



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**DEVELOPMENT OF AN INTELLIGENT TRAINER BOARD  
FOR ARDUINO COMPONENTS**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronic Engineering Technology (Telecommunication) with Honours.

by

**ARFAH HAFIEZA BINTI MOHD HARUN**

**B071610303**

**940912-08-5714**

FACULTY OF ELECTRICAL AND ELECTRONIC ENGINEERING  
TECHNOLOGY

2019

**BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA**

Tajuk: Development of an Intelligent Trainer Board for Arduino Components

Sesi Pengajian: Semester 1 2019/2020

Saya **ARFAH HAFIEZA BINTI MOHD HARUN** 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:

.....

.....

ARFAH HAFIEZA BINTI MOHD

AMAR FAIZ BIN ZAINAL ABIDIN

HARUN

Cop Rasmi Penyelia

Alamat Tetap:

No. 294, Jln. Masyarakat,

Kg. Tengku Hussein Baru,

30020, Ipoh, Perak.

Tarikh:

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 an Intelligent Trainer Board for Arduino Components is the results of my own research except as cited in references.

Signature: .....

Author : ARFAH HAFIEZA BINTI MOHD  
HARUN

Date:

## **APPROVAL**

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

Signature: .....

Supervisor:           **AMAR FAIZ BIN ZAINAL ABIDIN**

Signature: .....

Co-supervisor:           **RAHAINI BINTI MOHD SAID**

## **ABSTRAK**

Arduino adalah platform prototaip elektronik yang pesat di mana ia merupakan sumber terbuka. Segala perisian dan perkakasan dapat dilaksanakan dan fleksibel untuk diubah dan dilanjutkan. Masa kini, kit Arduino perlu disambungkan ke papan pemasangan elektronik berasingan dan disambungkan dengan komponen yang berkaitan; input dan output, untuk mengkonfigurasi projek berasaskan Arduino. Kerumitan ini boleh menimbulkan kesilapan dan pengekodan yang salah.

Papan Pelatih Komponen Arduino dibangunkan untuk pengguna yang berminat untuk meneroka dan memperluaskan pengetahuan mereka kepada idea pembinaan litar mengenai pengaturcaraan berasaskan Arduino. Projek ini dibina menggunakan MIT Apps Inventor dan dihubungkan melalui Bluetooth ke telefon pintar Android. Setelah disambungkan, soalan akan dipaparkan dan pengguna perlu melakukan sambungan litar berdasarkannya. Komponen ini akan mensimulasikan pengekodan Arduino yang diprogramkan ssetelah sambungan dibuat.

Satu tinjauan dijalankan ke arah pensyarah dan pelajar di Fakulti Teknologi di Universiti Teknikal Malaysia Melaka (UTeM) untuk menyiasat kebolehpercayaan papan latihan ini untuk pengguna.

## ABSTRACT

Arduino is a rapid electronic prototyping platform in which it is an open source where software and hardware is practicable and flexible to be extended and edited. Concurrently, the Arduino kit must be connected to a separate breadboard which contains all related components; of input and outputs, to configure an Arduino-based project. The hassle of worrying of misconnections and wrong coding could be too much in one time.

Arduino Component Trainer Board is developed for user who keen on exploring and expand their knowledge to the idea of circuit construction regarding Arduino-based programming. An application is build using MIT Application Inventor and to be connected via Bluetooth to an Android smartphone. Once connected, questions will be displayed and user to do the circuit connection based on it. The component will simulate Arduino coding programmed as the connection is made.

A survey is conducted towards lecturers and students in Faculty of Technology of Universiti Teknikal Malaysia Melaka (UTeM) to investigate the reliability of the trainer board for users.

## **DEDICATION**

This report is finished on time with all the supports and loves received from my dear families and best friends. Not to forget, supervisors who has nothing but genuine guide all year-round throughout PSM 1 and PSM 2.



