UNIVERSITI TEKNIKAL MALAYSIA MELAKA

HUMAN POWERED ENERGY HARVESTING ELECTRONIC DEVICE

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree of Electronic Engineering Technology (Industrial Electronics) with Honours

by

ELLYANA SHAIRA BINTI ABD AZIZ
B071110236
900406-04-5262

FACULTY OF ENGINEERING TECHNOLOGY

2015

DECLARATION

I hereby, declared this report entitled "Human Powered Energy Harvesting Electronic Device" is the results of my own research except as cited in references.

Signature : ______________________________________

Author's Name: ELLYANA SHAIRA BINTI ABD AZIZ

Date : 13 JANUARI 2015

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor's of Electronic Engineering Technology (Industrial Electronics) with Honours. The member of the supervisory is as follow:

………………………………

(MR. MOHD FAUZI BIN AB RAHMAN)

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Human Powered Energy Harvesting Electronic Devices**

SESI PENGAJIAN: **2014/15 Semester 1**

Saya **ELLYANA SHAIRA BINTI ABD AZIZ**

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (✓)

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
✓	TIDAK TERHAD	

Disahkan oleh:

_________________________ _________________________

Alamat Tetap:

NO. 5 Jalan SL 7/4

Bandar Sungai Long,

43000, Kajang, Selangor

Cop Rasmi:

Tarikh: 13 Januari 2015

Tarikh: 13 Januari 2014

** Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

ABSTRAK

Projek ini membentangkan tentang kepelbagaian fungsi, keupayaan tubuh badan manusia untuk menghasilkan tenaga pasif dari hasil pergerakan tubuh dan tenaga ini dapat dibekalkan dalam jangka yang lama kepada peranti mudah alih dan peranti elektronik. Jangka masa sesuatu peranti elektronik sangat penting dan mempunyai banyak kelebihan berbanding peranti yang mempunyai kemampuan terhad. Melalui projek ini, satu sumber tenaga persekitaran iaitu tenaga yang dihasilkan manusia daripada lapik dalam kasut apabila mereka berjalan atau berlari dan tenaga ini disimpan di dalam bentuk tenaga elektrik. Berdasarkan ciri-ciri tenaga, tenaga yang dihasilkan melalui manusia, kaedah penukaran dan litar penyimpanan telah direka dan diuji bagi kegunaan peranti elektronik yang mempunyai penggunaan tenaga yang rendah.

ABSTRACT

This project presents a fully functional, self-sufficient body-worn energy harvesting system for passively capturing energy from human motion, with the long term vision of supplying power to portable, wearable, or even implanted electronic devices. Extended lifetime of electronic devices is very important and also has more advantages in systems with limited accessibility. From this project, one form of ambient energy sources: human power generated from a shoe insole when a person is walking or running and its conversion and storage into usable electrical energy. Based on source characteristics, electrical-energy-harvesting, conversion, and storage circuit were designed, built, and tested for low power electronic applications.

DEDICATION

To my beloved parents
My supervisor,

and to all my friends,

Thanks for all support and ideas.

ACKNOWLEDGEMENT

First I would like to express my grateful to ALLAH S.W.T. as for the blessing given that I can complete my final year project. In preparing this paper, I have been involved with many people in helping me to complete this project.

I am grateful and would like to express my sincere gratitude to my supervisor Mr Mohd Fauzi Bin Ab Rahman, to the preliminary ideas, invaluable guidance, continuous encouragement and continuous support in making this research possible. I appreciate his consistent support from the beginning till the end of this project. Thanks to all my lab mates, members and staff of the Electronic & Computer Engineering Technology Department of Universiti Teknikal Malaysia Melaka who helped me in many ways during the project.

I acknowledge my sincere gratitude to my parents for their love, dream and sacrifice throughout my life. I cannot find the appropriate words that could properly describe my appreciation for their devotion, support and faith in my ability to attain my goals. Special thanks should be given to my committee members. I would like to acknowledge their comments and suggestions, which was crucial for the successful completion of this final year project.

The next category is those who help me to grow further and influence in my project are my colleagues who always help me in order to finish this project. I really appreciate the idea and information given.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

AC	-	Alternater current
DC	-	Direct current
DMM	-	Digital Multimeter
LCD	-	
LED	-	Light Emitting Diode
MEMS	-	
MMPT	-	Maximum Power Point Tracker
SDLC	-	System Development Life Cycle
PMCC	-	Power Management Control Circuits
PZT -	-	piezoceramic
PVDF	-	piezopolimer
RMS	-	Root-Mean-Square
VEH	-	vibration energy harvester
Vpp	-	Voltage Peak-to-Peak
Vrms	-	Voltage root-mean-square
R	-	resistor
Ω	-	Ohm
µΩ	-	micro-Ohm
mΩ	-	milli-Ohm
kΩ	-	kilo-Ohm
V	-	voltage
µV	-	micro-volt
mV	-	milli-volt
kV	-	kilo-volt
I	-	curremt
µA	-	micro-Ampere
mA	-	milli-Ampere

P	-	Power
µW	-	micro –Watt
mW	-	milli-Watt
kW	-	kilo-Watt
Hz	-	Hertz
MHz	-	MegaHertz
GHZ	-	GigaHertz
kg	-	kilogram
µm	-	micro-meter
mm	-	millimetre
℃	-	degree Celsius
H	-	Hour

CHAPTER 1

INTRODUCTION

1.1 Project overview

Human energy harvesting is a process of captures small amounts of energy that can be generate from the human body. Perhaps the most energy abundant and readily utilized form of ambient human power is walking. In this project, the user developed the shoe sole embedded with piezoelectric transducer disc. The piezoelectric shows the ability to transform electrical into mechanical energy and conversely, mechanical into electrical energy.

