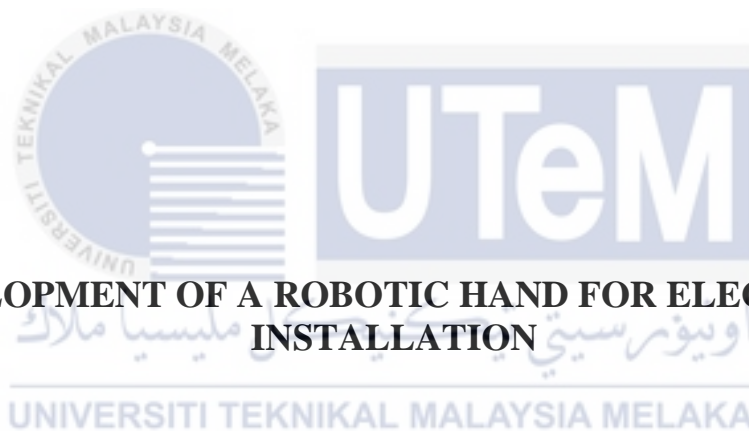




**Faculty of Electrical and Electronic Engineering Technology**



**DEVELOPMENT OF A ROBOTIC HAND FOR ELECTRICAL  
INSTALLATION**

**AHMAD IKHMAL HAKIM BIN OMAR**

**Bachelor of Electrical Engineering Technology (Industrial Power) with Honours**

**2021**

# **DEVELOPMENT OF A ROBOTIC HAND FOR ELECTRICAL INSTALLATION**

**AHMAD IKHMAL HAKIM BIN OMAR**

**A project report submitted  
in partial fulfillment of the requirements for the degree of  
Bachelor of Electronics Engineering Technology with Honours**



**Faculty of Electrical and Electronic Engineering Technology**

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

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INSTALLATION

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## DECLARATION

I declare that this project report entitled “Development of a robotic hand for electrical installation” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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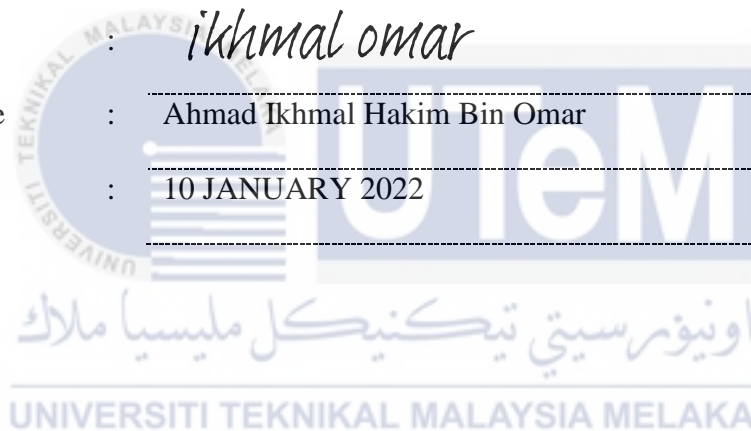
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.....  
.....

## DEDICATION

*To my beloved mother, Hasimah Mohamad, and father, Omar Busu,*



## ABSTRACT

Present-day, the construction sector has been criticized for being reluctant to implement new technology, and labor productivity has remained stagnant. In order to make this construction grow fast as needed, it required new technology to replace human work to ensure the electrical construction grows faster, accurately, and safely. A robotic hand with hand gesture was introduced to easily control the electrical installation without human touch. Hand gesture recognition is an emerging field of technology in robotics and human interaction. An urge needs to create such a device that can substitute the human for doing works safely. Due to a wide range of applications, such as pick-and-placed, upper-limb prosthesis, and robotic hands development, robotic hands development has been a lot of interest in recent years. The objectives of this study are to develop a prototype robotic hand that hand gestures can control, create a mechanical hand finger, utilize a flex sensor and wireless communication and demonstrate how a prototype robotic hand works and how well it performs Mechanical hands are designed to mimic our agility and versatility in manipulating objects. Understanding the anatomy and motion of the human hand is also crucial for robot hand study. This is a detailed project overview for the robotic hand system. A human hand (user) has been declared on the left side, consisting of an ESP32 (user) using five flex sensors. Aside from that has been designated as a robotic hand that operates the ESP32 (mechanical design) using five servo motors that drive the robotic hand's fingers. The project's design is being developed as soon as all of the necessary information has been obtained. Microcontrollers (ESP 32), a motor, a flex sensor, and a glove were used in this project. A servo motor is the type of motor that we use. As the microcontroller with a built-in wireless connection or module, the ESP 32 was chosen. It includes everything you will need to connect the microcontroller to a computer or power it up, including a USB cord. In conclusion, an initial result in this research is expected to meet the objective of this studies and give significance to the researchers and users.