## ACKNOWLEDGEMENTS

Praises and gratitude to Allah s.w.t for His eternity blessings and wisdoms given for me in completing my studies and Projek Sarjana Muda (PSM). I also would like to express my highest appreciation to my supervisor, Amar Faiz Bin Zainal Abidin who gives absolute support, encouragement and consolation to me in completing this project throughout my highest and lowest state my mind. I am so grateful for his sincereness and valuable guidance that has been extended to me. Also, special thanks to my two best friends, Nur Shahidah Binti Shafaie and Nurin Lydia Binti Marah Azman who stays with me through my thick and thin. Them two being besides me throughout my degree life has been my greatest strength and security and I really appreciate them. Never forgotten, I am so thankful for the blessings given by all family members and friends. I wish you could see this, Mama. Love you, forever and always.

# TABLE OF CONTENTS

	<b>PAGE</b>
<b>TABLE OF CONTENTS</b>	<b>x</b>
<b>LIST OF TABLES</b>	<b>xv</b>
<b>LIST OF FIGURES</b>	<b>xvi</b>
<b>LIST OF SYMBOLS</b>	<b>xix</b>
<b>LIST OF ABBREVIATIONS</b>	<b>xx</b>
<b>CHAPTER 1 INTRODUCTION</b>	<b>1</b>
1.1 Introduction	1
1.2 Background Study	1
1.3 Problem Statement	3
1.4 Objectives	4
1.5 Scope of Works	4
1.6 Project Contributions	5
<b>CHAPTER 2 LITERATURE REVIEW</b>	<b>6</b>
2.1 Introduction	6
2.2 Past Related Research	7
2.2.1 Assorted Componets Checker (ACC)	7
2.2.2 Components Checker	9
2.2.3 Transistor Checker	10

2.2.4	IC Tester	11
2.3	Educational Technology	11
2.3.1	Wiki's Application in the Educational Technology for University Teachers	12
2.3.2	Modern Education Technologies in Higher Special Education	14
2.3.3	Application Study of Modern Educational Technology under Cloud Computing Platform	15
2.3.4	Using Educational Technology to Support Education for Deaf Students	17
2.4	Educational Trainer	18
2.4.1	Module-Based Edukit for Teaching and Learning 8051 Microcontroller Programming	18
2.4.2	Development of educational contents for electronic circuit learning	20
2.4.3	FPGA/Embedded System Training Kit Targeted to Graduate Students Towards Industry Level Short Training	21
2.4.4	Low Cost AVR Microcontroller Development Kit for Undergraduate Laboratory and Take-home Pedagogies	22
2.4.5	An Audio-Card Based Kit for Educational Purposes	24
2.4.6	An educational kit to teach to teach and learn Operational Amplifiers	25
2.5	Arduino	26

2.5.1	A Portable Low-cost Arduino-based Laboratory Kit for control education	27
2.5.2	Arduino as a learning tool	28
2.5.3	Engaging Students with Open Source Technologies and Arduino	30
2.5.4	Use of the Arduino Platform in Teaching Programming	32
2.5.5	Assessing the Usefulness of Object-Based Programming Education Using Arduino	33
2.5.6	Using Arduino to Develop a Bluetooth Electronic Scale for Water Intake	34
2.5.7	A Portable Low-cost Arduino-based Laboratory Kit for control education	35
<b>CHAPTER 3      METHODOLOGY</b>		<b>37</b>
3.1	Introduction	37
3.2	Project Overview	37
3.3	Block Diagram of Project	43
3.4	Hardware Development	44
3.4.1	Arduino Mega 2560	44
3.4.2	Arduino UNO	45
3.4.3	Light Emitting Diode (LED)	45
3.4.4	Buzzer	46

3.5.5	Potentiometer	47
3.4.6	Resistors	47
3.4.7	I2C Liquid Crystal Display (LCD)	48
3.4.8	Humidity Sensor (DHT11)	49
3.4.9	Round Pin Female Header	49
3.4.10	Bluetooth Module	50
3.5	Software Development	51
3.5.1	Arduino	51
3.5.2	MIT App Inventor	52
3.6	Project Layout	53
3.7	Circuit Layout	54
3.8	Flow of the Project	55
3.9	Project Costing	57
<b>CHAPTER 4</b>	<b>RESULTS</b>	<b>58</b>
4.1	Introduction	58
4.2	Reliability Testing	58
4.2.1	Drop Test	58
4.2.2	Aging Test	59
4.3	Functionality Testing	61
4.3.1	Unit Testing and Integration Testing	61

