MATERIAL DETECTING AND HANDLING ROBOTIC ARM

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This report is submitted in partial fulfillment of the requirements for the award of Bachelor of Electronic Engineering (Industrial Electronics) With Honours

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Dedicated to my beloved family especially my father and mother, lecturers and also to all my friends

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ABSTRACT

The introduction, literature review, methodology, results and conclusions for the development of a Material Detecting and Handling Robotics Arm is discussed in this report. Since industries nowadays are facing with a rising cost in labor and workforce, automation plays a big part to increase productivity and still maintain its quality. The machine that will be used as transfer medium in this project is a robot arm where, the main objective is to build, test and run the robot arm as a working machine. From the literature review done, the types of robot arms that are available in the market now have been studied. The types are such as Cartesian, Cylindrical, Spherical, SCARA and Revolute can be used for multiple applications based on the industry's needs. A Programmable Logic Controller (PLC) will be used in this project that acts as the controller which determines the movements of the robot arm. The movements are gained from the DC motors that will provide motion for the robot arm based on the Degrees of Freedom (D.O.F) required. As for the sensing systems, a limit switch, inductive sensor and capacitive sensor will be placed strategically at the conveyor where it will then trigger the PLC to perform the next process which is, pick and place. Next, the gripper will built according to the size of the material to pick and place it efficiently to complete this project. To ensure the completion of this project, the methodologies have also been discussed here with a relevant flow chart and a ganntt chart. Lastly, as for the preliminary results of this project, the major components have been identified and the literature review has been completed.

ABSTRAK

Pengenalan projek, kajian latar belakang, metodologi kajian, keputusan dan kesimpulan untuk Mesin Pengesan dan Pengasingan Produk 'Robotics Arm' telah dibincangkan di dalam laporan ini. Oleh sebab industri kini banyak mengalami masalah dari segi kos kerja dan tenaga pekerja, automasi memainkan peranan yang penting dalam meningkatkan produkiviti dan juga meningkatkan kualiti produk. Mesin yang akan digunakan dalam projek ini sebagai mesin pangantara adalah 'robot arm' dan dimana objektif utama projek ini adalah untuk membina, menguji dan mengoperasi robot ini sebagai satu mesin yang sempurna. Daripada kajian latar belakang yang telah dijalankan, jenis-jenis 'robot arm' yang berada di pasaran juga telah dikenal pasti. Jenis –jenis robot ni terdiri daripada 'Cartesian', 'Cylindrical', 'Spherical', 'SCARA' dan 'Revolute' yang boleh digunakan untuk pelbagai aplikasi mengikut kehendak industri. Sebuah 'Programmable Logic Controller' (PLC) akan digunakan bagi tujuan mengawal pergerakan robot. Pergerakan ini didapati dari kegunaan motor AT dan ianya bergantung kepada tahap 'Degrees of Freedom' yang dikehendaki. Untuk tujuan sistem pengesan, pengesan dari suis sesentuh,jenis induktif dan kapasitif akan digunakan dan akan dipasang secara strategik pada 'conveyer' kepada PLC untuk proses seterusnya iaitu mengangkat dan menyusun produk ke dalam kotak yang ditetapkan. Untuk tujuan ini, pemegang akan dipasang pada 'robotics arm' mengikut saiz produk bagi melengkapkan projek ini. Untuk memastikan projek dapat disiapkan, metodologi telah dibincangkan dengan menggunakan carta alir dan carta gannt yang bersesuaian. Akhirnya, untuk keputusan awal projek ini, kesemua komponen utama telah dapat dikenal pasti dan kajian latar belakang telah selesai.

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DOF	-	Degrees of Freedom
PPP	-	Prismatic Prismatic Prismatic
SCARA	-	Selective Compliant Articulated Robot for Assembly
RPP	-	Rovolute Prismatic Prismatic
CPU	-	Central Processing Unit
ECM	-	Electrically Commutated Motor
FBD	-	Function Block Diagram
IL	-	Instruction List
LD	-	Ladder diagram
PLC	-	Programmable Logic Controller
PSM	-	Projek Sarjana Muda

CHAPTER I

INTRODUCTION

1.1 Project Introduction

The rapid growing and advancement of modern technology has yield to the developments and inventions of modern equipments and machineries. One of these inventions that give great impacts and implications to the lifestyles is industrial robotics arm. An industrial robot arm is meant to simplify task easier and still maintain its efficiency higher than that of a normal human operator in the industry [6]. These inventions have eased human significantly in all aspects and to upgrade of their daily lives. The basic robot arm consist of several rigid links connected in series by revolute or prismatic joints which can perform various task such as welding, material handling (pick & place), and thermal spraying, to painting and drilling.

