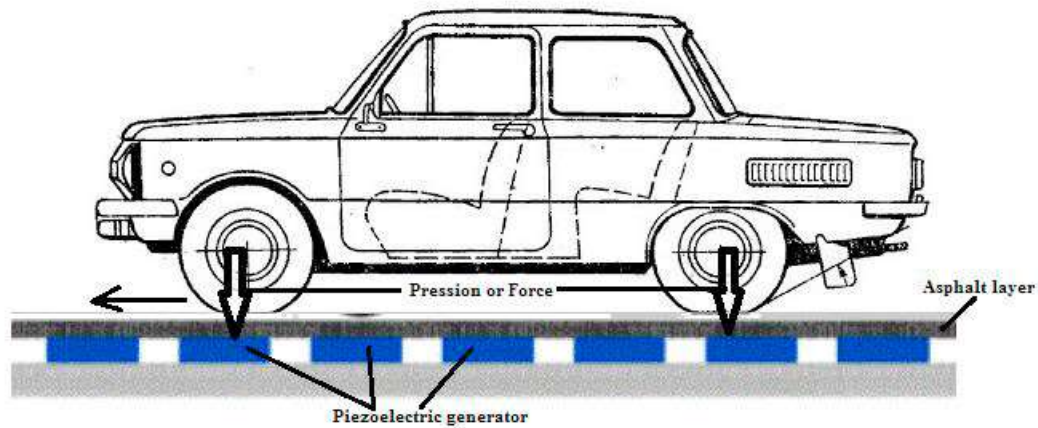


Figure 2.10: Embedded piezoelectric generator

Next is electricity generation through piezoelectric material in automobile by (Bhatt *et al.*, 2017). The primary objective of this research is to utilise piezoelectric materials to produce electricity gathered from the shocks and vibration. In vehicles, shocks and vibration are regulated or the key topics of investigation, as they are balanced by the suspension system. The suspension system is important because any vibrations will impact the suspension, which will ultimately aid in the production of electricity.

Next is research paper about when at the room temperature, ionic-activated semiconducting gas sensors are operated by piezoelectric generators by (Song *et al.*, 2021). As illustrated in figure 2.11, they constructed self-powered gas sensors by combining ionic-activated semiconducting sensors, which are a potential choice for room-temperature functioning, with an oval-shaped piezoelectric generator and a light-emitting diode warning. The self-powered sensor has a low detection limit of 4.32 parts per billion of NO₂ and recovers rapidly and reliably (6 seconds) independent of NO₂ concentration.