4.3.2	Boundary Testing	62
4.4	Comparison Testing	63
4.4.1	Hardware Design	63
4.4.2	Application Design	64
4.4.3	Flowchart Design of the Project	66
4.4.4	Prototype of the Simulation Result	68
4.5	Result Analysis of Survey Questions	71
<b>CHAPTER 5</b>	<b>CONCLUSIONS</b>	<b>82</b>
5.1	Conclusion of the Project	82
5.2	Recommedation for Future Works	83
<b>REFERENCES</b>		<b>84</b>
<b>APPENDIX</b>		<b>86</b>

## LIST OF TABLES

<b>TABLE</b>	<b>TITLE</b>	<b>PAGE</b>
Table 3.2.1	Gantt Chart of FYP 1	27
Table 3.2.2	Gantt Chart of FYP 2	28
Table 3.7.1	Pin connection of Arduino UNO to Arduino Mega	54
Table 3.7.1	Pin connection of electronic components to Arduino UNO	54
Table 3.10.1	Price list for components	57
Table 4.2.1.1	Drop Test Table	59
Table 4.2.2.1	Aging Test Table	60
Table 4.3.1.1	Unit Testing Table	61
Table 4.3.1.1	Integrating Testing Table	62
Table 4.3.2.1	Boundary Testing Table	62
Table 4.4.1.1	Hardware Design Table	63
Table 4.4.2.1	Application Design Table	64
Table 4.4.3.1	Results of expected and actual result based on flowchart	66
Table 4.4.4.1	Simulation result for correct connection	69
Table 4.4.2.1	Simulation result for wrong connection	70

## LIST OF FIGURES

<b>FIGURE</b>	<b>TITLE</b>	<b>PAGE</b>
Figure 2.1.1	Main keywords searched up for guidance	6
Figure 2.2.1.1	Layout of ACC project	8
Figure 2.2.1.2	Output at LCD when the component has faulty	8
Figure 2.2.1.3	Output at LCD when the component is in good condition	8
Figure 2.2.2.1	Component Tester Board	10
Figure 2.2.3.1	Transistor Tester	10
Figure 2.2.4.1	IC Tester	11
Figure 2.3.1.1	Mode of educational technology training based on Wiki system	13
Figure 2.3.3.1	Hierarchical model of cloud computing	16
Figure 2.4.1.1	Conceptual of Edukit	19
Figure 2.4.1.2	Edukit inside an ice-cream box	19
Figure 2.4.2.1	Prototype of the kit	20
Figure 2.4.3.1	Overview of the Embedded System	21
Figure 2.4.4.1	Schematic diagram of power system	23
Figure 2.4.4.2	Schematic diagram of microcontroller socket	23
Figure 2.4.4.3	Schematic diagram of peripheral function modules	23
Figure 2.4.5.1	Educational kit architecture	25
Figure 2.4.6.1	Overall architecture of electronic kit	26
Figure 2.5.3.1	Arduino Uno Blinking Light Experiment	31
Figure 2.5.4.1	Benefits of Arduino platform	32
Figure 2.5.5.1	Activity of object-based programming	33
Figure 2.5.5.2	Object-based programming on Arduino	34
Figure 2.5.6.1	Architecture system of the Bluetooth Electronic Scale	35
Figure 3.2.1	Flowchart of Final Year Project	39
Figure 3.3.1	Block diagram of the project	43
Figure 3.4.1.1	Arduino Mega 2560	44



