



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**DEVELOPMENT OF PORTABLE STOVE OPERATING  
USING PELTIER EFFECT**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Industrial Automation & Robotic) with Honours.

by

**RAMIZAH AMIRA BINTI MOHAMAD**

**B071510398**

**960421-01-6982**

FACULTY OF ELECTRICAL AND ELECTRONIC ENGINEERING  
TECHNOLOGY

2019

**BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA**

Tajuk: DEVELOPMENT OF PORTABLE STOVE OPERATING USING PELTIER EFFECT

Sesi Pengajian: 2019

Saya **RAMIZAH AMIRA BINTI MOHAMAD** 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 (X)

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

Yang benar,

Disahkan oleh penyelia:

.....

RAMIZAH AMIRA BINTI MOHAMAD

.....

ARMAN HADI BIN AZAHAR

Alamat Tetap:

Cop Rasmi Penyelia

No 94,Blok 3 felda maokil 3,

85300 labis,Johor.

Tarikh:3/12/2018

Tarikh:

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

## **DECLARATION**

I hereby, declared this report entitled DEVELOPMENT OF PORTABLE STOVE OPERATING USING PELTIER EFFECT is the results of my own research except as cited in references.

Signature: .....

Author : RAMIZAH AMIRA BINTI MOHAMAD

Date: 3/12/2018

## **APPROVAL**

This report is submitted to the Faculty of Electrical Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Automation & Robotic) with Honours. The member of the supervisory is as follow:

Signature: .....

Supervisor :           **ARMAN HADI BIN AZAHAR**

Signature: .....

Co-supervisor:       **ROZILAWATI BINTI MOHD.NOR**

## ABSTRAK

*Portable stove operating using Peltier effect memberi tumpuan kepada pembangunan sebuah dapur mudah alih yang beroperasi dengan menggunakan Peltier untuk menyediakan haba. Dapur ini akan menjadi mudah alih kerana ia beroperasi menggunakan bekalan dari bateri Li-Po 3S. Voltan pengoperasian minimum untuk bateri menentukan 10.1V, dan maksimum ialah 12.6V, jadi jika bekalan lebih rendah daripada ambang minimum, Peltier akan ditutup secara automatik. Algoritma pengawal yang dipilih adalah pengawal Derivative Integral Proportional (PID) untuk mengawal suhu pemanasan atau penyejukan ketika suhu disesuaikan ke titik set. Mikrokontroler, Arduino Uno R3, akan menjadi papan utama untuk mengendalikan program ini untuk menjalankan pengaturcara.*

## **ABSTRACT**

Portable stove operating using Peltier effect focuses on the development of a portable stove that operates by using a Peltier to provide heat. The stove will be portable because it operates using the supply from a Li-Po 3S battery. The minimum operating voltage for the battery is specify to be 10.1V, and the maximum is 12.6V , therefore if the supply is lower than the minimum threshold the Peltier will auto shut down. The controller algorithm that is chosen is the Proportional Integral Derivative (PID) controller to control the temperature of heating or cooling when the temperature is being adjusted to its set point. A microcontroller, Arduino Uno R3, will be the main board for operating the program to run the programmers.

## **DEDICATION**

To my beloved parents, my family and my friends that I acknowledge my sincere indebtedness and gratitude to them for their love, dream and sacrifice throughout my life. Their sacrifice had inspired me from the day I learned how to read and write until I have become now. I cannot find the appreciate words that could find the appropriate words that could properly describe my appreciation for their devotion, support and faith in my ability to achieve my dreams.



## **ACKNOWLEDGEMENTS**

I would like to express my sincere gratitude to my supervisor, Mr Arman Hadi Bin Azahar for his continuous guidance throughout the project and help me in completing my degree final year project. I would like to thank his for his contribution to my project by sharing me with his experience. I appreciate that his contribution. Thank you very much.

## TABLE OF CONTENTS

	<b>PAGE</b>
<b>TABLE OF CONTENTS</b>	<b>x</b>
<b>LIST OF TABLES</b>	<b>xiv</b>
<b>LIST OF FIGURES</b>	<b>xv</b>
<b>LIST OF APPENDICES</b>	<b>xviii</b>
<b>LIST OF SYMBOLS</b>	<b>xix</b>
<b>LIST OF ABBREVIATIONS</b>	<b>xx</b>
<b>LIST OF PUBLICATIONS</b>	<b>xxi</b>
<b>CHAPTER 1      INTRODUCTION</b>	<b>22</b>
1.1      Introduction	22
1.2      Background of Project	22
1.3      Problem Statement	25
1.4      Objective of Research	26
1.5      Scope of Research	26
1.6      Thesis Organization	27
<b>CHAPTER 2      LITERATURE REVIEW</b>	<b>29</b>
2.1      Introduction	29
2.1.1      Method of the Development for Guided	30