## ***ABSTRAK***

Pada masa ini, sektor pembinaan dikritik kerana enggan mengimplementasikan teknologi baru, dan produktiviti tenaga kerja tetap tergendala. Untuk menjadikan pembinaan ini berkembang dengan pantas seperti yang diperlukan, ia memerlukan teknologi baru untuk menggantikan kerja manusia untuk memastikan pembinaan elektrik tumbuh dengan lebih cepat, tepat, dan selamat. Tangan robotik dengan gerakan tangan diperkenalkan untuk mengawal pemasangan elektrik dengan mudah tanpa sentuhan manusia. Pengecaman isyarat tangan adalah bidang teknologi yang muncul dalam robotik dan interaksi manusia. Desakan perlu membuat alat sedemikian yang dapat menggantikan manusia untuk melakukan kerja dengan selamat. Oleh kerana terdapat banyak aplikasi, seperti pemutaran tangan-kanan, prostesis anggota atas, dan pengembangan tangan robotik, pengembangan tangan robotik menjadi sangat menarik dalam beberapa tahun kebelakangan ini. Objektif kajian ini adalah untuk mengembangkan prototaip tangan robotik yang dapat dikawal oleh gerakan tangan, membuat jari tangan mekanikal, menggunakan sensor fleksibel dan komunikasi tanpa wayar dan menunjukkan bagaimana tangan robot prototaip berfungsi dan seberapa baik ia berfungsi. Tangan mekanik dirancang untuk meniru ketangkasan dan fleksibiliti kita dalam memanipulasi objek. Memahami anatomi dan gerakan tangan manusia juga penting untuk kajian tangan robot. Ini adalah gambaran keseluruhan projek terperinci untuk sistem tangan robotik. Tangan manusia (pengguna) telah dinyatakan di sebelah kiri, terdiri dari ESP32 (pengguna) yang menggunakan lima sensor flex. Selain itu telah ditetapkan sebagai tangan robot yang mengendalikan ESP32 (reka bentuk mekanikal) menggunakan lima motor servo yang menggerakkan jari tangan robotik. Reka bentuk projek sedang dibangunkan setelah semua maklumat yang diperlukan telah diperoleh. Mikrokontroler (ESP 32), motor, sensor flex, dan sarung tangan digunakan dalam projek ini. Motor servo adalah jenis motor yang kita gunakan. Sebagai mikrokontroler dengan sambungan atau modul tanpa wayar terbina dalam, ESP 32 dipilih. Ini merangkumi semua yang anda perlukan untuk menyambungkan mikrokontroler ke komputer atau menyalakannya, termasuk kabel USB. Sebagai kesimpulan, hasil awal dalam penyelidikan ini diharapkan dapat memenuhi objektif kajian ini dan memberi kepentingan kepada penyelidik dan pengguna.



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## TABLE OF CONTENTS

	PAGE
<b>DECLARATION</b>	
<b>APPROVAL</b>	
<b>DEDICATIONS</b>	
<b>ABSTRACT</b>	<b>i</b>
<b>ABSTRAK</b>	<b>ii</b>
<b>ACKNOWLEDGEMENTS</b>	<b>iii</b>
<b>TABLE OF CONTENTS</b>	<b>i</b>
<b>LIST OF TABLE</b>	<b>iv</b>
<b>LIST OF FIGURES</b>	<b>v</b>
<b>LIST OF SYMBOLS</b>	<b>viii</b>
<b>LIST OF ABBREVIATIONS</b>	<b>ix</b>
<b>LIST OF APPENDICES</b>	<b>x</b>
<b>CHAPTER 1 INTRODUCTION</b>	<b>1</b>
1.1 Background	1
1.2 Problem Statement	4
1.3 Project Objective	4
1.4 Project Scope	5
<b>CHAPTER 2 LITERATURE REVIEW</b>	<b>6</b>
2.1 Introduction	6
2.2 Robotic Hand	7
2.3 Related Project Overview	8
2.4 Example Of Anthropomorphic Robotic Hand	14
2.4.1 Robotic Hand Controller Based on Flex Sensor	14
2.4.1.1 Mechanical Design	14
2.4.1.2 Control Design	15
2.4.2 Harada Hand (California Institute of Technology)	15
2.4.2.1 Mechanical Design	16
2.4.2.2 Control Design	16
2.4.3 EH1 Milano Hand (Prensilia SRL)	17
2.4.3.1 Mechanical Design	17
2.4.3.2 Control Design	17
2.4.4 IH1 Azzura Hand (Prensilia SRL)	18
2.4.4.1 Mechanical design	18

