

**DEVELOPMENT OF ROUTE OPTIMIZATION FOR AN  
E-WASTE MONITORING SYSTEM**

**MUHAMMAD FIRDHAUS BIN SAMSUL BAHARI**

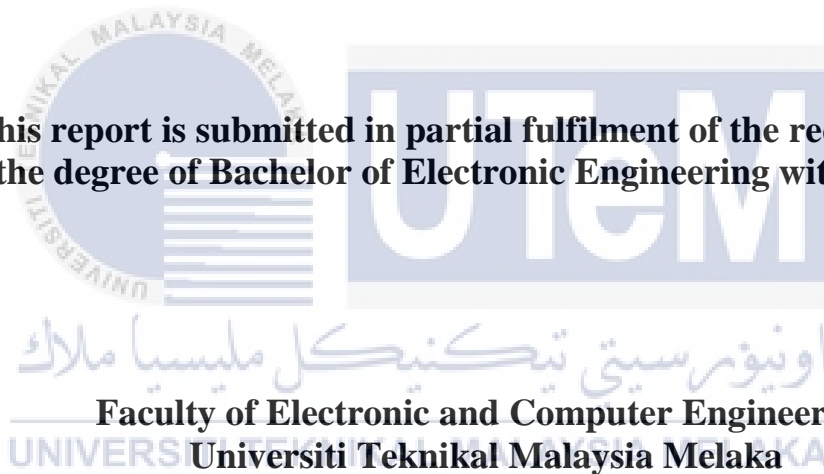


**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**DEVELOPMENT OF ROUTE OPTIMIZATION FOR AN  
E-WASTE MONITORING SYSTEM**

**MUHAMMAD FIRDHAUS BIN SAMSUL BAHARI**

**This report is submitted in partial fulfilment of the requirements  
for the degree of Bachelor of Electronic Engineering with Honours**



**2023**

**BORANG PENGESAHAN STATUS LAPORAN  
PROJEK SARJANA MUDA II**

Tajuk Projek : **DEVELOPMENT OF ROUTE OPTIMIZATION FOR AN E-WASTE MONITORING SYSTEM**  
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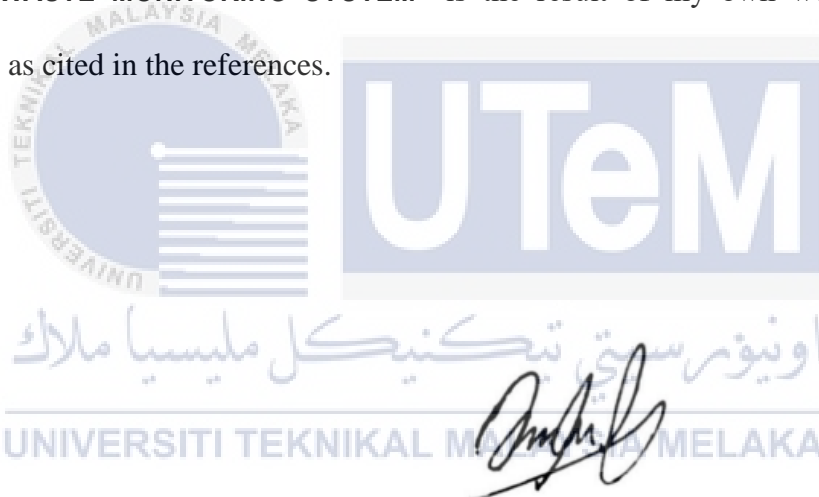
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## DECLARATION

I declare that this report entitled “**DEVELOPMENT OF ROUTE OPTIMIZATION FOR AN E-WASTE MONITORING SYSTEM**” is the result of my own work except for quotes as cited in the references.



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## APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.



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## DEDICATION

This Project is done with tremendous effort and hardship. Through this project's effort, this project is dedicated to the people who played a role in completing this research. I would like to thank to my supervisor DR. SHARATUL IZAH BT SAMSUDIN, with the freedom and advice given by him was really an inspiration and motivation to complete my project. Lastly, this gratitude also gives to all my lecturer and friends for helping me during my project.

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## ABSTRACT

When an electronic device or equipment piece reaches the end of its useful life, it is considered electronic waste. Toxic chemical components of e-waste may harm ecosystems and human health if not adequately controlled and monitored. The project aims to optimise e-waste collection routes when containers are full. This project has two key components: hardware and software. An Ultrasonic sensor (HR-SR04) is used on the hardware side to detect the amount of e-waste in the bin, followed by a Temperature sensor (LM35) to identify the temperature level in the e-waste bin, as an initial preparation for fire safety measures if a fire arises. The brain that controls the ultrasonic function and temperature sensor is the NodeMCU. It also communicates with the software component. Following that, I use ThingSpeak for the software component to monitor the quantity of e-waste and the temperature in the bin. Ant Colony Optimization algorithms will be used to identify the quickest paths for trash truck drivers to gather e-waste. The existence of this project will improve the organisation and efficiency of garbage collection. Furthermore, garbage truck drivers do not need to spend time physically inspecting every waste locations; instead, they choose a shorter route and just collect e-waste at a specific place. As a

result, the environment will be saved from chemical pollution created by electrical waste.





