



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**AN ACCURACY STUDY ON THE POSITIONING OF THE PICK
AND PLACE MANIPULATOR TRAINER**

This report submitted in accordance with the requirements of the Universiti Teknikal
Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering
(Robotic and Automation) with Honours.

By

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FACULTY OF MANUFACTURING ENGINEERING

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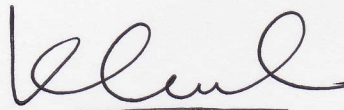
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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotic and Automation) with Honours. The members of the supervisory committee is as follow:



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ABSTRACT

This project is a further study to improve the pick and place manipulator trainer to be more accurate on positioning through identifying the problems that had occur on the previous manipulator project. Through the literature review, some idea on the particular part which requires improving are studied. Then, the study on existing hardware is done by identifying problem using calculation and graphical review. The critical parts involved are gripper, rotary table, and dual rod cylinder. In order to overcome the limitation of positioning, the control system is improved by changing and adding the feed back component's signal to the pneumatic actuator such as sensor, reed switch, and directional valve. On the other hand, the OMRON CPM 2A controller will be use to replace the Keyence KV- 16T. Through this project, theoretical knowledge and practical skill is applied into this manipulator. This project provides a further understanding on software coding and hardware usage.

ABSTRAK

Projek ini merupakan kajian sambungan untuk memperbaiki robot supaya lebih tepat capai kedudukannya. Pada permulaan, masalah yang dihadapi dari robot tersebut perlu dikenalpastikan. Dari karya jurnal, beberapa bahagian yang dirancang untuk diperbaiki perlu faham dan mendapatkan beberapa idea. Seterusnya, bahagian robot dikaji melalui pengiraan dan graf. Bahagian yang berkaitan dalam kajian ini adalah penyepit, meja berputar dan silinder. Untuk menyelesaikan masalah robot capai kedudukan, jenis kawalan diperbaiki dengan menggunakan alat-alat suapbalik pada silinder seperti penderia, reed switch dan directional valve. Pengawal robot tersebut digantikan dengan OMRON CPM 2A kepada Keyence KV- 16T. Daripada projek in, pengetahuan and praktikal kemahiran dapat diaplikasikan ke dalam projek ini. Projek ini mampu banyak membantu dari segi pemahaman yang berkaitan dengan perisian robot dan perkakasan yang digunakan dalam projek ini.

DEDICATION

To my beloved family and friends.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

CNC	- Computer Numerical Control
PLC	- Programmable Logic Controller
a	- Safety Margin
f	- Force
g	- Gravitational Acceleration
I/O	- Input and Output
I	- Moment of Inertia
kg	- Kilogram
m	- Mass
cm	- Centimeter
mm	- Mili-meter
mJ	- Milli-joule
MPa	- Mega Pascal
N	- Newton
Nm	- Newton Meter
VAC	- Alternative Voltage
VDC	- Direct Voltage

μ - Coefficient of Friction

ω - Angular Acceleration

CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, robots play an important role in industry. They can replace human labor in highly hazardous situations, especially in the processes of nuclear clean-up, dismantling and decontamination (Caldwell, 1999). In the industry field, robot manipulator arm is a most common industrial robot to perform the pick-and-place operation. Industrial robots have used three primary actuator types: electric motors (DC or AC), hydraulic cylinders and pneumatic cylinders (Caldwell, 1989). Mostly, the controlled motion was done using electric motors and computers due to powerful if compare with other forms of actuation have become practical for providing motion. But in term of cost, there is not economical and need more experience in programming.

Pneumatic actuators are widely using in robotic systems due to low cost, quickness of response and high power with low weight, power and high volume ratios (Henke, 1970). Moreover, it has a high payload-to-weight ratio that is especially important for pick and place task. They are also clean, easy to work with, and lightweight. In addition, compressed air is readily available at nearly every industrial facility. Unfortunately, position stabilization of a pneumatic actuator is difficult during the motion with high accuracy at the desired positioning.