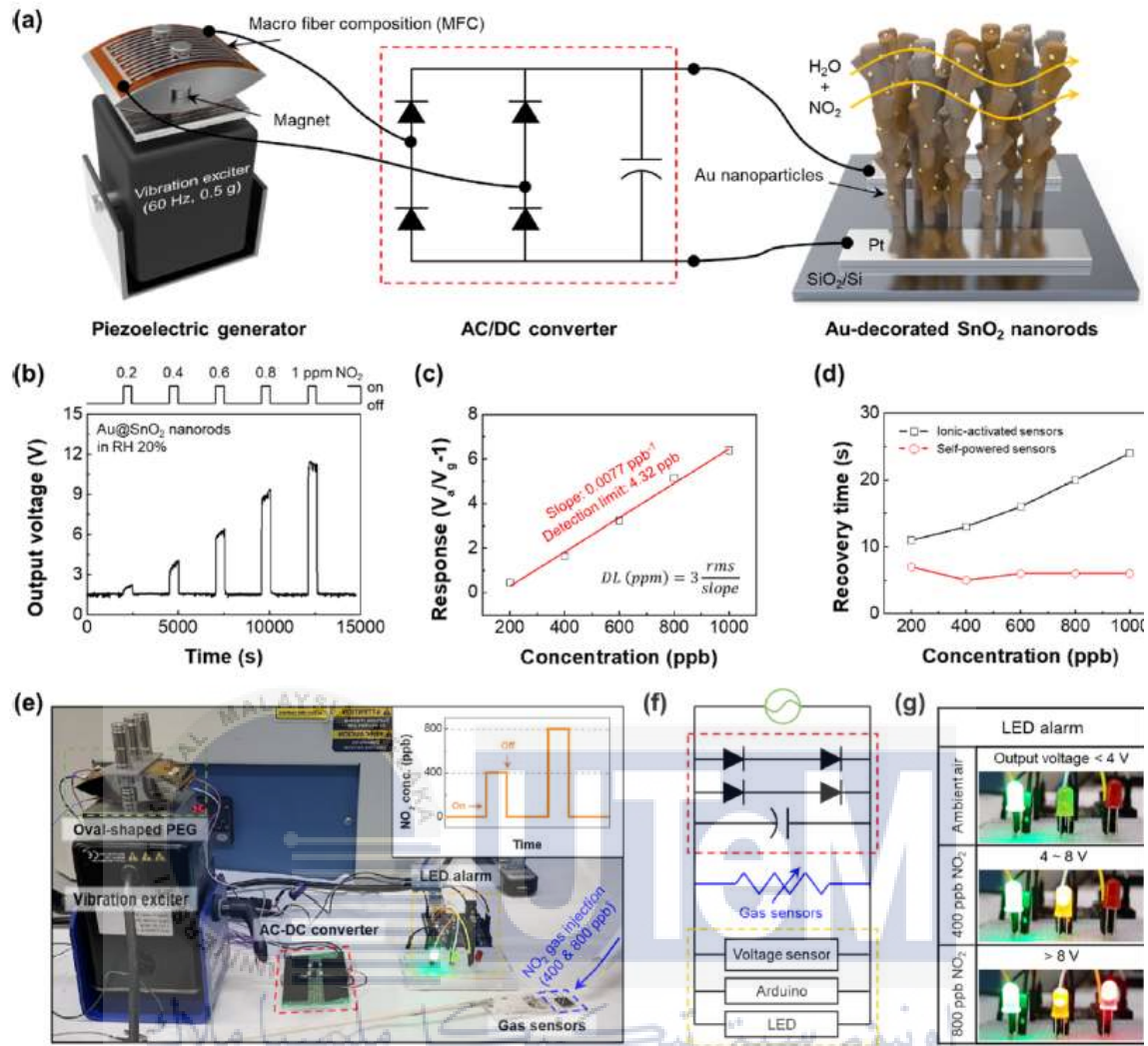


Figure 2.11: (a) Self-powered gas sensors using oval-type PEG and Au-decorated SnO₂ nanorods are shown schematically. (b) Output voltage against time (c) At 25°C, the response to varied NO₂ concentrations is compared to the theoretical detection limit. (d) Ionic-activated and self-powered sensor recovery times as a function of NO₂ concentration. (e) Self-powered gas sensor networks in action. (f) Proposed circuit diagram; (g) LED indicator with various NO₂ concentrations.

Then, (Kiran *et al.*, 2020) work on the advancements in ocean wave energy conversion technologies based on piezoelectric materials because of their excellent conveniences and recently electrical engineers have concentrated their efforts on creating piezoelectric materials-based ocean wave energy conversion devices. Piezoelectric oceanic wave energy converters (OWECs) have many advantages over other types of converters, including their compact size, light weight, lack of the need for an intermediate unit, and lower environmental effect.

After that, based on research paper by (Rui *et al.*, 2019) about an inner spherical detector with piezoelectric energy collecting in a self-powered pipeline. This research suggests a piezoelectric energy harvester design for developing a self-powered PISD that is intelligent as shown in figure 2.12. The harvester transforms mechanical energy into electrical energy by spinning it. There are no auxiliary structures on the harvester, which is made up of a piezoelectric cantilever beam due to internal space constraints and a ban on the use of magnets. The harvester was built in at three different ways, with the longest harvester (100 mm) achieving the best results. After load optimization, at 2.6 Hz, the PISD's rotating frequency, a total of 15.27 W was recorded.



Figure 2.12: Prototype of a self-powered inner spherical detector for pipelines.

Last project is about a new piezoelectric energy harvesting handrail with vibration and force excitations has been designed by (Li, Xu and Tam, 2019). The design, fabrication, and testing of a new form of energy harvesting handrail are presented in this paper as shown in figure 2.13. The handrail energy harvester is remarkable in that it has two modes of operation for gathering vibration and pulling force energy during service. To provide good stability and anti-jamming capacity for the energy harvester, a compound bridge-type compliant force amplifier is employed, and its parameters are adjusted utilising a multi-objective genetic algorithm with finite-element analysis simulation. The usefulness of the derived analytical model is confirmed by experimental findings. Based on the findings, the highest power generation is up to 150 W under vibration excitation and 15 mW under random pulling force data.

