

DEVELOPMENT OF PICK AND PLACE ROBOTIC ARM USING
ARDUINO



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2020



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF PICK AND PLACE ROBOTIC ARM USING ARDUINO

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

اونيورسي تيكنيكل مليسيا ملاك
UNIVERSITI TEKNIKA by MALAYSIA MELAKA

LIN WAI KIT

B071710662

970810-38-5019

FACULTY OF ELECTRICAL AND ELECTRONIC ENGINEERING

TECHNOLOGY

2020

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: **DEVELOPMENT OF PICK AND PLACE ROBOTIC ARM USING ARDUINO**

Sesi Pengajian: **2020**

Saya **LIN WAI KIT** 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,



.....
LIN WAI KIT

Alamat Tetap: NO 702, Jalan Haruan,
Taman Bernam, 35900 Tanjong Malim,
Perak.

Tarikh: 12/01/2021

Disahkan oleh penyelia:



NURUL KAUSAR BINTI AB MAJID
Juruaa Pengajar
Jabatan Teknologi Kejuruteraan Elektrik
Fakulti Teknologi Kejuruteraan
Elektrik dan Elektronik
Universiti Teknologi Malaysia Melaka

.....
NURUL KAUSAR BT AB MAJID

Cop Rasmi Penyelia

Tarikh: 12/01/2021

*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 PICK AND PLACE ROBOTIC ARM USING ARDUINO is the results of my own research except as cited in references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.


Signature:
Author: LIN WAI KIT
Date: 12/01/2021
اونيورسيتي تيكنيكل مليسيا ملاك
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPROVAL

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



Signature:

Supervisor: NURUL KAUSAR BT AB MAJID

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEDICATION

This thesis is dedicated to my parents and family member who give me moral support and encouragement during completing this report. I also would like to dedicate my friends and supervisor that always possibly help me when I have trouble with this project.



ABSTRACT

In recent years, people paid more and more attention to industry and daily work, which is also being replaced and automated by robots. A robot is an automatically operated machine that replaces human efforts, although it may not look like a human or perform functions in a human way. Pick and place robot is one of the technologies used to perform picking and placing operations in manufacturing industry. The design of this system can eliminate human error and human intervention and make the work more accurate and efficient. Literature mentions that the pick and place robot is designed and implemented in various field, such as bottle filling industry, packaging industry and also rehabilitation for patients with arm disability or stroke. The purpose of this project is to design and develop a low-cost pick and place 4 DOF robotic arm. In this project, servomotors act as the joints of robotic arm and is controlled by programming of Arduino Uno. The Arduino Uno acts as the microcontroller in this project. There are four potentiometers attached to the Arduino Uno and each servomotor or joint of robotic arm is controlled by potentiometer. By moving the servomotors, the Arduino robotic arm able to rotate 180 degree for picking and placing some objects from one place to another. The servomotor used in this project is low torque and can also be used with high torque servomotor to pick up and place more heavy objects. In addition, the robotic arm also can be controlled via Bluetooth or smartphone applications.

ABSTRAK

Pada tahun-tahun terakhir, orang-orang memperhatikan industri dan kerja sehari-hari, yang juga diganti dan otomatis oleh robot. Robot adalah mesin yang beroperasi secara otomatis yang menggantikan usaha manusia, walaupun ia tidak kelihatan seperti manusia atau melakukan fungsi dengan cara manusia. Pilih dan letak robot adalah salah satu teknologi yang digunakan untuk melakukan pilih dan letak operasi dalam industri pembuatan. Rencana sistem ini boleh menghapuskan ralat manusia dan campuran tangan manusia, dan membuat kerja lebih tepat dan efektif. Literatur menyebutkan bahawa robot pilih dan letak dirancang dan dilaksanakan dalam berbagai bidang, seperti industri penuh botol, industri pakej dan juga pemulihan semula untuk pesakit dengan cacat lengan atau stroke. Tujuan projek ini adalah untuk merancang dan mengembangkan pilih dan letak robot dengan biaya rendah. Dalam projek ini, mesin servo bertindak sebagai gabungan lengan robot dan dikawal oleh program Arduino Uno. Arduino Uno bertindak sebagai pengawal mikro dalam projek ini. Terdapat empat potentiometer yang dilampirkan kepada Arduino Uno dan setiap motor servo atau gabungan lengan robot dikawal oleh potentiometer. Dengan menggerakkan motor servo, lengan robot Arduino mampu memutar 180 darjah untuk mengambil dan menempatkan beberapa objek dari satu tempat ke tempat lain. Motor servo digunakan dalam projek ini adalah torque rendah, dan juga boleh digunakan dengan motor servo torque tinggi untuk mengambil dan menempatkan objek lebih berat. Selain itu, lengan robot juga boleh dikawal melalui Bluetooth atau aplikasi melalui telefon pintar.