## ABSTRAK

Apabila peranti atau peralatan elektronik mencapai penghujung hayat bergunanya, ia dianggap sebagai sisa elektronik. Komponen kimia toksik bagi e-waste boleh membahayakan ekosistem dan kesihatan manusia jika tidak dikawal dan dipantau secukupnya. Projek ini bertujuan untuk mengoptimumkan laluan pengumpulan e-waste apabila kontena penuh. Projek ini mempunyai dua komponen utama: perkakasan dan perisian. Penderia Ultrasonik (HR-SR04) digunakan pada bahagian perkakasan untuk mengesan jumlah e-sisa dalam tong, diikuti dengan Sensor Suhu (LM35) untuk mengenal pasti tahap suhu dalam tong e-waste, sebagai persediaan awal untuk langkah keselamatan kebakaran jika berlaku kebakaran. Otak yang mengawal fungsi ultrasonik dan sensor suhu ialah NodeMCU. Ia juga berkomunikasi dengan komponen perisian. Selepas itu, saya menggunakan ThingSpeak untuk komponen perisian untuk memantau kuantiti e-waste dan suhu dalam tong sampah. Algoritma Pengoptimuman Koloni Semut akan digunakan untuk mengenal pasti laluan terpantas untuk pemandu lori sampah mengumpul e-sisa. Kewujudan projek ini akan menambah baik organisasi dan kecekapan kutipan sampah. Tambahan pula, pemandu lori sampah tidak perlu meluangkan masa memeriksa secara fizikal setiap lokasi sisa; sebaliknya, mereka memilih laluan yang

lebih pendek dan hanya mengumpul e-sisa di tempat tertentu. Akibatnya, alam sekitar akan diselamatkan daripada pencemaran kimia yang dihasilkan oleh sisa elektrik.



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## TABLE OF CONTENTS

Declaration	i
Approval	i
Dedication	i
Abstract	i
Abstrak	iii
Acknowledgements	5
Table of Contents	vi
List of Figures	x
List of Tables	xv
List of Symbols and Abbreviations	xvi
List of Appendices	xvii
<b>CHAPTER 1 INTRODUCTION</b>	<b>1</b>

1.1	Project Background	2
1.2	Problem Statement	3
1.3	Objectives	4
1.4	Scope of Project	4
1.5	Chapter Outline	5
<b>CHAPTER 2 BACKGROUND STUDY</b>		<b>6</b>
2.1	Sensor	7
2.2	Route optimization	8
2.2.1	The relevant factors in route optimization.	9
2.3	Vehicle Routing Problem (VRP) [5]	9
2.3.1	VRP Flavors	10
2.3.2	Capacitated Vehicle Routing Problem (CVRP)	11
2.4	Smart Bin	12
2.5	Algorithms	13
2.6	Genetic Algorithms (GA)	13
2.6.1	Linear Programming (LP)	14
2.6.1.1	Linear Programming Model	15
2.6.2	Ant Colony Optimization Algorithms (ACO)	17
2.6.2.1	ACO Mathematical Model	18
2.6.2.2	Advantages and Disadvantages of ACO	19

2.7	Comparison of the previous research	20
<b>CHAPTER 3 METHODOLOGY</b>		25
3.1	Research Methodology Flowchart	26
3.2	Detail Description of the Methodology Flowchart	27
3.3	Ant Colony Optimization Algorithms (ACO) Flowchart	29
3.4	Components of the hardware	31
3.4.1	Applications	36
3.5	Circuit diagram for prototype	36
3.6	Software used	37
3.6.1	Arduino IDE	37
3.6.2	ThingSpeak	39
3.6.3	Python Version 3.9	40
3.6.4	Visual Studio Code (VSC)	41
3.6.5	Google Map Platform	43
3.6.5.1	Directions API	44
<b>CHAPTER 4 RESULTS AND DISCUSSION</b>		46
4.1	Result of developing the Smart Bin	47
4.2	Result from Thingspeak	48
4.3	Result for route optimization by using python	54
4.3.1	Dataset	54

4.3.2	By using Ant Colony Optimization	56
4.3.3	By using Linear Programming	59
4.4	Discussion	62
4.5	Ansalysis	65
4.5.1	Case study A	65
4.5.2	CASE STUDY B	72