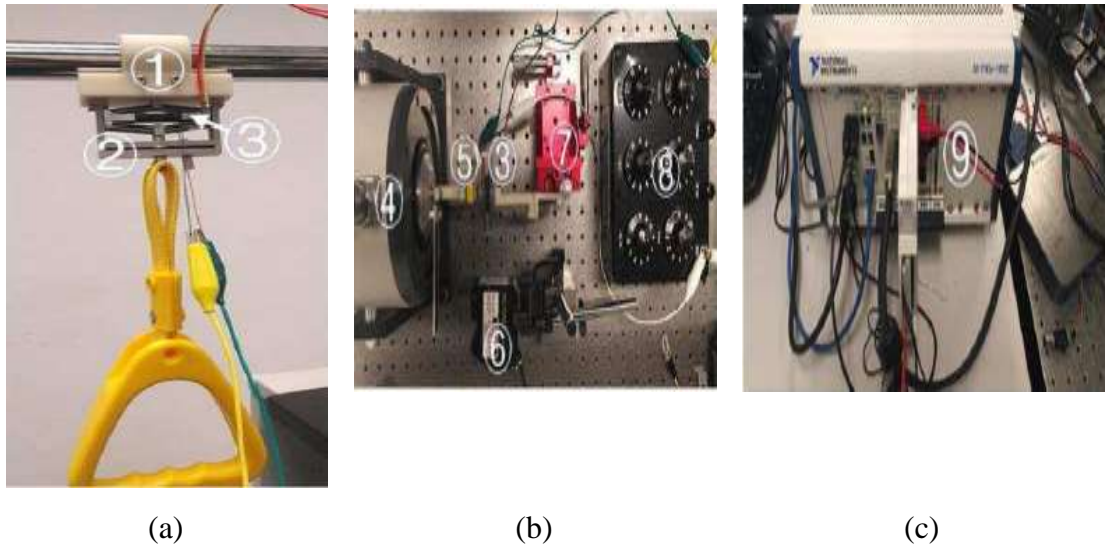


Figure 2.13. The energy harvesting prototype and experimental setup. (a) Prototype of energy harvester with 1: clip, 2: protection frame, 3: compound bridge-type force amplifier; (b) and (c) experimental setup with 4: shaker, 5: force sensor, 6: laser displacement sensor, 7: triaxial displacement platform, 8: resistance box, and 9: data acquisition device.

2.3.1 Summary of literature review

No	Author	Title	Year	Remarks
1	Muhammad Iqbal, Farid Ullah Khan, Murtuza Mehdi, Quentin Cheok, Emeroylariffion Abas, Malik Muhammad Nauman	Power harvesting footwear based on piezo-electromagnetic hybrid generator for sustainable wearable microelectronics	2020	<ul style="list-style-type: none"> Through dual transduction, a hybrid piezo-electromagnetic insole energy harvester transfers biomechanical energy from walking, running, and jogging into usable electrical energy. Vibration-intense operation for a lengthy period of time, a vibrating cantilever or spring in electromagnetic energy harvesters may limit the harvester's life owing to mechanical strain. For long-term wearable microelectronic device operation, improving conversion efficiency with a superior power conditioning circuit and a rectifier with the lowest drop-down voltage.

2	Lumbumba Taty-Etienne Nyamayoka, Lijun Zhang, Xiaohua Xia	Feasibility study of embedded piezoelectric generator system on a highway for streetlights electrification	2018	<ul style="list-style-type: none"> Vehicle movement is an appealing strategy for capturing wasted energy generated on highways and converting it into renewable, sustainable electrical energy that can be used to power streetlights. The inbuilt piezoelectric generator produced 1.576587613 kWh per day, which is enough to power 6 250 W high-pressure sodium (HPS) streetlights.
3	Young Geun Song , Inki Jung, Joonchul Shin, Young-Seok Shim, Gwang Su Kim, Byeong-Kwon Ju, Chong-Yun Kang	Ionic-activated semiconducting gas sensors operated by piezoelectric generators at room temperature	2021	<ul style="list-style-type: none"> A self-powered gas sensor with no reliance on a battery or external power source was greatly sought to efficiently reduce power consumption and applicable for practical applications. The self-powered sensor has a low detection limit of 4.32 parts per billion of NO₂ and recovers rapidly and reliably (6

				seconds) independent of NO ₂ concentration.
4	Rishi Sikka	Piezoelectric based wireless charger	2019	<ul style="list-style-type: none"> • Converting energy produced by human activity into a usable form that can be used to wirelessly charge any battery. • A wireless piezoelectric-based mobile charger is intended to charge a mobile phone's battery without the use of an external power supply.
5	Arpit Bhatt, Chirag Nagar, Vihan Bhaysar, Yash Shah	Electricity generation through piezoelectric material in automobile	2017	<ul style="list-style-type: none"> • Produce power from automobiles, which is also environmentally friendly. • Since the amount of charge generated is so small, a charge amplifier is needed to generate an output voltage large enough to be calculated.
6	Adnan Mohamed Elhalwagy, Mahmoud Yousef M. Ghoneem,	Feasibility study for using piezoelectric energy harvesting floor in buildings interior spaces.	2017	<ul style="list-style-type: none"> • Get the most out of piezoelectric energy harvesting floors in building interiors, based on the varying weights of each usage component and the

	Mohamed Elhadidi			<p>integration of multiple piezoelectric technological capabilities.</p> <ul style="list-style-type: none"> • An aid for architects and interior designers in incorporating this technology into their designs as part of the required low energy usage in buildings.
7	Xiaochen Xu, Dongwei Cao, Hailu Yang, Ming He	Application of piezoelectric transducer in energy harvesting in pavement	2017	<ul style="list-style-type: none"> • For traffic signals, signage, and other purposes, construct a piezoelectric transducer package box. • Because the efficiency of a piezoelectric box for energy collecting is insufficient for large-scale energy demand, it may be more practicable to use it to traffic infrastructure such as traffic markers and warnings for cars travelling in the opposite direction. Its benefits include the lack of a need for long-distance power and the ability for traffic

				<p>facilities to self-power, It can also change its working time based on the number of vehicles on the lane, achieving the energy-saving goal.</p>
8	<p>Mahbubur Rahman Kiran, Omar Farrok, MD. Abdullah-Al-Mamun, MD. Rabiul Islam, Wei Xu</p>	<p>Progress in piezoelectric material based oceanic wave energy conversion technology</p>	2020	<ul style="list-style-type: none"> • Piezoelectric oceanic wave energy converters (OWECs) have many advantages over other types of converters, including their compact size, light weight, lack of the need for an intermediate unit, and lower environmental effect. • Several important mathematical models are applied. and evaluated to construct highly efficient oceanic energy harvesters using piezoelectric devices.
9	<p>Xiaobo Rui, Zhoumo Zeng, (member, ieee), Yu Zhang, Yibo Li,</p>	<p>An intelligent self-powered Pipeline Inner Spherical Detector with piezoelectric energy harvesting</p>	2019	<ul style="list-style-type: none"> • Development of an intelligent self-powered Pipeline Inner Spherical Detector using a piezoelectric energy harvester (PISD).