ACKNOWLEDGEMENTS

I would like to take this opportunity to express my deepest gratitude to all the outstanding people who have provided continuous support, guidance, experience, understanding and commitment to my successful project. In addition, I would like to express my heartfelt thanks to my supervisor, Mrs Nurul Kausar BT AB Majid for her support, suggestions and encouragement, and for helping me in completing the implementation and documentation of this project. I would like to thank every lecturer who has taught me, especially those who have given me all the knowledge, skills and tips for my research. These knowledge, skills and tips are very important for me to complete this project. In addition, I would like to thank all my friends of BEEA, BEEE, BEET and BEEC in particular for providing me with transportation and making suggestions and improvements on my project. I really appreciate their guidance and cooperation. It is blessings and gracious encouragement of my parents, respected elders and my supporting colleagues that make me able to accomplish this project.

TABLE OF CONTENTS

	PAGE
DECLARATION	ii
APPROVAL	iii
DEDICATION	iv
ABSTRACT	I
ABSTRAK	II
ACKNOWLEDGEMENTS	III
TABLE OF CONTENTS	IV
LIST OF TABLES	IX
LIST OF FIGURES	X
LIST OF APPENDICES	XIII
LIST OF SYMBOLS	XIV
LIST OF ABBREVIATIONS	XV
CHAPTER 1 INTRODUCTION	1
1.1 Introduction	1
1.2 Problem statement	3
1.3 Objectives	4
1.4 Project scope	4
1.5 Expected result	5
1.6 Thesis organization	5

CHAPTER 2	LITERATURE REVIEW	7
2.1	Introduction	7
2.2	Literature search	8
2.2.1	Mobile Robotic Arm.	8
2.2.2	Cortical control of a prosthetic arm for self-feeding.	8
2.2.3	An arm-wrestling robot driven by dielectric elastomer actuators.	9
2.2.4	Brain-machine interface via real-time fMRI: Preliminary study on thought-controlled robotic arm.	9
2.2.5	Real-time control of a robotic arm by neuronal ensembles.	10
2.2.6	Robotic arm skate for stroke rehabilitation.	10
2.2.7	A low cost compliant 7-DOF robotic manipulator.	11
2.2.8	A pneumatic robot for re-training arm movement after stroke: rationale and mechanical design.	12
2.2.9	Arm rehabilitation with a robotic exoskeleton in virtual reality.	13
2.2.10	A sensor-based dual-arm tele-robotic system.	13
2.2.11	6 DOF PC-based robotic arms (PC-ROBOARM) with efficient trajectory planning and speed control.	14
2.2.12	Survey of robotic arm and parameters.	15
2.2.13	Accelerometer-based control of an industrial robotic arm.	16
2.2.14	Automated tracking and grasping of a moving object with a robotic hand-eye system.	17
2.2.15	RUPERT: An exoskeleton robot for assisting rehabilitation of arm functions.	18
2.2.16	A biomimetic approach to inverse kinematics for a redundant	

	robot arm.	19
2.2.17	Robotic movement elicits visuomotor priming in children with autism.	19
2.2.18	A pilot clinical study on robotic assisted rehabilitation in VR with an arm exoskeleton device.	20
2.2.19	Robot-aided sensorimotor arm training improves outcome in patients with chronic stroke.	21
2.2.20	Analysis of a commercial EEG device for the control of an robot arm.	21
2.2.21	Design of a 3 DOF robotic arm.	21
2.2.22	Robotic arm design, development and control for agriculture applications.	22
2.2.23	Design and development of a robotic arm.	23
2.2.24	Development of the mobile robot with a robot arm.	24
2.2.25	Design of a controlled robotic arm.	25
CHAPTER 3 METHODOLOGY		26
3.1	Introduction	26
3.2	Flowchart	26
3.3	Software design	28
3.3.1	MIT App Inventor	28
3.3.2	Arduino IDE	31