**CHAPTER 5 CONCLUSION AND FUTURE WORKS** 79

5.1	Conclusion	80
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5.2	Future work	81
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<b>REFERENCES</b>		82
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<b>APPENDICES</b>		86
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## LIST OF FIGURES

Figure 1.1: The strategies, action plans, and targets that have been identified in the Solid Waste Management between the years 2005-2014 in Melaka.....	3
Figure 2.1: The differences between the regular route and the optimized route.....	8
Figure 2.2: An example of a VRP (left) and its solution (right).....	10
Figure 2.3: The concept of smart bin with IoT.....	12
Figure 2.4: The definition of the graph, decision variable, objective function and the constraints of the Capacitated Vehicle Routing Problem (CVRP).....	15
Figure 2.5: Formulate according to given constraints and model.....	15
Figure 3.1: Process of Research Flowchart .....	26
Figure 3.2: Detail Description of the Methodology Flowchart.....	27
Figure 3.3: Process of coding by using Ant Colony Optimization Algorithms.....	29
Figure 3.4: Ultrasonic Sensor (HC-SR04).....	31
Figure 3.5: Ultrasonic Sensor Diagram.....	32
Figure 3.6: LM35 Temperature sensor.....	33
Figure 3.7: NodeMCU ESP8266.....	34



Figure 3.8: NodeMCU ESP8266 development board.....	35
Figure 3.9: NodeMCU ESP8266 Pin out.....	35
Figure 3.10: Schematic Diagram.....	36
Figure 3.11: Arduino IDE.....	37
Figure 3.12: ThingSpeak.....	39
Figure 3.13: Python.....	40
Figure 3.14: Visual Studio Code (VSC).....	41
Figure 3.15: Project Block Diagram.....	45
Figure 4.1: The Smart bin outside view.....	47
Figure 4.2: The Smart Bin inside view.....	47
Figure 4.3: The percentage of waste in the smart bin 1.....	48
Figure 4.4: The percentage of waste in the smart bin 2.....	48
Figure 4.5: Channel Setting for Field 1 until Filed 8.....	49
Figure 4.6: The coding show the duration of time and the total demand for 6 park of the bins.....	50
Figure 4.7: Coding for create the stimulated data for Channel Field 3 until ` Channel Field 8.....	50
Figure 4.8: The fill level percentage which creates by python for Channel Field 3.....	51
Figure 4.9: The fill level percentage which creates by python for Channel Field 4.....	51
Figure 4.10: The fill level percentage which creates by python for Channel Field 5.....	52
Figure 4.11: The fill level percentage which creates by python for Channel Field 6.....	52
Figure 4.12: The fill level percentage which creates by python for Channel Field 7.....	53

Figure 4.13: The fill level percentage which creates by python for Channel Field 8.....	53
Figure 4.14: Latitude and Longitude for each park.....	54
Figure 4.15: Read the file where I stored and locate or find the dataset from 0-9 by using Data Frame.....	55
Figure 4.16: Waste level in each of the bins as predicted.....	55
Figure 4.17: The number and the capacity for garbage trucks.....	55
Figure 4.18: The total distance of all garbage trucks take to collect waste by using ACO.....	56
Figure 4.19: Graph before and after using Ant Colony Optimization with Mat plot to minimize cost distance.....	56
Figure 4.20: The routes that garbage trucks take to collect waste after using ACO.....	57
Figure 4.21: The duration of time to calculate the routes by using ACO.....	57
Figure 4.22: Plotted point for each smart bin located on the google map for Ant Colony Optimization Programming.....	57
Figure 4.23: Optimized route to collect waste for Sekolah Menengah Kebangsaan Ayer and Universiti Teknikal Malaysia Melaka with only using 5 minute and 2.6 km.....	58
Figure 4.24: Optimized route to collect waste for MITC Melaka, Kampung Baru Ayer Keroh, Multimedia University and Taman Ayer Keroh Heights only using 44 minute and 24.3 km.....	58
Figure 4.25: Plotted point for each smart bin located on the google map for Linear Programming.....	59
Figure 4.26: The total distance to collect all the waste from the park.....	59
Figure 4.27: The routes that garbage trucks take to collect waste after using LP.....	59