	Xinjing Huang, Yue Liu, and Tianshu Xu			<ul style="list-style-type: none"> The experiment's rotation is not very stable, but the output voltage is equal to that in the lab, with sinusoidal features and a relatively stable frequency.
10	Zhenjing Li, Qingsong Xu, (Senior Member,IEEE), Lap Mou Tam	Design of a new piezoelectric energy harvesting handrail with vibration and force excitations	2019	<ul style="list-style-type: none"> The handrail energy harvester is special in that it has two functioning modes for absorbing energy generated during service by vibration and pulling force. The piezoelectric stack is better at capturing energy from a pulling force input.

Table 2.1: Summary of literature review

2.4 Summary

This chapter defines in specific about the general definition of piezoelectric, history of piezoelectric, piezoelectric material, piezoelectric effect, application of piezoelectric and advantages and disadvantages of piezoelectric. These literature review start from 2016 until 2020, the many different type of piezoelectric previous project such as, generation of piezoelectric from footwear, car on highway, footstep, handrail and from ocean wave. Apart from that, this chapter also generate ideas on how to design the piezoelectric generator by referring to previous researchers including the type of software, component, function, and interface.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The practical “how” of any piece of research is referred to as research technique. It is indeed as to how a researcher plans a project in a systematic approach to ensure that the results are accurate and reliable and meet the study's goals and objectives. The technique is a collection of philosophically compatible theories, concepts, or ideas that apply to a specific discipline or disability field. Rather than a simple sequence of techniques, methodology refers to the logic and philosophical concepts that underpin a particular study of the scientific method. As a result, scientific literature is included in a section on the study's methodology.

3.2 Flowchart of project methodology

The literature review and knowledge selection for this project are based on the flow above. The literature reviews supplemented the source of information, which included journal articles, conference papers, and publications relevant to this project. This project divided into two part that are project design circuit and hardware construction. Before moving on to hardware production, the circuit will be finalized and designed. In this case, the circuit will be built on a board and the functionality will be checked. The project circuit and hardware are then integrated to finish the device. If an error occurs, the device will be tested again. If a mistake occurs, the rebuild process will proceed as planned, including reconstructing the circuit. The thesis must then be finished and submitted. Finally, this project's presentation and production have been completed.

