

**ROBOTIC SYSTEM DESIGN CONTROLLED BY USING HAND-GESTURE  
MOTION SENSOR**

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Dedicated to  
My Beloved Parents  
Who had never stopped praying and trying to give the best for their beloved children.

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## ABSTRACT

The evolution of information technologies has increased and improved the interaction between human beings and computers. Nowadays, there are inventions to enhance computer system to allow detection of human motion. As evidence, hand gesture motion sensor is one of the innovative products which allow the communication between these two parties. The aim of this project is to design and construct a hand gesture motion sensor controlled robotic arm system. Globally, robotic system becomes more popular and is utilized in a wide range of areas. However, most systems are handled by traditional input method such as keyboard, mouse and controller or being preprogrammed. Hence, the new approach of operating robotic system by hand gesture will subsequently be proposed as an alternative method of controlling system without the necessity of controller or preprogrammed. The purpose of this project is to develop a simple robotic arm system and interface it with the Leap Motion Controller, as the hand gesture motion sensor. The process of design and construct of a robotic arm system will be presented in this thesis. Besides that, the method used to interface the Leap Motion Controller for communication with robotic arm system will be demonstrated and discussed. A robotic arm prototype was successfully implemented and controllable by hand gesture and the results are recorded in this thesis.

## ABSTRAK

Evolusi teknologi maklumat telah meningkat dan telah menambahbaik interaksi di antara manusia dan komputer. Kini, banyak ciptaan telah meningkatkan sistem komputer untuk membolehkan pengesanan gerakan manusia. Sebagai bukti, sensor gerakan tangan adalah salah satu produk inovatif yang memainkan peranan komunikasi di antara pihak manusia dan komputer. Matlamat projek ini adalah untuk mereka bentuk dan membina satu sistem robotik yang dikawal daripada sensor gerakan tangan. Secara global, sistem robotik telah semakin popular dan diaplikasikan dalam pelbagai bidang. Walau bagaimanapun, kebanyakan system robotik ini dikendalikan dengan kaedah input tradisional seperti papan kekunci, tetikus dan pengawal atau yang diprogramkan. Oleh itu, pendekatan baru yang beroperasi sistem robotik dengan gerakan tangan manusia akan dicadangkan sebagai kaedah alternatif sistem kawalan tanpa perlu pengawal atau diprogramkan. Tujuan projek ini adalah untuk membangunkan satu sistem robotik dan dipadankan dengan Leap Motion Controller, sebagai sensor gerakan tangan. Proses reka bentuk dan pembinaan sistem robotik akan dibentangkan di dalam tesis ini. Selain daripada itu, kaedah yang digunakan untuk berinteraksi di antara Leap Motion Controller dan system robotik akan ditunjukkan dan dijelaskan dalam projek ini. Satu sistem robotik prototaip telah Berjaya dihasilkan dan dapat dikawal oleh gerakan tangan manusia dan keputusannya telah direkodkan di dalam tesis ini.



## TABLE OF CONTENT

<b>CHAPTER</b>	<b>CONTENT</b>	<b>PAGE</b>
	<b>TITLE</b>	<b>i</b>
	<b>VERIFICATION FORM</b>	<b>ii</b>
	<b>AUTHOR RECOGNITION</b>	<b>iii</b>
	<b>SUPERVISOR RECOGNITION</b>	<b>iv</b>
	<b>DEDICATION</b>	<b>v</b>
	<b>ACKNOWLEDGEMENT</b>	<b>vi</b>
	<b>ABSTRACT</b>	<b>vii</b>
	<b>ABSTRAK</b>	<b>viii</b>
	<b>TABLE OF CONTENT</b>	<b>ix</b>
	<b>LIST OF TABLE</b>	<b>xii</b>
	<b>LIST OF FIGURE</b>	<b>xiii</b>
<b>1</b>	<b>INTRODUCTION</b>	
	1.1 Background	1
	1.2 Problem Statement	3
	1.3 Objectives	4
	1.4 Scope of the Project	4
	1.4.1 Robotic System	4
	1.4.2 Leap Motion Controller	5
	1.5 Significance of the Project	5
	1.6 Report Structure	6

<b>2</b>	<b>LITERATURE REVIEW</b>	
2.1	Robotics System	8
2.2	Robotic Arm System	10
2.3	Control in Robotics System	12
2.4	Hand Gesture Interaction	13
2.5	Leap Motion Controller	14
2.6	Related Works	17
2.7	Summary	22
<b>3</b>	<b>METHODOLOGY</b>	
3.1	Detail of the Project	23
3.1.1	Description	23
3.1.2	Block Diagram	24
3.1.3	Process of the Project	24
3.2	Robotic Arm System	26
3.2.1	Construct Process	26
3.2.2	Components	27
3.2.3	Construction of the Base Part	29
3.2.4	Construction of the Arm Part	33
3.2.5	Arduino and the Circuitry	38
3.3	Software Part	42
3.3.1	Development Process	42
3.3.2	Leap Motion Controller	44
3.3.3	Arduino	46
3.3.4	Programming Part	47
3.4	Summary	57