2.4.4.2	Control design	19
2.4.5	The Biomimetic Anthropomorphic Robotic Hand	19
2.4.5.1	Mechanical design	19
2.4.5.2	Control design	20
<b>2.5</b>	<b>Significant of Comparison</b>	<b>20</b>
2.5.1	Mechanical design	21
2.5.2	Control design	22
<b>CHAPTER 3</b>	<b>METHODOLOGY</b>	<b>23</b>
<b>3.1</b>	<b>Introduction</b>	<b>23</b>
<b>3.2</b>	<b>Research methodology</b>	<b>23</b>
<b>3.3</b>	<b>Project Overview</b>	<b>25</b>
3.3.1	Transmitter overview by flow	27
3.3.2	Receiver system overview by flow	28
<b>3.4</b>	<b>Coding of the project</b>	<b>29</b>
3.4.1	Introduction	29
3.4.2	Transmitter code	29
3.4.3	Receiver coding	30
<b>3.5</b>	<b>Design of the project</b>	<b>31</b>
<b>3.6</b>	<b>Circuit Design</b>	<b>33</b>
<b>3.7</b>	<b>Materials of main components (mechanical design)</b>	<b>35</b>
3.7.1	Introduction	35
3.7.2	ESP32	35
3.5.2.1	Datasheet of ESP32	36
3.7.3	Flex Sensor Introduction	37
3.7.4	Servo Motor	38
3.5.4.1	Datasheet of servo motor	39
<b>3.8</b>	<b>Materials of main components (control design)</b>	<b>40</b>
3.8.1	Introduction	40
3.8.2	Glove	40
3.8.3	Needle and Thread	41
<b>3.9</b>	<b>System Operating Procedure</b>	<b>42</b>
<b>3.10</b>	<b>Content analysis</b>	<b>42</b>
<b>CHAPTER 4</b>	<b>RESULT AND ANALYSIS</b>	<b>44</b>
<b>4.1</b>	<b>Introduction</b>	<b>44</b>
<b>4.2</b>	<b>Simulation Result</b>	<b>44</b>
<b>4.3</b>	<b>Development Result</b>	<b>46</b>
<b>4.4</b>	<b>System Performance</b>	<b>49</b>
4.4.1	Result for thumbfinger	50
4.4.2	Result of index finger	53
4.4.3	Result of middle finger	56
4.4.4	Result of ring finger	59
4.4.5	Result of Pinky Finger	62
<b>4.5</b>	<b>Communication Module Performance</b>	<b>65</b>
<b>4.6</b>	<b>Discussion</b>	<b>66</b>
<b>CHAPTER 5</b>	<b>CONCLUSION</b>	<b>71</b>
<b>5.1</b>	<b>Conclusion</b>	<b>71</b>

<b>5.2</b>	<b>Future Recommendation</b>	<b>72</b>
<b>5.3</b>	<b>Commercialization Potential</b>	<b>72</b>
	<b>REFERENCES</b>	<b>73</b>
	<b>APPENDICES</b>	<b>76</b>



## LIST OF TABLES

<b>TABLE</b>	<b>TITLE</b>	<b>PAGE</b>
Table 2.1	Comparison of mechanical design	21
Table 2.2	Comparison of control design	22
Table 3.1	Specification type	35
Table 3.2	Datasheet of ESP32	36
Table 3.3	Servo Motor Operating Specification / Datasheet	39
Table 4.1	Result of simulation	45
Table 4.2	The degree of bend of flex sensor movement and robotic hand's finger.	48
Table 4.3	Result for thumbfinger	50
Table 4.4	Result of Index Finger	53
Table 4.5	Result of middle finger	56
Table 4.6	Result of ring finger	59
Table 4.7	Result of Pinky Finger	62
Table 4.8	Distance of controller	65
Table 4.9	Summary of robotic hand Performance	67
Table 4.10	Range of flex sensor value based on rotation of flex sensor	69