2.2	Outdoor Equipment	31
2.3	Camp Stove	32
2.4	Thermoelectric Module	42
2.5	Controller for Temperature Control	48
	2.5.1 PID Controller	49
	2.5.2 Bang Bang Controller	51
2.6	Summary	52
<b>CHAPTER 3 METHODOLOGY</b>		<b>54</b>
3.1	Introduction	54
3.2	Flow Progress of Project	54
	3.2.1 Main Block Diagram	54
	3.2.2 Flow Chart of the Overall Project	55
	3.2.3 Flow Chart of the System	57
	3.2.4 Project Integration	60
3.3	Hardware Project Design	61
	3.3.1 Box Shape	62
	3.3.2 Thermal Insulation Surround the Box	63
	3.3.3 Wind Block Panels	64
	3.3.4 Box Material	64
3.4	Hardware Development	65

3.4.1	Arduino Uno	66
3.4.2	Liquid Crystal Display (LCD)	67
3.4.3	Heat Sink and Fan	67
3.4.4	Lipo Battery 12V	69
3.4.5	LM35 Temperature Sensor	70
3.5	Circuit Design	71
3.6	Development System	75
3.6.1	PID Controller	75
3.7	Project Planning	78
3.8	Summary	79
<b>CHAPTER 4 RESULT AND DISCUSSION</b>		<b>81</b>
4.1	Introduction	81
4.2	Temperature Test	81
4.3	Connection Test	86
4.4	PID Calibration	89
<b>CHAPTER 5 CONCLUSION AND RECOMMENDATION</b>		<b>97</b>
5.1	Introduction	97
5.2	Conclusion	97
5.3	Recommendation	98

**REFERENCES 99**

**APPENDIX 101**

## LIST OF TABLES

<b>TABLE</b>	<b>TITLE</b>	<b>PAGE</b>
Table 2.1:	Pros and cons of each category and cooking time	40
Table 2.2:	Performance specification of TEC12706 ( Hebei I.T. (Shanghai) Co., Ltd., 2009)	45
Table 2.3:	Tuning effect of PID controller terms	51
Table 3.1:	Properties of Common Cooking Materials	65
Table 3.2:	Project estimation cost	79
Table 4.1:	Temperature of hot side of Peltier (°C) Vs Time (s)	83
Table 4.2:	Series Connection analysis without load	86
Table 4.3:	Parallel Connection analysis without load	86
Table 4.4:	Series Connection analysis with load	86
Table 4.5:	Parallel connection analysis with load	86

## LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 1.1:	Camp stove using wood burning (Recreation, 2017)	23
Figure 1.2:	Camp stove using wood burning (Recreation, 2017)	23
Figure 1.3:	The types of camping stove. (a) Canister (b) liquid fuel (c) alcohol burning (d) solid fuel (e) wood burning (Recreation, 2017)	25
Figure 2.1:	K-Chart project overall	30
Figure 2.2:	Aspirational Youth & Young Adult Participation (Recreation, 2017)	31
Figure 2.3:	Charcoal stove in Japan (minzoku, 2014)	33
Figure 2.4:	Model 9 stove using white gas (Kephart, 1907)	34
Figure 2.5:	Solar cooking stove (Sydney, 2014)	35
Figure 2.6:	Induction stove (Lasobras <i>et al.</i> , 2014)	36
Figure 2.7:	Instrument used by seebeck to observe the deflection of compass needle (Horman, Lee and Wagner, 2013)	42
Figure 2.8:	Peltier plate working demo (Field and Bruce, 2005)	43
Figure 2.9:	Peltier heat pump effect mechanical and electrical installation	44
Figure 2.10:	Thermoelectric module in (a) cooling mode (b) power generation mode (Zhang, Wang and Pickrell, 2013)	46
Figure 2.11:	Closed loop control system (Bissell, 2009)	49

Figure 2.12: PID controller for block diagram (Nair and Mohan, 2016)	50
Figure 2.13: Block diagram of Bang Bang controller for temperature	52
Figure 3.1: Main block diagram	55
Figure 3.2: Flow Chart of overall project	57
Figure 3.3: Flow Chart of operating system	59
Figure 3.4: The project integration	60
Figure 3.5: Flow Chart of Hardware Design	61
Figure 3.6: 4-Dimension of Cook Stove from top view, front view and side view	62
Figure 3.7: The thermal insulator	63
Figure 3.8: Arduino Uno Board	66
Figure 3.9: Liquid Crystal Display (LCD)	67
Figure 3.10: Heat sink that is attached with 12V DC fan	68
Figure 3.11: Lipo Battery	70
Figure 3.12: LM 35 temperature sensor	71
Figure 3.13: Flow Chart of circuit design	72
Figure 3.14: Circuit design for the whole operation	73
Figure 3.15: The PID flow control process flow chart	76
Figure 3.16: PID Controller Flow Chart	78
Figure 4.1: Prototype of Portable Stove	82
Figure 4.2: Graph between Temperature ( $^{\circ}\text{C}$ ) and Time (s)	84
Figure 4.3: Graph of Connection test of 4 Peltier	87



