# DESIGN AND DEVELOPMENT OF A 5-DOF ROBOTIC ARM AND MOVEMENT CONTROLLED BY ANDROID FOR PICK AND PLACE TASKS

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**Special thanks to my family, project supervisor, friends, and other staff in UTeM**

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## ABSTRACT

In this century, Robot has been widely used especially in Industrial Area. Robot is used in repetitive tasks where error take account. Robot can be either controlled by user or to perform autonomously. In this project, the mobile robot has a 5-DOF robotic arm to perform the pick and place task. Besides that, the mobile robot has 4 wheels for mobility. The mobile robot is powered up by 2200mAH Li-PO Battery which can last for an hour. Furthermore, it is built with an Arduino UNO and controlled by Android Smartphone with an app called "JoyStick Controller". Bluetooth is used as a connection between the Arduino and Android Smartphone. The User Interface of the application is designed in a way to allow the user to handle the mobile robot easier.

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# ABSTRAK

Pada abad ini, Robot telah digunakan secara meluas terutamanya di kawasan perindustrian. Robot digunakan dalam tugas-tugas yang berulang-ulang di mana setiap kesilapan diambil kira. Robot boleh digunakan sama ada dikawal oleh pengguna atau digunakan secara automatik. Dalam projek ini, robot mudah alih mempunyai 5-DOF lengan robot untuk melaksanakan tugas mengambil dan meletak. Selain itu, robot mudah alih ini mempunyai 4 roda untuk bergerak. Robot mudah alih ini dikuasakan oleh 2200mAh Bateri Li-PO yang boleh bertahan selama satu jam. Tambahan pula, ia dibina dengan Arduino Uno sebagai mikropengawal dan dikawal oleh telefon pintar Android dengan aplikasi yang dipanggil "JoyStick Controller". Bluetooth digunakan sebagai jaringan antara Arduino dan telefon pintar Android. Aplikasi mesra pengguna telah direka sebagai satu cara bagi membolehkan pengguna untuk mengendalikan robot mudah alih lebih mudah.

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# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

In this century, Robots are significantly increase as robots being immersed into our daily tasks, machines are replacing human especially in industrial area whereas the automation of process has increase the efficiency while decreasing time consume and human labor. As the technologies getting more advance, the improvement of technologies has inspired a whole generation of engineer to push the barriers of technology. Challenge such as to develop a robotic arm to work the way human arm does.

Human are restricted by physical and mental limitation whereas robots are inversible. They can work repetitively and way more effectively and efficiently compare to human. They replace human to outperform a duty which human unable to do. Robots do not have soul, they are lifeless. They perform what they are programmed to be and they can work 24/7. They can lift heavy weight and can accurately perform the job with less error. Robots are widely used in many fields of applications including office, industrial automation, military task, hospital operations, security systems, dangerous environment, and agriculture.

Generally, industrial robotic arm is widely used for pick and place task where it is programmed to execute the task to be fast and accurate. From SMT machine to automation, it can work independently or cooperate with human force especially in a large scale or heavy weight which human unable to handle. This can greatly reduce the risk factor as well as increase the efficiency of work done.

Furthermore, robots are deployed especially in hazardous situation such as terrorist bomb threat, land mine patrol and nuclear disaster. They are often used to deal with

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hazardous materials to enhance the human safety especially in hazardous environment such as extremely hot or cold temperature, polluted air, and radioactivity. Human is unable to endure these hazardous environments for a long time.

## 1.2 Project Overview

This project is about the design and development of 5 Degree of Freedom (DOF) robotic arm with mobility to move around. This mobile robot will be powered up by a LiPo Battery which does not rely on the power plug. It is controlled using Android Smartphone through an application called "JoyStick Controller" via Bluetooth. Besides, Arduino acts as a control station for the mobile robot to function. Furthermore, it has a servo motor mounted underneath to act as a stab to increase the stability. Overall, this mobile robot can pick the object from any angle, lift and place from one destination to another with the help of its wheels, and the control is manually done by the user.