3.4	Hardware Design	32
3.4.1	Arduino Uno	32
3.4.2	Servomotor	35
3.4.3	Potentiometer	36
3.4.4	HC-06 Bluetooth module	37
3.4.5	Circuit design	39
3.5	Operational Flow	40
 CHAPTER 4 RESULT AND DISCUSSION		 41
4.1	Introduction	41
4.2	The Developed Pick and Place Robotic Arm	41
4.3	Testing	51
4.4	Result Analysis	54
4.5	Button vs Slider	54
4.6	Servo motor vs Stepper motor in motion control	58
4.6.1	Pro and Cons of stepper motors in motion control	58
4.6.2	Pro and Cons of servo motors in motion control	58
4.7	Varies the speed of servo motor	59
4.8	Bluetooth module vs Wi-Fi module	61
4.8.1	Speed	62
4.8.2	Range	62
4.8.3	Power Consumption	62
4.8.4	Cost	63
4.9	Weakness	63

4.10	Summary	63
------	---------	----

CHAPTER 5	CONCLUSION AND RECOMMENDATION	65
------------------	--------------------------------------	-----------

5.1	Introduction	65
-----	--------------	----

5.2	Conclusion	65
-----	------------	----

5.3	Recommendation	66
-----	----------------	----

5.3.1	Wi-fi module	66
-------	--------------	----

5.3.2	Camera and Monitor	67
-------	--------------------	----

5.4	Project Potential	67
-----	-------------------	----

REFENRECES		68
-------------------	--	-----------

APPENDIX		73
-----------------	--	-----------



LIST OF TABLES

TABLE	TITLE	PAGE
Table 3.1	Technical Specifications of Arduino Uno R3	33
Table 3.2	Pin Description of Arduino Uno R3	34
Table 4.1	Table of value of delay and speed of servo motor	60



LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 2.1:	The structure of the arm-wrestling robot.	9
Figure 2.2:	Cortical neurons provide the signal to control the arm movement.	10
Figure 2.3:	The CAD model of the arm skate platform.	11
Figure 2.4:	The low-cost compliant manipulator.	12
Figure 2.5:	The L-Exos wear by a user.	13
Figure 2.6:	The system architecture.	14
Figure 2.7:	Robotic arm model (Left); Simulation model (Right).	15
Figure 2.8:	Robotic arm with labels.	16
Figure 2.9:	Industrial robot MOTOMAN HP6 controlled by arm gestures and postures.	17
Figure 2.10:	Tracking and grasping system.	18
Figure 2.11:	RUPERT IV.	19
Figure 2.12:	L-Exos wear by user.	20
Figure 2.13:	Solid model of robotic arm	22
Figure 2.14:	Robotic arm constructed by using aluminium links.	23
Figure 2.15:	Proposed block diagram for robotic arm.	24
Figure 2.16:	Robotic arm controlled by EMG signal.	25

Figure 2.17: Controlled glove with sensors.	25
Figure 3.1: Flowchart for the project.	27
Figure 3.2: App Inventor's design editor.	29
Figure 3.3: App Inventor's blocks editor.	30
Figure 3.4: Flow of MIT App Inventor.	30
Figure 3.5: Arduino IDE.	31
Figure 3.6: Arduino Uno R3.	32
Figure 3.7: Servomotor.	36
Figure 3.8: Potentiometer.	37
Figure 3.9: HC-06 Bluetooth module.	38
Figure 3.10: Pinout of HC-06 Bluetooth module.	38
Figure 3.11: Simulation circuit diagram using Proteus.	39
Figure 3.12: Operational flow chart for pick and place robotic arm	40
Figure 4.1: Front view of Developed Arduino Robotic Arm	42
Figure 4.2: Side view of Developed Arduino Robotic Arm.	43
Figure 4.3: Arduino Robotic Arm control by potentiometers.	45
Figure 4.4: Voltage divider circuit with Bluetooth module.	47
Figure 4.5: Mobile app developed by MIT app inventor.	48
Figure 4.6: Prototype Arduino Robotic Arm.	49
Figure 4.7: 4 DOF of Arduino Robotic Arm.	50
Figure 4.8: Pick action of developed robotic arm.	52
Figure 4.9: Place action of developed robotic arm.	53
Figure 4.10: Example of button control.	55
Figure 4.11: Example of slider control.	57

Figure 4.12: Sweep coding.