Figure 4.4: Graph of Temperature ( $^{\circ}\text{C}$ ) vs Time (s) without PID controller	90
Figure 4.5:Proportional (P) Variation Only	91
Figure 4.6:Proportional-Integral (PI)Variation Only	92
Figure 4.7:Manual Tuning when $K_p=20$ , $K_i=10$ , $K_d=10$	93
Figure 4.8: Manual Tuning when $K_p=20$ , $K_i=10$ , $K_d=30$	93
Figure 4.9: Manual Tuning when $K_p=40$ , $K_i=20$ , $K_d=40$	94
Figure 4.10: Manual Tuning when $K_p= 50$ , $K_i=35$ , $K_d=60$	94
Figure 4.11:Temperature ( $^{\circ}\text{C}$ ) vs Time(S) with PID Controller	95

## LIST OF APPENDICES

APPENDIX	TITLE	PAGE
	Appendix 1 Coding For Heating Process	101

## LIST OF SYMBOLS

<b>K<sub>p</sub></b>	-	Proportional Gain
<b>K<sub>i</sub></b>	-	Integral Gain
<b>K<sub>d</sub></b>	-	Derivative Gain
<b>T</b>	-	Instantaneous Time

## **LIST OF ABBREVIATIONS**

<b>PID</b>	Proportional Integral Derivative
<b>LCD</b>	Liquid Crystal Display
<b>TEC</b>	Thermoelectric Cooling

## **LIST OF PUBLICATIONS**

## CHAPTER 1

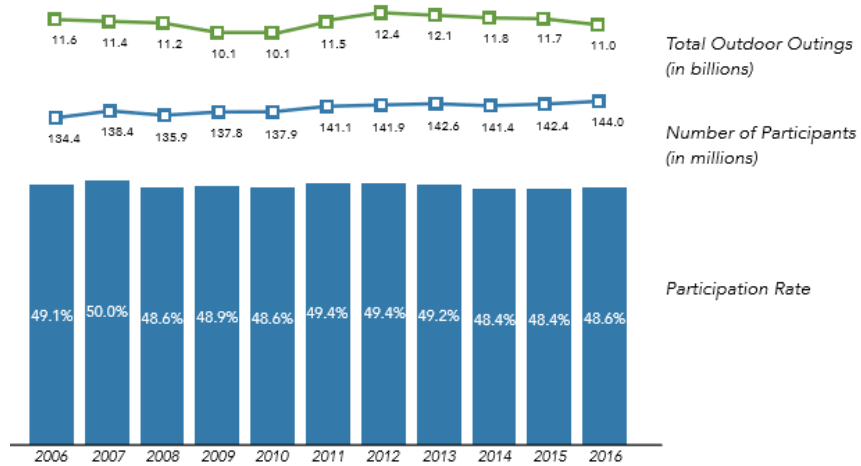
### INTRODUCTION

#### 1.1 Introduction

This chapter will clarify about the background of the project, problem statement, objective, scope and thesis organization of this project which is the highlight of the project.

#### 1.2 Background of Project

Nowadays, outdoor activities and outdoor recreation are the most activities people are involving. It is refers to leisure time in the outdoors, often in rural or town. Figure 1.1 shows the data for outdoor participation from 2006 to 2016. Numerous movement can be done alone or in a bunch like experience hustling, hiking, cycling, camping, canoeing, crayoning, angling, climbing, horseback riding, chasing, kayaking, shake climbing, running, cruising, skiing, surfing, ATV riding, and sports (Recreation, 2017).



**Figure 1.1: Camp stove using wood burning (Recreation, 2017)**

When go outdoor activities, all the equipment should be prepared well. More preparation should be considered such as food and beverage for those who take a long journey to do outdoor activities. People will plan their meals before the journey. People will bring along a stove as it is more convenient to cook. The stove should be ultralight and easy for people to carry during explorations. Figure 1.2 shows the example of traditional camp stove using wood burning.



**Figure 1.2: Camp stove using wood burning (Recreation, 2017)**

A few decades ago, people would gather firewood to cook. This traditional camp stove is not practical if the wood was wet caused by bad weather, people could not light up the fire. This method does not guarantee if the food is safe and clean to eat. All these things may be harmful to people and environment because of the occurring open burning. Wood burning contributes pollution to environment in the form of smoke when the wood was burned.

Nowadays there are many variety of design and models of camp stove. These portable camp stove can be categorized based on the type of burner used and stove design. There are many types of camping stove people always use like canister, liquid fuel, alcohol burning, solid fuel and wood burning (Handbook, 2014). Portable camp stove allowed people to cook anything wherever they are. But some of this portable stove is not suitable for high land which has a high pressure so it is difficult to light up the flame. Furthermore, these stoves do not work in extreme cold.

The current portable camp stoves are still not light in weight. Although these type of burner are small but the stove is still heavy to bring. People also will bring the fuel according to how long the duration. Then, people should bring many burners for long distance explorations. In addition, the heat distribution, pollution, safety, the stove weight is difference based on the characteristics. Figure 1.3 shows the types of camping stove people that had in market.