Figure 4.28: The duration of time to calculate the routes by using LP.....	59
Figure 4.29: Optimized route to collect waste for Universiti Teknikal Malaysia Melaka, Fakulti Teknologi Kejuruteraan Elektrikal and Taman Ayer Keroh Heights with only 43 minute and 24.1 km.....	60
Figure 4.30: Optimized route to collect waste for MITC Melaka and Kampung Baru Ayer Keroh with only 10 minute and 5.8 km.....	60
Figure 4.31: Optimized route to collect waste for Sekolah Menengah Kebangsaan Ayer with only 5 minute and 2.3 km.....	61
Figure 4.32: Plotted bin location for Case Study A.....	65
Figure 4.33: Parameter that used for ACO and Linear Programming process.....	65
Figure 4.34: Graf for ACO process.....	66
Figure 4.35: Result ACO.....	66
Figure 4.36: Optimized route to collect waste for Petron Bukit Beruang and Melaka Fashion City with only 14 minute and 8.7 km.....	66
Figure 4.37: Optimized route to collect waste for Micro-Nano Precision Sdn. Bhd. and Campus FTK and FKM UTeM with only 5 minute and 3.6 km.....	67
Figure 4.38: Optimized route to collect waste for Multimedia University , Mozac, Jalan Ayer Keroh and Masjid Tun Syed Ahmad Al Haj with only 29 minute and 18.6 km.....	67
Figure 4.39: Result from Linear Programming process.....	68
Figure 4.40: Optimized route to collect waste for Melaka Fashion City and Multimedia University with only 23 minute and 13.4 km.....	68
Figure 4.41: Optimized route to collect waste for Micro-Nano Precision Sdn. Bhd. and Campus FTK and FKM UTeM with only 10 minute and 6.3 km.....	69
Figure 4.42: Optimized route to collect waste for Mozac, Jalan Ayer Keroh and Masjid Tun Syed Ahmad Al Haj with only 16 minute and 8.2 km.....	69
Figure 4.43: Optimized route to collect waste for Petron Bukit Beruang	

with only 12 minute and 6.5 km.....	70
Figure 4.44: Plotted bin location for Case Study B.....	72
Figure 4.45: Plotted point for each smart bin located on the google map for Ant Colony Optimization and Linear Programming.....	72
Figure 4.46: Parameter that was set for Case Study B.....	73
Figure 4.47: Graf from the ACO process.....	73
Figure 4.48: Result from ACO process.....	73
Figure 4.49: Optimized route to collect waste for NSK Trade City (Melaka) Sdn Bhd, Bukit Katil, Melaka River Cruise and Taman Melaka Baru with only 22 minute and 11.7 km.....	74
Figure 4.50: Optimized route to collect waste for AEON MALL Bandaraya Melaka and NSK Trade City (Melaka) Sdn Bhd with only 37 minute and 19.6 km.....	74
Figure 4.51: Result from Linear Programming process.....	75
Figure 4.52: Optimized route to collect waste for AEON MALL Bandaraya Melaka, Pantai Hospital Ayer Keroh and Melaka River Cruise with only 30 minute and 13.7 km.....	75
Figure 4.53: Optimized route to collect waste for Bukit Katil, and Taman Melaka Baru with only 20 minute and 11.2 km.....	76
Figure 4.54: Optimized route to collect waste for Jonker Street Night Market and NSK Trade City (Melaka) Sdn Bhd with only 19 minute and 9.4 km.....	76

## LIST OF TABLES

Table 2.1: Advantages and Disadvantages of ACO.....	19
Table 2.2: Comparison of the previous research.....	20
Table 3.1: Example of APIs and SDKs.....	43
Table 4.1: Summary of the result.....	62
Table 4.2: Summary result for Case Study A.....	71
Table 4.3: Summary result for Case Study B.....	77

## LIST OF SYMBOLS AND ABBREVIATIONS

For examples:

IoT	:	Internet of Things
ACO	:	Ant Colony Optimization
VRP	:	Vehicle routing Problem
CVRP	:	Capacitated Vehicle Routing Problem
BSA	:	Backtracking Search Algorithms
TWL	:	Threshold Waste Level
GA	:	Genetic Algorithms
LP	:	Linear Programming
TSP	:	Traveling Salesman Problem
LCD	:	Liquid Crystal Display
IDE	:	Integrated Development Environment
VSC	:	Visual Studio Code
MPMDVRPTWHF	:	Multiple Pickup and Multiple Delivery Vehicle Routing issue with Time Window and Heterogeneous Fleets

## LIST OF APPENDICES

Appendix A: Arduino Code for Smart Bin.....	86
Appendix B: Python Code for Linear Programming.....	88
Appendix C: Python Code for Ant Colony Optimization.....	90



# CHAPTER 1

## INTRODUCTION



This chapter will provide an overview of the project, during which the project's goals and issue statement will be discussed. In addition, this chapter contains the project's scope statement, which outlines the areas of work that will be covered as well as those that will not be covered by the project. There is also a thesis statement at the conclusion of this chapter that gives a summary of each chapter in this thesis. This statement is located at the end of this particular chapter.