A piezoelectric transducer disc is flexible shapes and sizes. So that, it is easy to be embedded in the sole because of its geometry and harvesting of the energy. Furthermore, the piezoelectric transducer disc cheap compared to others. But, it has relatively low charge coefficients. That is why it must be supported from the mechanical energy to its fullest potential. As a motivation, this project helps electronic devices are no longer restricted by the periodic maintenance that batteries demand.

1.2 Problem statement

Most of the current portable products are conquered by rechargeable batteries and they will remain as the main source for this kind of consumer products. However, there are some disadvantages of batteries which are to either replace or recharge them periodically. The replace of a primary battery means that the portable product's user has to carry with another one while the recharge of the secondary battery, means that the electrical network has to be accessible to the portable product's user. The mobility of the portable is restricted by the duration of the battery. And as power requirements of most modern electronic portable devices are decreasing, it is possible to use the energy harvesting from human body activity in order to control these devices.

1.3 Objectives

The main aim of this project is to harvest energy from human powered to electronic device. In order to achieve the targeted aim, a few objectives as follows have been identified

i. To investigate the piezoelectric transducer disc for energy harvesting.
ii. To design the conversion circuit for shoe-insole based on piezoelectric transducer disc.
iii. To test and evaluate the energy harvesting by piezoelectric transducer disc in the shoe insole.

1.4 Scope project

The main flow of the project scope starts with energy harvesting, vibration (human), electro-mechanical transducer, piezoelectric and lastly piezoelectric transducer disc in the shoe sole. The chart contains characteristic of the project. This is some explanations of the main items of this project:

i. Energy harvesting by vibration

Vibration energy harvesting systems that convert ambient mechanical energy in the environment to usable electrical energy represent a promising emerging technology to achieve autonomous, self-renewable, and maintenance-free operation of wireless electronic devices and systems. A complete energy harvesting system comprises three main components: an energy harvester that converts the mechanical vibrations into electrical energy, an energy harvesting interface circuit that conditions and regulates the energy, and an energy storage element that stores the intermittent harvested energy.

ii. Piezoelectric

Piezoelectric systems can convert motion from the human body into electrical power. Piezoelectricity is the power produced from the piezoelectric effect. This process entails the change of the polarization of the piezo-material, generally crystal, when applying a mechanical force. Most of the piezoelectricity sources produce power on the order of milli-watts, too small for the system application, but enough for small devices.

iii. Piezoelectric polymer thin films

The piezoelectric materials such as polymer thin films are well-known for their sensing and actuating capabilities. These structures have the ability to control the shape, vibration and stability of the structural components due to their direct and converse piezoelectric effects.

1.5 Project outline

This project report contains five chapters. Chapter one states the overview and the introduction of the project which inclusive of project background, project objectives, problem statement, and scope of work. Chapter two explains on the project literature review, while chapter three discusses on the overall project methodology. Chapter four elaborates on the project results and discussions. The last chapter, chapter five concludes the whole research work and states recommendation for the future research work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, a general model of a pairs of shoes with piezoelectric will be explained followed by a brief explanation of the function and the characteristic of the piezoelectric fibre composites that suitable in this project. An overview of this topic is important due to fact that the piezoelectric is used to convert the mechanical energy into electrical energy by receive the energy by the vibration contact with the piezoelectric components. Followed by the brief explanations about the analytical model of the piezoelectric harvester a one of the medium that can produce energy to become a electronic device charger. In this topic, differences between the electrostatic, electromagnetic and the piezoelectric will be explained.

2.2 Generic models of energy harvesting

2.2.1 Kinetic motion energy (vibration)

Vibration energy harvesting systems that convert ambient mechanical energy in the environment to usable electrical energy represent a promising emerging technology to achieve autonomous, self-renewable, and maintenance-free operation of wireless electronic portable devices and systems. (Rao, et al., 2011). A perfect energy harvesting system consist of three main components; an energy harvester that converts the mechanical vibrations into electrical energy, an energy harvesting interface circuit that conditions and regulates the energy, and an energy storage element that stores the intermittent harvested energy.

Energy harvesting is the conversion of ambient energy into usable electrical energy. When compared to energy stored in common storage elements, such as batteries and capacitors; the environment represents a relatively infinite source of available energy. Researchers have been working on many projects to generate electricity from human power, such as exploiting, cranking, shaking, squeezing, spinning, pushing, pumping, and pulling. (Yildiz, 2011).