<b>4</b>	<b>RESULT AND DISCUSSION</b>	
4.1	Hardware Results	58
4.1.1	Base Part	58
4.1.2	Arm Part	59
4.1.3	Gripper Part	60
4.1.4	Arduino and Circuitry	60
4.1.5	Whole Robotic Arm System	61
4.2	Software Results	62
4.2.1	Data Log from Leap Motion Controller	62
4.3	Final Results	76
4.4	Discussion	87
4.5	Summary	89
<b>5</b>	<b>CONCLUSION AND RECOMMENDATION</b>	
5.1	Conclusion	90
5.2	Recommendation	91
5.3	Summary	92
	<b>REFERENCES</b>	<b>93</b>
	<b>APPENDIX A</b>	<b>96</b>
	<b>APPENDIX B</b>	<b>102</b>
	<b>APPENDIX C</b>	<b>103</b>
	<b>APPENDIX D</b>	<b>104</b>

**LIST OF TABLES**

<b>NO.</b>	<b>TITLE</b>	<b>PAGE</b>
2.1	Comparison between Leap Motion Controller and Microsoft Kinect	16
2.2	Comparison between related works	20
3.1	Comparison between Both Servo Motor used in the Project	28
3.2	Details of Voltage and Current of the Power Supply	41

## LIST OF FIGURES

NO.	TITLE	PAGE
2.1	Leap Motion Controller	14
2.2	The schematic view of the Leap Motion Controller	15
3.1	Block diagram of the system	24
3.2	Process flow of the project	25
3.3	Flow Chart of the Robotic Arm System Construction	26
3.4	Top View of the Design in 2D WireFrame View	29
3.5	Top View of the Design in Realistic View	30
3.6	Bottom View of the Design in Realistic View	30
3.7	Square Base of the Robotic Arm System	31
3.8	4 Rectangular Pieces to be attached on the Square Base	31
3.9	Base Part after Fabrication Process	32
3.10	Base for attach Servo Motor	32
3.11	Final Base Part of the Robotic Arm System	33
3.12	Arm Part Construction (a)	33
3.13	Arm Part Construction (b)	34
3.14	Arm Part Construction I	34
3.15	Arm Part Construction (d)	35
3.16	Arm Part Construction I	35
3.17	Arm Part Construction (f)	36

3.18	Arm Part Construction (g)	36
3.19	Arm Part Construction (h)	37
3.20	Arm Part Construction (i)	37
3.21	Screwed up between the Base Part and the Arm Part	38
3.22	The Connection of the System	39
3.23	Circuit Design Layout in Proteus	40
3.24	EmBoss EB-500W Power Supply (a)	41
3.25	EmBoss EB-500W Power Supply (b)	41
3.26	Connection between Power Supply and the Circuit	42
3.27	Flow Chart of the Software Development Part	43
3.28	Interaction between Leap Motion Controller and Arduino	44
3.29	Leap Motion Diagnostic Visualizer	45
3.30	Setting of the Web Socket in Leap Motion Control Panel	45
3.31	Standard Firmata Directory Guide	46
3.32	Programming with Notepad++	48
3.33	Save file in JavaScript Format	48
3.34	Running the Program in the Nodejs Command Prompt	49
3.35	Program for Connection to the Leap Motion Controller	50
3.36	Successfully Connect with Leap Motion Controller	50
3.37	Program for Connection to Arduino Board	51
3.38	Successfully Connect with the Arduino Board and Terminate It	52
3.39	Calculate for the Arm Angle with Inverse Kinematic	54
3.40	Calculate the Distance between 2 Fingers	56
4.1	Base Part of the Robotic Arm System	59
4.2	Arm Part of the Robotic Arm System	59
4.3	Gripper of the Robotic Arm System	60
4.4	Arduino and the Circuit for the System	61
4.5	Final Prototype of the Robotic Arm System	62
4.6	Sample Data when Hand Position on Middle of Leap Motion Controller	63
4.7	Sample Data when Hand Position Move to the Left End	64