Figure 3.4.2.1	Arduino UNO	45
Figure 3.4.3.1	Light Emitting Diode (LED)	46
Figure 3.4.4.1	Buzzer	46
Figure 3.4.5.1	Potentiometer	47
Figure 3.4.6.1	Resistors	48
Figure 3.4.7.1	I2C Liquid Crystal Display (LCD)	48
Figure 3.4.8.1	Humidity Sensor (DHT11)	49
Figure 3.4.9.1	Round Pin Female Header	50
Figure 3.4.10.1	Bluetooth Module	50
Figure 3.5.1.1	Arduino platform	52
Figure 3.5.2.1	MIT App Inventor	52
Figure 3.6.1	Expected project layout	53
Figure 3.9.1	General flowchart of the project	56
Figure 4.2.1.1.1	Drop test at 0.5m	59
Figure 4.2.1.1.2	Drop test at 1.0m	59
Figure 4.2.2.1.1	Temperature test outside at 8:00am	60
Figure 4.2.2.1.2	Temperature test outside at 6:00pm	60
Figure 4.2.2.1.3	Temperature test in refrigerator at 8:00am	60
Figure 4.2.2.1.4	Temperature test in refrigerator at 6:00pm	60
Figure 4.4.1.1.1	Expected design of top layout	63
Figure 4.4.1.1.2	Actual design of top layout	63
Figure 4.4.1.1.3	Expected outcome of the prototype	64
Figure 4.4.1.1.4	Actual outcome of the prototype	64
Figure 4.4.2.1.1	Expected design of home screen	64
Figure 4.4.2.1.2	Actual design of home screen	64
Figure 4.4.2.1.3	Expected design of question screen	65
Figure 4.4.2.1.4	Actual design of question screen	65
Figure 4.4.2.1.5	Expected design of correct answer screen	65
Figure 4.4.2.1.6	Actual design of correct answer screen	65
Figure 4.4.2.1.7	Expected design of wrong answer screen	65
Figure 4.4.2.1.8	Actual design of wrong answer screen	65
Figure 4.4.3.1.1	Expected result of “Welcome message”	66
Figure 4.4.3.1.2	Actual result of “Welcome message”	66

Figure 4.4.3.1.3	Expected result of Bluetooth pairing connection	66
Figure 4.4.3.1.4	Actual result of Bluetooth pairing connection	66
Figure 4.4.3.1.5	Expected result of display question in MIT App	66
Figure 4.4.3.1.6	Actual result of display question in MIT App	66
Figure 4.4.3.1.7	Expected result of correct connection	66
Figure 4.4.3.1.8	Actual result of correct connection	66
Figure 4.4.3.1.9	Expected result of wrong connection	66
Figure 4.4.3.1.10	Actual result of wrong connection	66
Figure 4.5.1	Pie chart for Question 1	66
Figure 4.5.2	Pie chart for Question 2	71
Figure 4.5.3	Pie chart for Question 3	72
Figure 4.5.4	Pie chart for Question 4	73
Figure 4.5.5	Pie chart for Question 5	74
Figure 4.5.6	Pie chart for Question 6	75
Figure 4.5.7	Pie chart for Question 7	75
Figure 4.5.8	Pie chart for Question 8	76
Figure 4.5.9	Pie chart for Question 9	77
Figure 4.5.10	Pie chart for Question 10	78
Figure 4.5.11	Pie chart for Question 11	78
Figure 4.5.12	Pie chart for Question 12	79
Figure 4.5.13	Pie chart for Question 13	80
Figure 4.5.14	Pie chart for Question 14	80
Figure 4.5.15	Pie chart for Question 15	81

## LIST OF SYMBOLS

<b>SYMBOL</b>	<b>EXPLANATION</b>
&	and
$\Omega$	Ohm
$\pm$	Plus-minus
$^{\circ}$	Degree (unit of angle)
$^{\circ}\text{C}$	Celcius (unit of temperature)
s	Seconds
cm	Centimeters
RM	Malaysia Ringgit
%	Percentage

## LIST OF ABBREVIATIONS

ABBREVIATION	EXPLANATION
USB	Universal Serial Bus
PC	Personal Computer
RAM	Random-access Memory
MCU	Microcontroller Unit
CPU	Central Processing Unit
IEEE	Institute of Electrical and Electronics Engineers
ACC	Assorted Component Checker
NPN	Negative-Positive-Negative
PNP	Positive-Negative-Positive
MOSFET	Metal Oxide Semiconductor Field Effect Transistor
BJT	Bipolar Junction Transistor
FET	Field Effect Transistor
MOOC	Massive Open Online Course
IT	Information Technology
TV	Television
R & D	Research and Development
DC	Direct-Current
DAC	Digital-to-Analog Converter
ADC	Analog-to-Digital Converter
PCB	Printed circuit board
CAD	Computer-Aided Design
AVR	Automatic Voltage Regulation
PIR	Passive Infrared Sensor
FYP	Final Year Project
PSM	Projek Sarjana Muda

# **CHAPTER 1**

## **INTRODUCTION**

### **1.1 INTRODUCTION**

The aim of this chapter is in creating the framework and introducing the brief idea of the project. It focused on the overview of the project, detailing the objectives, briefly discuss the problem statement, scope and provide the outcome of the project. Therefore, the structure of the whole project can be precisely visualized.