A hierarchical close loop feedback control for pneumatic manipulators is proposed to overcome this type of problem. Where the flow of the actuator is controlled for velocity, speed, and air consumption. An electrical signal to the controller is conducted as a feedback to the close loop system for reading the positioning of the manipulator.

1.2 Objective

The purpose of this project is to have an accuracy study on the positioning of the pick and place manipulator trainer. Thus, the following are the objectives of this project:

- a) To identify the specification and function of the existing hardware.
- b) To understand the sequence of the manipulator trainer.
- c) To analyse the correct position for each motion.
- d) To ensure the programming in order to control the manipulator trainer.

1.3 Scope

The scope of this invention cum study will be covering the following:

- a) Analysis the existing and improve hardware by come out result in graphical form.
- b) Redesign and apply the suitable electrical circuit.
- c) Select suitable component and device.
- d) Develop a fluent sequence control system and system operation.
- e) Program the PLC for increase the stability of the system.

1.4 Problem Statements

Through the observation and testing for the existing manipulator trainer, there were some problems and limitations as below:

- a) Manipulator just can run for one cycle only.
- b) All of the input signals are using mechanical type sensor with mechanical part for sensing the path.
- c) The accuracy, repeatability, and stability are out of effectiveness because using the mechanical part to fix the limit of manipulator path.
- d) The position of the manipulator cannot reset for homing when is needed.
- e) When the OFF button is press emergency, the manipulator still in running condition.
- f) Once the ON and OFF button is press equally, still can operate the manipulator is cause of improper interlock in the programming.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to Control Design

Robot is a re-programmable, multifunction manipulator designed to move material, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks. It usually consisting of a series of segments, jointed or sliding relative to one another, for the purpose of grasping and moving objects usually and several degrees of freedom. It may be remotely controlled by a computer or controller.

Controllers are the most important components in a robot system. If a robot has n joints, n controller are needed to control all joint actuators. The design of robot control is to solve the problem how robot's actuators are driven to achieve a desire performance. A robot control system is actually the intergration of electronic hardware and computer control software.

Marco A.M (1990) discovered that high accuracy is generally unachievable in manipulators capable of producing high task forces due to such factors as high joint, actuator, and transmission friction and link elastic and geometric distortions (Marco A. M, 1990). To overcome this limitation, a suitable control system in the pick and place manipulator system should be selected.

These are the terms for select of control system in robotics, as (Asfahl C.R, 1985):

a) Control resolution

Capability of robot's positioning system to divide the motion range of each joint into closely spaced points.

b) Accuracy

Capability to position the robot's wrist at a desired location in the workspace, given the limits of the robot's control resolution.

c) Repeatability

Capability to position the wrist at a previously taught point in the workspace.

There are two common classes of control systems, with many variations and combinations as open loop system and close loop system in Figure 2.1 and Figure 2.2. Through the control system, an automatic sequential control system may trigger a series of mechanical actuators in the correct sequence to perform a task like energize the solenoid valve to control the cylinder perform the physical task.

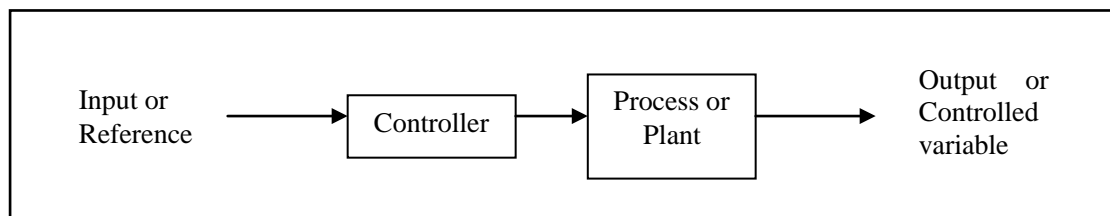


Figure 2.1: Open Loop Control System