A robot arm in the industry nowadays uses at least two or more Degrees of Freedom (D.O.F) to pick and place object, where one for moving and another to pick the object by gripping. As so, the robot arm in this project will be built with 3 D.O.F to provide full efficiency towards the aim of the project.

This project is about the designing and development of 'Material Detecting and Handling Robotic Arm' which includes both hardware and software. The Robotic Arm shall be designed to pick and place materials from a conveyor to a box by detecting the type and color of the material. For this purpose, the sensors which are to detect the type and the color of the material will be place strategically at the conveyor and will the trigger the PLC to control the robotic arm. Robotic arm will then pick and place the material according to the range of movement by the DC motors which is limited by the use of limit switches. A gripper will be built according to the size of the material to pick and place it efficiently. From this project, the application of the sensors, motors and PLC can be shown in one package.

The objective of this project is to build, test and run the robotic arm as a working machine by using a PLC. This is because, this project will benefit students in future to understand the basics of PLC, DC motors, types of sensors and mechanical assembly once they step into the working environment.

1.2 Project Background

What is robotics? Robotics, computer-controlled machine that is programmed to move, manipulates objects, and accomplishes work while interacting with its environment. Robots are able to perform repetitive tasks more quickly, cheaply, and accurately than humans. The word robot has been used since to refer to a machine that performs work to assist people or work that humans find difficult or undesirable.

Here is the brief explanation of the robotics arm history. George Devol applied for the first robotics patents in 1954 (granted in 1961). The first company to produce a robot was Unimation, founded by George Devol and Joseph F. Engelberger in 1956, and was based on Devol's original patents. Unimation robots were also called *programmable transfer machines* since their main use at first was to transfer objects from one point to another, less than a dozen feet or so apart. They used hydraulic actuators and were programmed in *joint coordinates*.

In 1969 Victor Scheinman at Stanford University invented the Stanford arm, an all-electric, 6-axis articulated robot designed to permit an arm solution. This allowed it to accurately follow arbitrary paths in space and widened the potential use of the robot to more sophisticated applications such as assembly and welding. Scheinman then designed a second arm and receiving a fellowship from Unimation to develop his designs, sold those designs to Unimation who further developed them with support from General Motors and later marketed it as the Programmable Universal Machine for Assembly (PUMA). In 1973 KUKA Robotics built its first robot, known as FAMULUS, this is the first articulated robot to have six electromechanically driven axes.

Interest in robotics swelled in the late 1970s and many US companies entered the field, including large firms like General Electric, and General Motors (which formed joint venture FANUC Robotics with FANUC LTD of Japan) [7].

1.3 Project Objectives

There are several objectives to be achieved in the end of the project which includes:

1. To develop a material detecting and handling robotic arm this can pick and place materials by detecting the type and color of the material.
2. To build, test and run the robotic arm as a working machine.
3. To study the types of sensors, motors and other components related in building this project.
4. To develop a program using the Programmable Logic Controller (PLC) and test the program on the robotic arm.

1.4 Problems Statement

Industries nowadays are facing with the rising cost of labor and workforce because of the expanding global market that requires products to be delivered more and on time without affecting the quality of the product itself. Human operators in industries are more likely to cause mistakes and are not efficient compared to the use of machines. Machines are efficient and are considered cost saving on the long term. Besides that, the process cycle time is longer for human operators.

The robot arm is basically a machine that can replace a human operator and perform various tasks efficiently and still maintain a constant speed while handling the process. By the use of the robot arm too, cost for labor or workforce can be reduced significantly while still maintain a proper production of an industry.