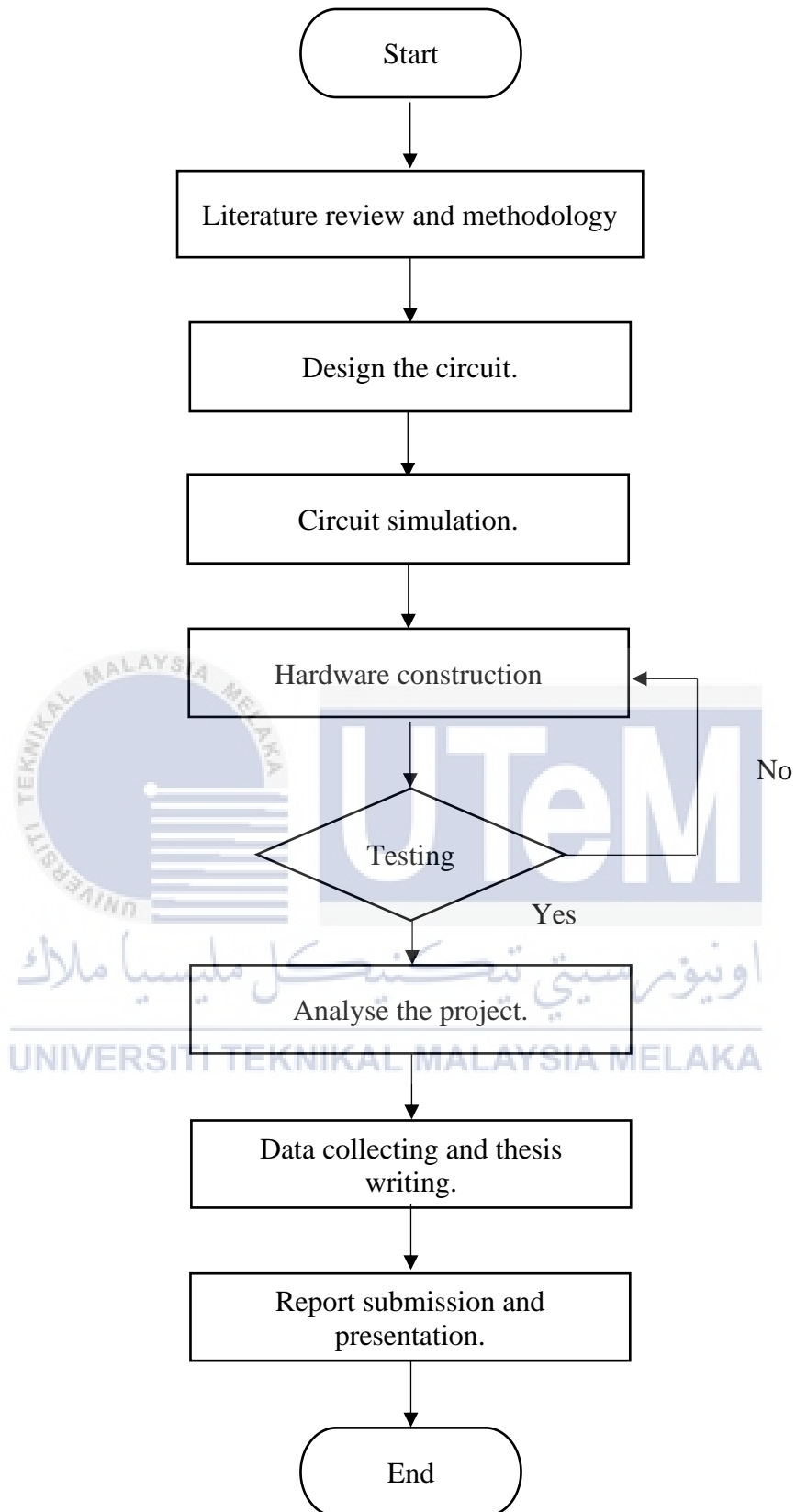


Figure 3.1: Project methodology flowchart

Project Gantt Chart

No	Tasks/Week	PSM 1														PSM 2													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	BDP briefing, Title selection and BDP registration	■																											
2	Title selection and BDP registration	■																											
3	Module implementation 1		■																										
4	Module implementation 2			■																									
5	Discussion with supervisor (chapter 1 Introduction)			■	■																								
6	Discussion with supervisor (chapter 2 Literature review)				■	■	■																						
7	Evaluation of work progress 1					■																							
8	Discussion with supervisor (chapter 3 Methodology)					■	■	■																					
9	Discussion with supervisor (chapter 4 Simulation result)						■	■	■	■	■																		
10	Discussion with supervisor (chapter 5 Conclusion)							■	■	■	■																		
11	First draft of PSM 1 report									■																			
12	Evaluation of work progress 2										■																		
13	Submit PSM 1 report to panel (<30% turnitin report) and upload to Ulearn											■																	
14	Slide presentation to panels												■																
15	Analysis data and result													■	■														
16	Drafting result and discussion														■	■	■												
17	Drafting conclusion and recommendation																■	■											
18	Compile report PSM 2																	■	■	■	■								
19	Final report																						■	■	■	■			
20	PSM 2 presentation																									■	■		
21	Report submission																											■	

Table 3.1: Project Gantt chart

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

The purpose of this study is to develop an automatic welcoming signage using piezoelectric generator and analyze whether there are any electric field values that can be generated using a piezoelectric sensor. This study is divided into several part namely simulation and experimental. For simulation, using Proteus 7 professional software to test whether piezoelectric is can generate enough electric to turn on the LED. Meanwhile for experimental, using 16 piezoelectric, 4 channel, 4 piezoelectric in parallel for each channel to generate electric that charged up different kind of capacitor and to analyze how much voltage produced per channel.

4.2 Simulation result

The goal of this simulation is to see if there are any electric field values that can be generated by utilizing a piezoelectric footstep to turn on an LED. The result is tested and simulated using Proteus 7 professional software. This software can be used to creates, manages schematic, layouts, and design, and can be used to measure voltage, current and frequency for the circuit. The rectifier circuit's primary function is to convert alternating current (AC) to direct current (DC). Figure 4.1 shows a rectifier circuit constructed in Proteus 7 professional software. This simulation is conducted using 1 to 5 piezoelectric in parallel.