## LIST OF FIGURES

<b>FIGURE</b>	<b>TITLE</b>	<b>PAGE</b>
Figure 1.1	Instrument technician control and calibration [4]	2
Figure 1.2	Supervisory robot at field [6]	2
Figure 1.3	Oil and Gas industry [8]	3
Figure 2.1	K-Chart of robotic hand	6
Figure 2.2	Mechanical design of past robotic hand [11]	7
Figure 2.3	Ivan virgala robotic hand design [12]	8
Figure 2.4	Salman design for control using flex sensor [3]	9
Figure 2.5	Robotic hand with artificial limb regeneration [10]	10
Figure 2.6	HRI robotic hand [13]	11
Figure 2.7	Rotation angle [14]	12
Figure 2.8	Connection between hand and sensor [15]	13
Figure 2.9	Robotic hand using blander 3D [16]	14
Figure 2.10	Flex sensor on glove [16]	15
Figure 2.11	Harada Hand [17]	16
Figure 2.12	EMG Sensors [17]	16
Figure 2.13	EH1 Milano Hand [18]	17
Figure 2.14	Design of EH1 Milano Hand control [18]	17
Figure 2.15	IH1 Azzura hand [19]	18
Figure 2.16	Embedded CPU [19]	19
Figure 2.17	Robotic Hand with Artificial Limb Regeneration [20]	20
Figure 2.18	EMG sensor [20]	20
Figure 3. 1	Hardware implementation	24
Figure 3.2	Flow chart of the project implementation	25

Figure 3.3	System project overview of the project	26
Figure 3.4	Transmitter flow	27
Figure 3.5	Receiver flow	28
Figure 3.6	Transmitter code	29
Figure 3.7	Receiver code	30
Figure 3.8	The robotic hand design by using Solidwork software.	31
Figure 3.9	Front view	32
Figure 3.10	Back view of robotic hand	32
Figure 3.11	Schematic diagram of controller circuit	33
Figure 3.12	Schematic diagram of receiver circuit	34
Figure 3.13	ESP32 Board	36
Figure 3.14	Front view of flex sensor	37
Figure 3.15	Dimension of servo motor	38
Figure 3.16	SG90 Tower Pro Micro Servo	39
Figure 3.17	Glove	40
Figure 3.18	Needle and thread	41
Figure 4.1	Simulation circuit using Tinker Cad	44
Figure 4.2	Flex sensor and servo motor against resistance	45
Figure 4.3	Rotation of servo motor flex sensor bend	47
Figure 4.4	Rotation of servo motor against movement of flex sensor and	47
Figure 4.5	Thumb finger bend	47
Figure 4.6	Analysis for Thumb Finger Performance	51
Figure 4.7	Analysis of index fingers	54
Figure 4.8	Analysis of middle fingers performance	57
Figure 4.9	Analysis of Ring Fingers Performance	60
Figure 4.10	Analysis of Pinky Fingers Performance	63





## LIST OF SYMBOLS

°C - Degree Celsius



## LIST OF ABBREVIATIONS

3D	-	Three Dimensions
CPU	-	Central Processing Unit
DOF	-	Degree Of Freedom
ESP	-	Espressif Systems
IOT	-	Internet Of Things
IDE	-	Integrated Device Electronics
MCU	-	Microcontroller Unit
PC	-	Personal Computers
PWM	-	Pulse Width Modulation
RF	-	Radio Frequency
SPI	-	Serial Peripheral Interface
SDIO	-	Secure Digital Input Output
SRAM	-	Static Random-access Memory
USB	-	Universal Series Bus
VDC	-	Voltage Direct Current
Wi-Fi	-	Wireless Fidelity
DC	-	Direct Current
V	-	Voltage
A	-	Ampere
A	-	Ampere
AC	-	Alternating Current



## LIST OF APPENDICES

APPENDIX	TITLE	PAGE
Appendices A	Coding Of Simulation	76
Appendices B	Development of the product	83
Appendices C	Gantt Chart BDP 1	86
Appendices D	Gantt Chart BDP 2	88



# CHAPTER 1

## INTRODUCTION

### 1.1 Background

Present-day, the construction sector has been criticized for being reluctant to implement new technology, and labor productivity has remained stagnant [1]. This proved by [2], the researchers compared other industries and found that labor productivity in the construction sector has remained flat over the last two decades. Therefore, to make this construction grow fast as needed, it required new technology to replace human work to ensure the electrical construction grows faster, accurately, and safely.

Electrical also a crucial part of the construction, but electrical construction grows slow as today the oil and gas industries also use electrical to control, install, and monitor the equipment of the process. The central problem of the installation of electrical parts is high risk. When performing dangerous tasks such as landmine demining or clearance in the military, driving hazardous vehicles in transportation, exploring outer space, or working with high temperature melting metal in industrial manufacturing, people can face high levels of risk and even life-threatening situations [3]. To imitate or replicate life-like behaviors and appearances, various scientific disciplines, such as ethics, psychology, anthropology, and neuroscience, must be enriched by robotics and artificial intelligence to reduce accidents.