This project highlights the problem in manufacturing industry. Since material has become in various type whether from metal or nonmetal material, packaging the material according to the color has made the respective industry to provide different packaging section or lines for avoid any mistakes.

The robot arm that is being developed in this project can be used in this industry without facing any problem since it can differentiate the type and color of the material, pick and place it according to the fix box. The process too shall be more efficient and faster than a normal human operator.

1.5 Project Scope

The robotic arm project is focus on both the hardware and software application. The hardware will be design from a robotic arm kit (Fishertechnik Kit) that will be modified according to the Degrees Of Freedom (D.O.F) needed in this project. The project involves building, testing and running a 3 Degrees of Freedom (D.O.F) robot arm as a working machine to perform its task.

The hardware consists of mechanical structure and assembly; DC motors for movements, gripper for pick and place purposes, sensors as the sensing type and color of the material and a Programmable Logic Controller (PLC) to control the whole robot arm. The program will be developed in the CX-programmer and will be simulated before running on the project. Relays will be used to interface between the hardware (robotic arm) and the software (PLC program).

1.6 Project methodology

As stated at the objectives above, the robotic arm shall be build, test and run as a working machine, the process list below should be considered. The entire point list below is the process that has to be done from the start until the finishing part.

1. Literature review:

For this, a through research shall be done before starting on the project. Literature review will be done from research through books, journals and the internet in websites. This is to know the equipments, materials and components needed in building the project. Beside that, the research will include all the hardware that is related in this project such as the DC motors, sensors and other electrical/electronic components. Sensors too shall be studied and reviewed to find the perfect candidate for the job of detecting the type and color of the material.

2. Building the hardware:

After that, the sketches of the project will be done based on the gathered information. Then, the robotic arm will be build by using, test and finally it'll be run to test whether it is functioning or not. The troubleshooting will be done if it can't function properly during the testing.

3. Software development:

The software which is the PLC program shall be tested and simulated.

5. Finishing :

Finally, testing the operation, application and result of robotic arm. The troubleshooting between hardware and software will be done if it can't function properly during the testing. Then, presentation on outcome of project will be prepared. Besides that, preparation and presentation of technical report also prepared.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This chapter will provide details and discuss about the source that are related to this project. It consists of the products that are already in the market nowadays and also contains the theory of the components, equipments, programming software and controller that will be used in the project.

Research has to be done to provide an initial review in the robotic arm field before starting on this project. It is essential to know how to absorb some industrial robot arm methods that are connected directly or indirectly with this project. While carrying out research in the robotic arm field, any advantages or disadvantages about the current robot arm in the market can be taken as a reference to develop a successor pick and place robot arm. The main key points to take as reference are the control system involved, motors and sensors used, and also the theories and analysis that are relative to the pick and place robot arm.

2.2 Hardware development

2.2.1 Robot arm construction

An industrial robot is a general-purpose, computer-controlled manipulator consisting of several rigid links connected in series by revolute or prismatic joint. One end of the limb is attached to a supporting base while the other end is free and equipped with a tool or gripper to manipulate objects or to perform assembly tasks. The motion of the joints results in relative motion of the links.

Mechanically, a robot arm is composed of an arm and a wrist subassembly unit which is designed to reach work piece located within its work volume. The work volume is the sphere of influence that of a robot arm where its movements can deliver the wrist subassembly unit to any point within the sphere. The arm generally can move anywhere within the work volume by employing the correct Degrees of Freedom (D.O.F). The combination of the movements positions the wrist at the work piece. The wrist subassembly unit usually consists of three rotary motions.

The concept is illustrated by the Cincinnati Milacron T3 robot arm and Unimation PUMA robot arm as shown on Figure 2.1.

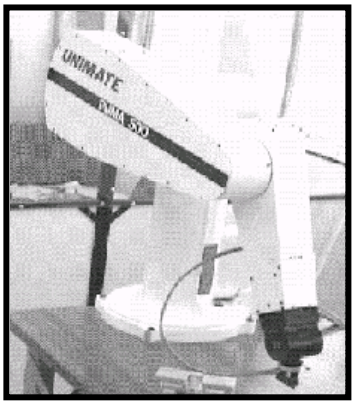

Figure 2.1 Unimation PUMA robot arm.