## 1.3 Problem Statement

Hazardous chemical is defined as a chemical that is health hazard or physical hazard by OSHA. In chemical manufacturing company, the sample must be periodically checked to ensure it meets the standard requirements. These checking will be done by the laboratory technician. Although human body can excrete the chemicals from human body by the help of the liver. However, when human is exposed to these harmful substances for a periodical time, it will adverse the health effects. This means the laboratory technician will in risk of having cancerous cell when testing the sample periodically.

## 1.4 Objectives

The objectives of this project are:

a. To design and develop a mobile robot with robotic arm which can hold and tilt the test tube.
b. To control the mobile robot using Android Smartphone through Android Application.

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## 1.5 Scope of Work

The project scopes are:

a. To determine the complexity and degree of freedom (DOF) level of the robotic arm.

b. To design a mobile robot with robotic arm.

c. To determine and choose the most appropriate microcontroller and wireless communication

d. To create an application with a user-friendly interface.

## 1.6 Limitation

a. The robotic arm can lift an object up to 100g.

b. The mobile robot is unable to climb up or down the stair.

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# CHAPTER 2

# LITERATURE REVIEW

## 2.1 LITERATURE REVIEW

This section will review and compare the existing project. Then, a verdict is made on how to design the robot, follows by introducing the components used.

### 2.1.1 Review of the existing robot

Arian Faravar [1] constructed a 5-DOF Robotic Arm using PIC 16F877A Microcontroller. It uses 2 servo motors to lift the upper part of the robotic arm as he mentioned the power, torque and size of the servo motor will affect the dimension of the robotic arm. Furthermore, he uses PIC 16F877A microcontroller is because it has a good range of interfaces which are analogue, digital pins and pulse width modulation (PWM) and in-circuit debugging. Figure 2.1 shows the robotic arm for this project.

Figure 2.1: Structure of the robotic arm [1]

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Mohammed Shoeb Shah and P. B. Borole [2] built a Surveillance and Rescue Robot using Android Smartphone. The robot itself has a robotic arm with 4 wheels. It only moves forward, backward, left, or right turn. Arduino is used to control the robot movement, robotic arm, and sensors. They mounted the android smartphone on the rescue robot to provide vision, connectivity to the Arduino. Therefore, the robot can be remotely controlled using laptop through the internet with the help of GSM of the android smartphone.

Kavita P. More [3] propose a Wireless Hand Gesture to control the robot. The robot consists of 4 wheels and a Robotic Arm, an end-effector. It uses the flex sensor to capture the movement of the hand to control the Robot by converting the raw mechanical data into electrical form. The author chose Arduino UNO as the microcontroller because ATmega328 which reside in the Arduino UNO is commonly used as it is simple, low-powered, and low cost. The robot required two Xbee modules which will be placed at transmitter and receiver section for the communication. The range of the operation is up to 20 to 30 meters only. Besides, it uses L293D as the motor driver to control the DC motor. L293D acts as a H-Bridge which allow the voltage to flow either direction. Thus, allowing to control the rotation of the DC motor. It also provides current up to 600-mA at voltage from 4.5V to 36V. Figure 2.2 shows the mobile robot with a gripper of this project and Figure 2.3 shows the Wireless Hand Gesture used to control the robot.

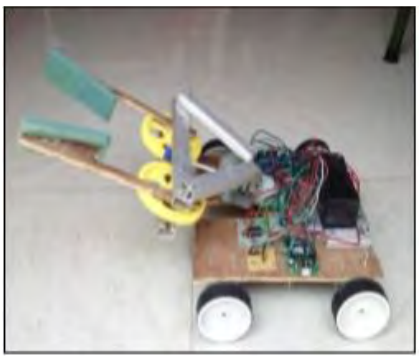

Figure 2.2: Robot with a gripper [3]

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