Figure 1.1 Instrument technician control and calibration [4]

In industry, robot technology for works was striking until 80%, especially in the automotive, factory, military, office, and hospital sectors. The robot is made to facilitate human creation that is high risk—for instance, installation and calibration of electrical devices or electrical parts in hazardous places. The new capabilities of robots significantly impact how humans view them as the robotic communicate with them [5].



Figure 1.2 Supervisory robot at field [6]

Therefore, a robotic hand is invented to solve the problems. According to [7], the robotic hands or known as anthropomorphic robotic hands, most likely originates from the expectation of using motorized prosthetic hands to restore lost hand dexterity. The robotic hand is developed to substitute the human work during the execution of electrical work that is high risk due to current flow or electrical shortage that quickly exploded. In addition, this robotic hand is an accessible and effective device that can reduce the risk and maintain worker safety.

The development of a robotic hand for electrical installation purposes is a concept that comes after several studies in the electrical field. According to industry inquiry, it is essential to minimize the risks of an individual employee, which can cause injuries during managing and controlling the hardcore duties. Employees in the electrical sector, for example, are more vulnerable to hazards such as electrical sparks, which are incredibly harmful. Thus, a wireless robotic hand is vital to scale down the risks as the workers are not directly in contact with the electrical devices. Only the wireless robotic hand will take the job that is controlled by human gestures. The direction of a human finger governed the mechanism of robotic hand movements.



Figure 1.3 Oil and Gas industry [8]

Hence, this research further investigated the evolution of a robotic hand by creating a new controlling feature that using gloves with the addition of a wireless component. The robotic hand moves simultaneously with a human hand gesture to install the electrical parts in the factories, plants, or place that difficult to access by a human. The robotic hand implements a flex sensor as input parts to control the mechanical movement like a real human finger. Besides that, the servo motor function as actuators and wireless modules to connect between transceiver and receiver.

## 1.2 Problem Statement

High risk in the workplace was overgrowing as the workers needed to be involved in the electrical industry exposed to hazard. There are numerous unwanted accidents in manual electrical handling operations, such as hand burning due to explosion even though the workers already wore a set of PPEs. In 2019, an electrical technician on-site almost lost his hand during the shutdown due to electrical burning during the termination of the wire at the generator [9]. To avoid direct touch during hazardous electrical handling, another mechanism that functions precisely like a human hand is required.

A robotic hand with hand gesture was introduced to easily control the electrical installation without human touch. Hand gesture recognition is an emerging field of technology in robotics and human interaction [3]. An urge needs to create such a device that can substitute the human for doing works safely. The development of a robotic hand for electrical installation has a positive impact, especially in hazardous workspaces such as humans challenging access and high voltage. Hence, this is important to examine the viability of the robotic hand as a substantial device for electrical installation in a power plant. Over the last few decades, productivity increases made possible using industrial robots have aided in developing new robotic applications in on-site building construction [2].

## 1.3 Project Objective

Various objectives must be met to complete this project. The objectives are:

- a) To develop a prototype robotic hand that hand gestures can control.
- b) To create a robotic hand finger, utilize a flex sensor and wireless communication.
- c) To develop and evaluate the finger control system.

## 1.4 Project Scope

This process will be done by producing a robotic hand for electrical installation to use a flex sensor and a wireless device and installing the necessary software and hardware. The input using the sensor, which is a flexible sensor, is the project's first constraint. There are five flexible sensors in this project that symbolize the five fingers on a robotic hand. The adjustable sensor's purpose is to collect bending resistance like a human finger, which can then be converted to voltage readings using a microcontroller. The actual flex sensor reading were set 2100 to 2900 for index, middle and ring finger while 3000 to 3500 for pinky and thumb finger as using 5.5" and 6.7" sensor.

Next, two ESP32 microcontrollers were used as the primary controller device for the process aspect of this project. This microcontroller includes a 512 KiB SCRAM memory size with an integrated Wi-Fi and Bluetooth module. This ESP32 uses an ultra-low power co-processor and runs at 160 or 240 MHz with up to 600 DIMPS. This microcontroller requires only 3.3V of electricity and 5A of current to switch on. The built-in wireless system has a range of about 10 meters.

Finally, there are five servo motors in the output portion, SG90 Tower Pro Micro Servo. The robotic hand are best for low-speed, standard-size applications that require precise positioning. This servo motor can control robotic fingers by tying a thread to the servo motor shaft and connecting it to the robotic fingers. Aside from that, this servo motor has a maximum rotation of 180 degrees, which corresponds to the flexible sensor employed.