### **1.2 BACKGROUND STUDY**

An Arduino-based system course has become one of many crucial courses in today engineering field. Arduino is an open-source electronics platform used for constructing and programming of electronics. To pursue an Arduino-based project, it needed an Arduino board where all boards are entirely open-source, allowing users to build them separately and finally adapt them to their exact needs. As time and technology evolve, there are many kinds of Arduino boards invented such as Arduino Uno (R3), LilyPad Arduino, Red Board, Arduino Mega (R3) and Arduino Leonardo. Arduino boards are an easy and low-cost board that allows users to build the boards separately and adapt them to their own engineering project and different applications.

Arduino can be counterfeited as a little computer that can program to do things and interact with the world through all kinds of electronic components such as electronic sensors, lights, and motors. Basically, it makes electronic projects accessible to everyone and users can be as creative as they can and make all their ideas a reality. Many programmers use the Arduino because it makes things easier as it is the simpler version of C++ and the already made Arduino microcontroller are easy to program, erase and reprogrammed at any given time which made them very convenient.

Among many benefits of using Arduino is that the software of Arduino is well-suited and flexible with all kinds of operating systems such as in Linux, Windows and Macintosh, etc. Furthermore, an Arduino is very easy to use; even for beginners now that there are a lot of Arduino's source code available and accessible online. There are many and growing support from people and organizations out there that embrace Arduino, therefore whenever difficulties arise, there is always a pre-coded project and something new to learn online. Users just need to connect the Arduino board to the computer via USB and communicate using a standard serial protocol, runs in standalone mode and an interface connected to Personal Computers (PC).

However, even an easy-to-use Arduino has its own weaknesses. One of them is it hides the software complexity to make things easier for the user. All these limitations may trouble the users later as it causes the user to lack an understanding of how certain things work. An equally important weakness of Arduino is the complexity of accessing the library. It is not very efficient in certain parts, may waste RAM and CPU cycles and controls a lot of peripherals of the MCU. Above all, an Arduino board is a device that is very sensitive and delicate, so it must be handled carefully.

### **1.3 PROBLEM STATEMENT**

To develop skills in Arduino programming, one must know how to build a basic circuit connection with components competent to Arduino. A basic Arduino kit sold in store is completed with all necessities to build a circuit, however, there is not one kit that have an integrated component attached on a board. This causes some difficulties for user in building a circuit connection based on an Arduino program.

There are so many starter kits sold in the market for individual who have interest in exploring Arduino. The price is very affordable, at the price of less than RM100. In this case, the Arduino starter kit sold in the market that provided with basic circuit building, have a price that may be way cheaper than this trainer board. However, the trainer board benefits can win over as it is component integrated rather than individually.

To configure an Arduino-based project, the user must firstly construct a hardware circuit which contains respective and needed components based on the program configured, then only the Arduino is programmed and connected to the board. Some components may be found having faulty from the retail shop of the components bought. For this reason, the trainer board may firstly check the functionality of the components before proceeding using it to any electronic projects.

## **1.4 OBJECTIVES**

The main objectives of this project are:

1. To build a trainer with all-in-one Arduino components with an aim to save more time in building the hardware of the project.
2. To design an affordable and low cost, portable and integrated trainer kit to be used by anyone who wants to learn how an Arduino works. The trainer kit of size 25.7cm x 20.5cm x 10cm with a cost of less than RM200 can be used effortlessly by many who are devoted to brush up their knowledge in Arduino.
3. To evaluate the performance of the intelligence trainer board in relation to electronic components that are tested using it.

## **1.5 SCOPE OF WORKS**

Scopes are recorded to guarantee the venture will be inside its expected limit. The scopes will be functional to guarantee those projects are heading in the right course with attain the objective. Considering in designing the trainer board, not all electronic components will be available, though the most basic and relevance components will be possible to operate. Hence, the Arduino-based project must take regard in the type of components available on the trainer board only before proceeding to design the project.