4.8	Sample Data when Hand Position Move to the Right End	64
4.9	Sample Data when Hand Position Move to the Top End	65
4.10	Sample Data when Hand Position Move to the Bottom End	66
4.11	Sample Data when Hand Position Move Forward	67
4.12	Sample Data when Hand Position Move Backward	67
4.13	Data Track when Movement of Hand Position	68
4.14	Sample Data when Hand Rotation in the Middle along X-Axis	69
4.15	Sample Data when Hand Rotate to the Left	70
4.16	Sample Data when Hand Rotate to the Right	70
4.17	Data Track when Hand Rotation along X-axis	71
4.18	Sample Data when Hand Rotation in the Middle along Z-Axis	72
4.19	Sample Data when Hand Move Upward	73
4.20	Sample Data when Hand Move Downward	73
4.21	Data Track when Hand Rotation along Z-axis	74
4.22	Sample Pointables Position of Index Finger	75
4.23	Sample Pointables Position of Middle Finger	76
4.24	Base of the Robotic Arm System in Center Position	77
4.25	Hand Gesture Movement in Center Position	77
4.26	Base of the Robotic Arm System Moving Toward Left Side	78
4.27	Hand Gesture Moving Toward Left Side of the Leap Motion	78
4.28	Base of the Robotic Arm System Moving Toward Right Side	79
4.29	Hand Gesture Moving Toward Right Side of the Leap Motion	79
4.30	Arm of the Robotic Arm System Moving Upward	80
4.31	Hand Gesture of Moving Upward from the Leap Motion	80
4.32	Arm of the Robotic Arm System Moving Downward	81
4.33	Hand Gesture of Moving Downward to the Leap Motion	81
4.34	Palm of the Robotic Arm System Rotate to the Left Side	82
4.35	Hand Gesture of Rotating the Hand to the Left Side	82
4.36	Palm of the Robotic Arm System Rotate to the Right Side	83
4.37	Hand Gesture of Rotating the Hand to the Right Side	83
4.38	Palm of the Robotic Arm System Moving Upward	84

4.39	Hand Gesture of Moving the Palm Upward	84
4.40	Palm of the Robotic Arm System Moving Downward	85
4.41	Hand Gesture of Moving the Palm Downward	85
4.42	Opening of the Gripper of the Robotic Arm System	86
4.43	Hand Gesture used to Control the Gripper to be Open	86
4.44	Palm Part with 5 Artificial Fingers	87



## **CHAPTER 1**

### **INTRODUCTION**

This chapter is to introduce about the project. This project is to construct a robotic arm system that able be controlled by the hand gesture movement. The background of the project will be introduced. Then the problem behind the project and the solution will be discussed. After that, the objective of the project will be stated clearly. The scope of the project will be defined as well as the significance of the project. All the concept of the project will be discussed within this chapter.

#### **1.1 Background**

Nowadays, robotic system has become an essential element in our daily life. It functions in a wide range of areas. The trend of implementing robotic system has been adopted by many industries and countries. In general, robotic system is used to handle specific tasks that are tough and hazardous to human beings. Different robotic system will be designed to fulfill different task requirements and will have their own researches in order to achieve the specific task requirement of the system. However, the process of

designing a robotic system is time-consuming as it involves many considerations towards the construction of robotic system and the designing of controlling the system. The controlling system plays an important role because it will ensure that the robotic system could perform a specific task accordingly.

Over the past decades, the robotic system is designed with controlling by the traditional input methods such as input from keyboard, mouse or controller. However, with the evolution of technologies and computers, there are many researches on human-computer interaction technologies. Hence there are lots of different input devices has been implemented such as sensors which are able to allow computer communicate with the real environment [1]. This phenomenon leads to a new era of different controlling method for the robotic system where the human activity gestures could control the movement of robotic systems.

The purpose of this project is to construct a robotic system that is able to be controlled by human's hand gesture motion where the robotic system can be controlled without using the traditional input methods or being preprogrammed. The movement of robotic system will be designed and constructed to follow the human hand gesture activity. This will be an alternative method to control the robotic system which the robotic system motion will be mimicked to human activity gestures. The focus of this project is the robotic arm system. The robotic arm system will be constructed by using the Arduino as the microcontroller. The Leap Motion Controller is used as the input device to interact with the robotic arm system.

## 1.2 Problem Statement

This project is to construct a robotic system which able controlled by human hand gesture activities. It is a new interactive technology between human and machine by using human hand gesture to controlling the robotic system. The robotic system will be able to perform its specific task according to the users hand gesture activity. Hence this new intuitive method provides a platform of controlling the robotic system without physical contact between human and machine.

Currently, most robotic systems in the industries are controlled by traditional input method or being preprogrammed. This design brings inconvenience to users who are unable to control the robotic system effectively and expertly with a controller or has low understanding towards the robotic system. Trainings and basic knowledge are required by the users to control the robotic system. Thus, the design of controlling robotic system with hand gestures will become a solution to the existing problem as it is more convenient and user friendly compared to the traditional input method. Users could control the robotic system to move according to their own desired movement by using hand gesture motions.

Besides that, this new intuitive method to controlling the robotic system by using hand gesture motion also able to allow users to work on those risky activities or handle heavy object. Users can control the robotic system in a distance by using hand gesture in order to help them handle the dangerous activities such as handle toxic substances or bomb disposal. This method provides a more precise movement of the robotic system instead of using the controller. Users also can control the robotic system by their hand gesture movement to handle some heavy object or robot controlled operation in the manufacturing industry. This new interactive method between human and machine provide a more convenient method to controlling the robotic system in much of the area.