Several types of flash lights were powered with wind up generators in the early 20th century. Further versions of these devices, such as wind-up cell phone chargers and radios, became commercialized in the market. The commercially available Freeplay's wind-up radios require 60 turns in one minute of cranking, which produces for the storage of 500 Joules of energy in a spring. The spring system drives a magnetic generator and efficiently produces enough power for about an hour of radio play.

Tapping directly into the biological processes that turn fat into energy is beyond currently available technology. However, energy might be harvested indirectly from everyday human activity or might be intentionally energized by a human. Indeed, market for years. At the same time, there has been a significant body of research on human generated power which can find potential applications particularly in low power biomedical applications.

The related systems need to be wearable and typically consists of sensors, signal conditioning electronics and wireless transmission technology. (Cain, et al., 2011). More power allows longer operation, higher sampling rates, and wireless transmission over a longer distance, and support of additional features. Therefore powerful, low weight and packed energy storage devices and energy harvesting from the human body are crucial technologies for long-lifespan and reliable operation. Power may be recovered passively from body heat, breathing, blood pressure, arm motion, typing, and walking or actively through user actions such as winding or pedaling. In cases where the devices are not actively driven, only some power can generally be harvested without inconveniencing or annoying the user.

A summary of the potential power sources and the total power from various body-centered actions is provided in Figure 2.1.1.

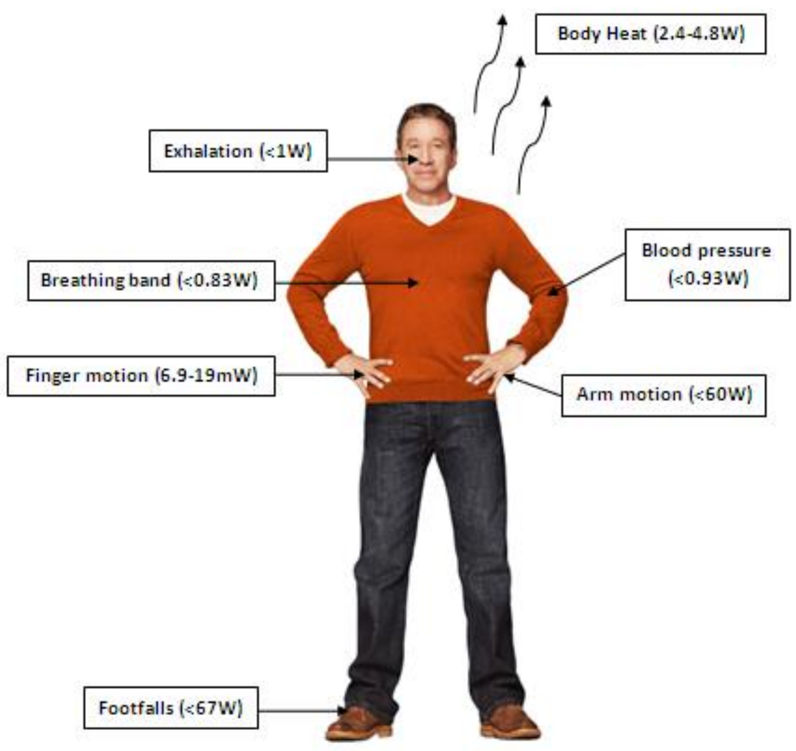

Figure 2.1.1: Possible power recovery from body-cantered sources with total power for each action listed. (Cain, et al., 2011).

2.2.2 Solar energy

Energy from the sun can be used to heat homes through passive solar design, solar hot water systems, solar space heating and electrical generation (photovoltaic or PV). It is renewable energy source that does not contribute to green house gasses. Compared to fossil fuel-generated electricity, each kilowatt of PV electricity annually offsets up to 16 kilograms of nitrogen oxides, 9 kilograms of sulfur dioxides, and 2,300 kilograms of carbon dioxide (CO2). (K, 2009)

Photovoltaics solar panels change solar radiations (insolation) into direct current (DC) electricity. When referring to electrical generation, insolation is described at watts per square meter. On a normal day, the total insolation is about 1,000 watts per meter square. By measuring the insolation, the peak sun hours can be recorded. Peak sun hours vary throughout the year and can be affected by the Earth's position relative to the sun, location of site (latitude), atmospheric condition, and any obstructions at a given site (shade). Photovoltaic solar systems typically consists several panel wired together (array), electrical disconnects, over-current protection (circuit breaker of fuses), inverter, junction box, and other specialized equipment depending on application (grid-tied, off-grid, battery-backup).

2.2.3 Heat energy

Thermo-electric (TE) materials offer the opportunity to generate electricity from waste heat. However, due to the temperature refer to the Figure of Merit (ZT), the average efficiency of thermo-electric materials is relatively low and varies across the operating temperature range (100-500 degrees C). (Tervo, et al., 2009). While current thermo-electric generators are able to get high efficiencies within a relatively small temperature range, their efficiency is still too low for practical, commercial applications and their thermo-electric properties can rapidly degrade due to elevated temperatures, under thermal cycling, and as the result of the differential thermal expansion effects of different thermo-electric materials that make-up these devices. Highly efficient nano-structured and functionally graded