60

Figure 4.13: Servo motor moving from A to B.

60



LIST OF APPENDICES

APPENDIX	TITLE	PAGE
Appendix 1:	Gantt Chart of The Project	73
Appendix 2:	Coding for Potentiometer (Manual Control)	74
Appendix 3:	Coding for Bluetooth module (Smartphone Control)	76



LIST OF SYMBLO

ms millisecond

m metre

GHz Giga Hertz

Mbps Mega bit per second

Gbps Giga bit per second



LIST OF ABBREVIATIONS

DOF	degree of freedom
rtfMRI	Real-time functional magnetic resonance imaging
WREX	Wilmington Robotic Exoskeleton
VR	virtual reality
LCD	Liquid Crystal Display
BIO	basic input-output
PRO-M	programmable memory
ADC	analog-to-digital converter
ANN	Artificial Neural Network
ILC	Iterative learning controller
BMI	brain-machine interface
EEG	electroencephalography
EMG	electromyography
OS	operating system
GUI	graphical user interface
IoT	Internet of Things
NFC	Near-Field Communication
IR	Infrared
UHF	Ultra-High Frequency

BLE

Bluetooth Low Energy

PP

Polypropylene



CHAPTER 1

INTRODUCTION

1.1 Introduction

The definition of robot is to study, design, and manufacture with robot system. With the rise of manufacturing activities, people invented a kind of robotic arm to help each industry to complete a task or work, rather than using manpower. Robots are often used to perform safe, dangerous, high repetitive and unpleasant tasks. The robot can complete material handling, assembly, arc welding, resistance welding, machine tool loading and unloading, painting and other functions. It is very useful because it has high precision, intelligence and infinite energy levels to do work compared to humans. For example, in the assembly or packaging line, the robotic arm is widely used. It can lift small objects to achieve the repeated action that humans cannot bear for a long time. This is because it is not limited by fatigue or health risks of the robotic arm, the robotic arm can complete the task of lifting light materials efficiently and in time.

In the second half of the 20th century, the original meaning of the word robot changed. Although in science fiction, robot is still a kind of artificial machine whose performance is similar to or better than that of human. In the real world, robot is used to represent simpler machines. In industry, a controlled joint mechanical system is also called robot. Mobile robot is a kind of intelligence autonomous vehicle. For many people, the term robot has become a general term for any automatic machine. There are many people trying to redefine the word

robot. In industry, robot is a kind of “automatic control and reprogrammable multipurpose manipulator” which is defined by ISO that can be programmed on three or more axes. Related to web search engine, robot is an “automatic program that tracks links to websites on behalf of search engine or directory”. According to these definitions. Is the famous robot R2D2 in Star Wars as a robot?

The machines we now call robot recombine some of the capabilities of science fiction robots, such as the ability of industrial robots to operate or the ability of mobile robots to navigate, but there are still many gaps. There are many reasons for these changes in the meaning of the word robot, but the main reason may be marketing. In business marketing, the word robot is used to give products a future and complex connotation, such as “kitchen robot”. There is also another way of marketing in the scientific community, where the term robot is overused. For instance, trying to make their funding requirements for Research & Development (R&D) activities more attractive. However, this over marketing has some negative effects on those who are still working on robotics.

In this highly developed society, time and manpower are the key constraints to accomplish tasks on a large scale. In most regular and frequently work, automation plays an important role in saving human resources. One of the main and most frequently performed tasks is the selection and placement from source to destination.

Today’s industries are increasingly turning to computer-based automation, mainly because of the need to increase productivity and deliver uniform quality end products. In the past, due to the inflexibility and high cost of the hard-automation system for automated manufacturing tasks, people have a wide range of interests in the use of mechanical arm which can perform various manufacturing functions at a lower cost in a flexible environment. The use of industrial mechanical arm reflects some contemporary trends of