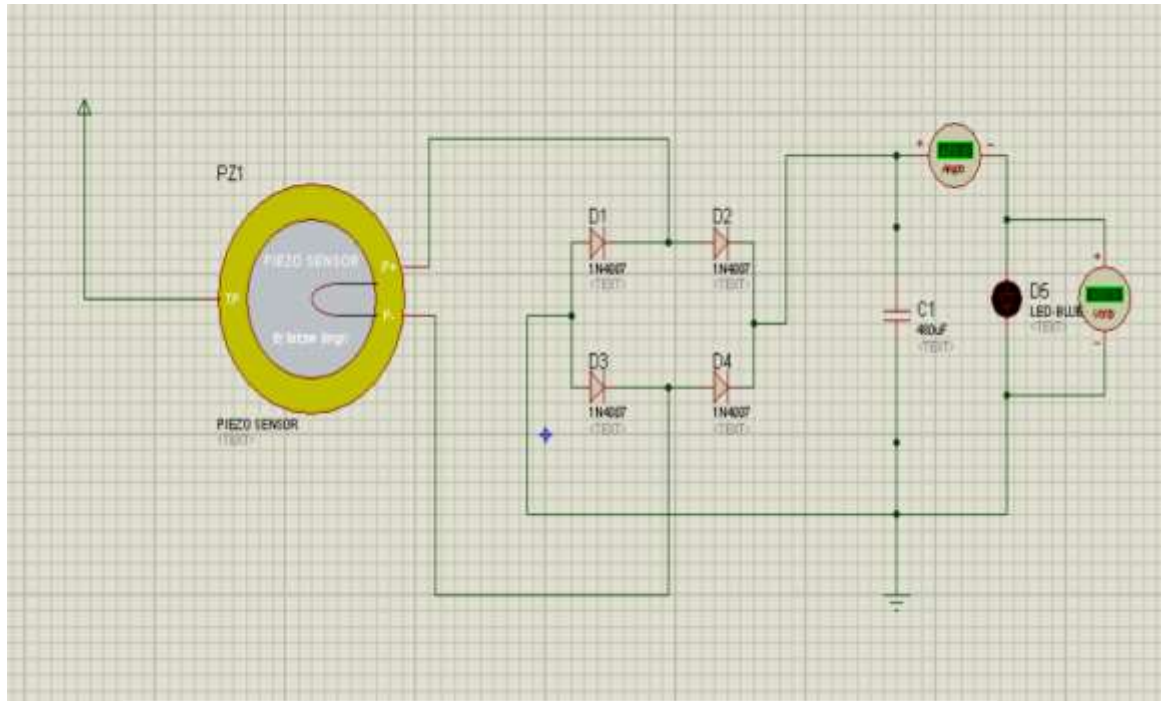


Figure 4.1: Rectifier circuit to converts AC output of piezoelectric to DC using Proteus 7 Professional.

By adding piezoelectric one by one, the data was recorded over five levels of setup. When more piezoelectric is added, the circuit's overall output current and voltage increase. Table 4.1 demonstrates that as more piezoelectric is added, the output current and voltage produced by the circuit increases marginally.

Number of piezoelectric	Voltage	Current
1	2.68V	0.16A
2	2.76V	0.19A
3	2.79V	0.20A
4	2.81V	0.20A
5	2.83V	0.21A

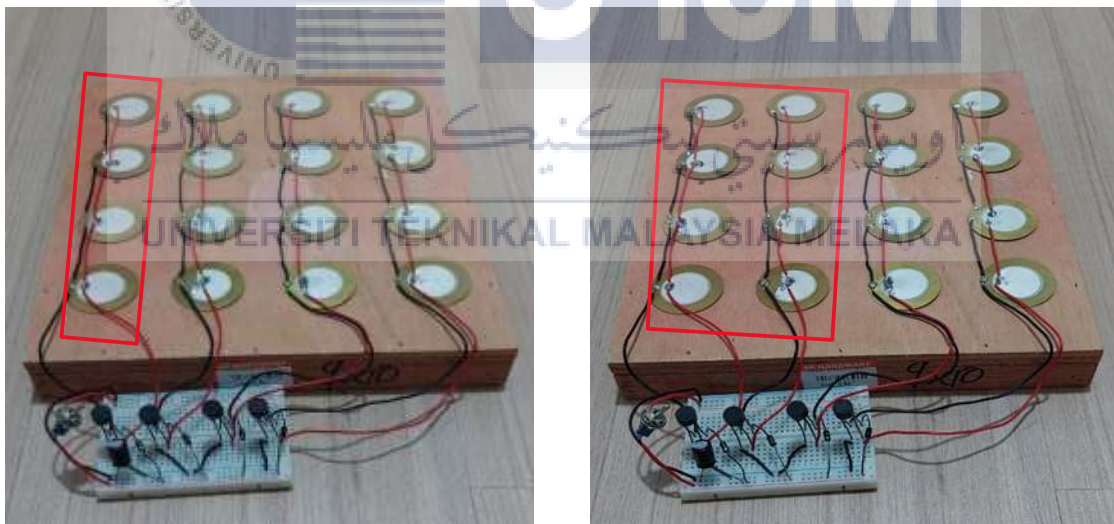
Table 4.1: Simulation data of voltage and current based on number of piezoelectric.

4.3 Experimental result

This study was carried out to point out the generation of electricity using piezoelectric sensor connected in parallel 4 channel, 4 piezoelectric each and to analyze how much voltage is produced with different amount of push and using different variation of capacitors. This study overall using 16 piezoelectric connected in 4 channel, 4 piezoelectric sensor in parallel in each channel.