### **1.3 Objectives**

The aim of this project is to construct a robotic arm system which can be controlled by human hand gesture activity. Therefore, the objectives of this project are:

- 1.3.1 To design and construct a robotic system with Arduino.
- 1.3.2 To implement a hand gesture motion system for the robotic system.
- 1.3.3 To develop the communication system between Leap Motion Controller and robotic system.

### **1.4 Scope of the Project**

The scope of the project is divided into two parts which is the robotic system and the leap motion controller.

#### **1.4.1 Robotic System**

The robotic system selected in this project is a robotic arm system. The robotic arm system is chosen in this project because it is the most human-like arm among the robotic system. Therefore, this project able to design the movement of the robotic arm system which will mimic with human hand gesture motion. The robotic arm system will be designed as four Degree of Freedom (DOF). Besides that, a gripper that controlled by another servo motor will be connected to the robotic arm system. A real-time and wired connection system is selected in the design of the robotic arm system. However, the robotic arm system will have a limitation of motion and rotation angle and the gripper only able to handle light weight object.

### **1.4.2 Leap Motion Controller**

The Leap Motion Controller is the hand gesture sensor used in this project. It is Universal Serial Bus (USB) connection between the personal computer (PC) and the installation of Leap Motion Application in the PC is required. During the controlling of the robotic system, the Leap Motion Controller must be turned on as “resume tracking”. Although the controller is able to detect the motion of both hands, however the system is designed to use one hand to controlling the robotic system. Besides that, the hand gesture activity also must be performed on top of the Leap Motion Controller.

## **1.5 Significance of the Project**

The proposed robotic arm system design of this project is based on a user friendly controlling system platform. It is simple and easy to use as the users could control the robotic arm system by just placing their hand on top of the Leap Motion Controller and perform their hand gesture activity. Consequently, the motion of a robotic arm system will mimic with the user’s hand gesture activity.

Secondly, the result of this project also emphasizes on sustainability element. Similar concept and method of this robotic arm system can be implemented in different categories and types of the robotic system. Besides that, this system could be further improved on it's functionality in future researches. Furthermore, the concept of the hand gesture implements in the hardware also can be used in the other area of researches.

Lastly, this designed robotic system has its own value of commercialization. It could be implemented to support the elderly and disabled people in home environments [1]. It also could be modified and adopted by any industries, especially in the manufacturing industry to perform any difficult and hazardous task or some robots

controlled operation. In addition, it could be designed as advance robotic toys which are operated with a hand gesture control system [2].

## **1.6 Report Structure**

This report consists of five chapters, which are Introduction (Chapter One), Literature Review (Chapter Two), Methodology (Chapter Three), Result and Discussion (Chapter Four) and Conclusion and Recommendation (Chapter 5).

Chapter 1 will be discussing about the introduction of the project. In general, all concept of this project is described in this chapter. The background of project and the problem statement is identified. In addition, the objectives of the project will be stated in this chapter. The scope of the project as well as the significant of the project will be defined.

Chapter 2 will provide related literature reviews on the topics robotics system, robotic arm system, controlling in robotic system, hand gesture interaction and Leap Motion Controller. Besides that, this chapter also provides some review from other researches on topics which are relevant to this project.

Chapter 3 will explain about the methodology of the project. Work processes and problem solving methods of the project will be explained in order to achieve the objectives of the project. The process of robotic arm system construction and implementation method of the communication system between Leap Motion Controller and the robotic arm will be explained in this chapter.

Chapter 4 will show all the results while working on the project and the final achievement of the project. This chapter also will present some of the data logging that will be used in the project from the Leap Motion Controller. Some of the problems and obstacles throughout the project will be discussed later in this chapter.

Chapter 5 will be concluded all the process based on this project. Some recommendations and future implementation in order to further improve this project will be presented in this chapter as well.

## CHAPTER 2

### LITERATURE REVIEW

This chapter includes the study of the review based on robotics system, robotic arm system, controlling in robotic system, hand gesture interaction and Leap Motion Controller. Then the review of other relevant projects is provided as well as the comparison information between them.

#### 2.1 Robotics System

A Czech novelist, Karel Capek has popularized the term of “robot” in a 1921 play Rossum’s Universal Robots (R.U.R). The term of “robot” in Czech is a word in the meaning of worker or servant. According to [17], a robot is an autonomous system which exists in the physical world, can sense its environment, and can act on it to achieve some goals. In other word, robot is a reprogrammable, multifunctional manipulator or a device that's designed to perform some specific tasks to achieve the goals. Robotics is the study of robots, which means it is the study of the autonomous system that able to perform its