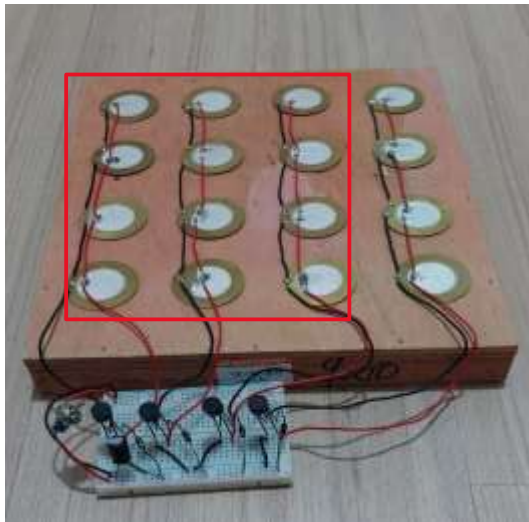
4.3.1 Generation analysis

The purpose of this study is to analyze how much voltage is produced in 100uF, 25V by using different number of channels added. In figure 4.2, there are 4 channels altogether, each channel contains 4 piezoelectric connected in parallel and each channel also having their own bridge rectifier. Thus, making it total of 16 piezoelectric. In table 4.2, the data obtained show that the more piezoelectric sensor connected, the more voltage is produced from the circuit. The voltage produced also depend by the force of push applied. When the piezoelectric push harder, the voltage increases slightly.

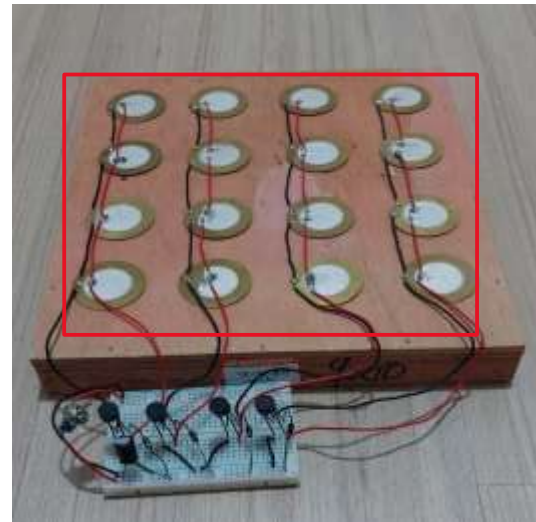


(a)

(b)



(c)



(d)

Figure 4.2: (a) 1 channel, 4 piezoelectric connected in parallel. (b) 2 channel, 4 piezoelectric connected in parallel. (c) 3 channel, 4 piezoelectric connected in parallel. (d) 4 channel, 4 piezoelectric connected in parallel.

Number of channels	Number of pushes	Voltage
1	10	216mV
2	10	336mV
3	10	595mV
4	10	776mV

Table 4.2: Analysis on number of channels connected, no. of push, and voltage produced.

4.3.2 Capacitor variation test

This study was executed to analyze the generation of electricity using piezoelectric sensors when connected to 3 different variation of capacitors and how much voltage is produced with different number of pushes applied. The data obtained in table 4.3 show that the capacitor with larger value 560uF, 35V takes longer time to charge because it holds a larger charge, therefore, it takes longer to charge up and on the contrary, the smaller the capacitor value, the shorter time it takes for a capacitor to charge up. For example, the smaller capacitor value, 100uF, 25V produced more voltage with 10 pushes than the 560uF, 35V capacitor.

Capacitor variation	Number of pushes	Voltage
100uF, 25V	10	1.095V
	30	2.4V
	50	3.23V
220uF, 6.3V	10	0.662V
	30	1.605V
	50	2.21V
560uF, 35V	10	0.192V
	30	0.499V
	50	0.735V

Table 4.3: Analysis on number of pushes and voltage produce by using different variation of capacitors.

4.3.3 LED and welcoming signage as output

This study was done to analyze whether the capacitor charge stored can light up the LED and welcoming signage. The capacitor that been chose is 100uF, 25V because it can charge the capacitor faster than the other capacitor. The output is conducted using LED first to see whether there is enough charged to light up the LED. In figure 4.3 show that the LED light up for split second because capacitor released all its charge toward the output.

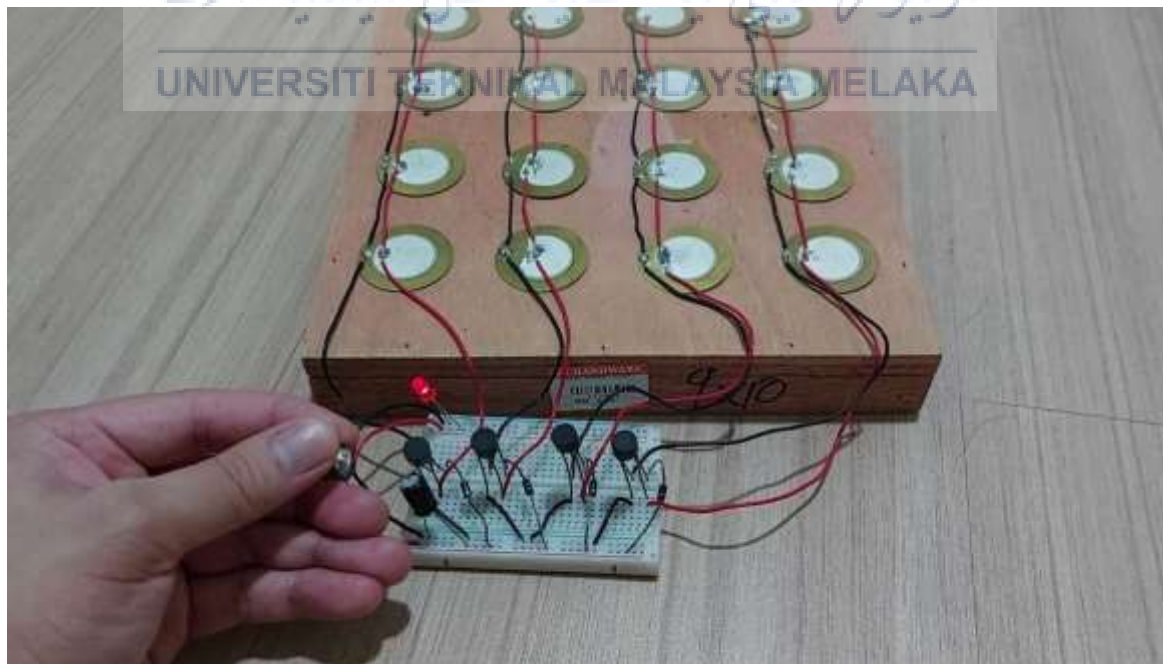


Figure 4.3: LED as an output.

Then, the final project output is by using the welcoming signage LED strip. The welcoming signage manage to turn on for split second but need more pushes than the single LED. In figure 4.4 shows that the welcoming signage LED strip lights up brightly in the night.

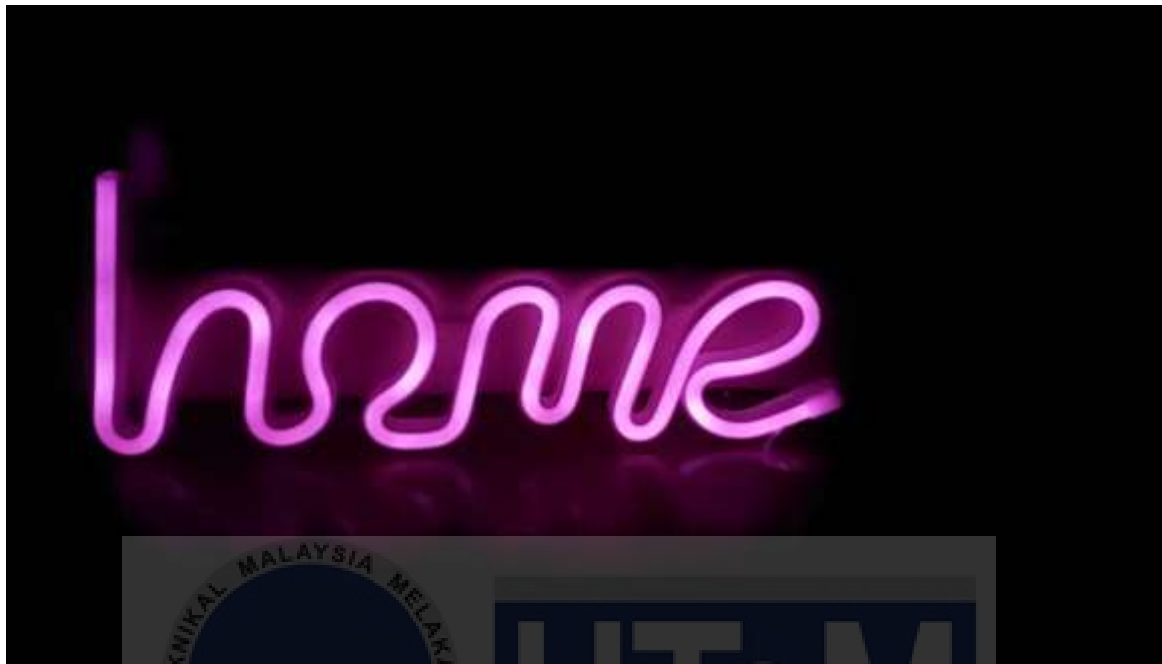


Figure 4.4: Welcoming signage LED strip as an output.



CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

To sum up, the project's goal is to use footsteps to light up welcoming signage while employing piezoelectric to control the principle and electricity generation. As a result, the plan can determine whether this test is truly useful for an alternate method of supplying power, given that the supply is always being replenished, and whether it appears to be a never-ending supply. Furthermore, when compared to any previous breakthrough, the whole cost of developing and designing this task is affordable. The piezoelectric plate model and the piezoelectric sensor pressure area are the most important parts to plan carefully since they are the most important parts to consider. Regarding this concept, developing a green power generation by designing electricity from reused energy could be a good notion. The fact that the source is easier to spread among people and is environmentally beneficial makes it a strong case for pushing the notion of harvesting vibration energy throughout the world.

5.2 Recommendations

Adding additional features to this project to make it better or functionalities is an efficient approach to use waste energy while lowering the cost of electricity production. Due to a limitation of current, the piezoelectric has yet to produce enough electrical energy for widespread use. There is still no piezoelectric electrical generator on the market today. In order to measure output voltage and current, a larger piezoelectric sensor will be employed in the future. A current booster circuit will be developed, allowing the output current to be used as a free energy high output input source for high-powered electronic components.

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APPENDICES

