UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF CONTROL PANEL FOR ARISTO ARM ROBOT

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

by

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ABSTRAK

Pembangunan Panel Kawalan untuk Robot lengan Aristo berdasarkan sistem gelung terbuka. Dengan menerapkan Semasa Terus (DC) sebagai bekalan kuasa kepada Robot Arm Aristo sistem. Dalam perkembangan ini konsep mengajar belum diadili dan panel kawalan telah dibuat. Untuk mengintegrasikan sistem ini, PS 12 pin akan digunakan. Masalah utama semasa projek ini dilaksanakan ialah, berdasarkan kepada Pn. Silah Hayati bt. Kamsani, salah satu pensyarah robotik utama yang Mekatronik, sejak 2005 sehingga sekarang, Robot Arm Aristo telah tidak digunakan. Fungsi-fungsi yang tidak digunakan betul tetapi sebaliknya ia adalah hanya lebih item dipaparkan dalam Makmal Robotik. Daripada maklumat yang diberikan oleh En.Faizul, yang merupakan salah satu juruteknik di makmal robot, pemacu utama keras sistem ini telah rosak sejak robot sejak dibeli. Masalah dalam pembangunan ini boleh ringkasan sebagai ketidakpastian sama ada robot itu mampu bergerak atau sebaliknya, Hard Disk yang rosak dan akhir sekali Panel kawalan adalah tidak berfungsi dan tiada isyarat dapat dikesan. Menurut kajian yang dibuat oleh Puan Urmila Meshram, Encik Pankaj Bande dan Prof. RR Harkare, dalam kertas mereka Perkakasan dan Perisian Co-reka bentuk untuk Kawalan Jawatan Lengan Robot Menggunakan VHDL & FPGA, 2006 untuk membuat panel kawalan, litar pemacu dan litar sensor memainkan peranan yang penting. Pulse Width Modulation (PWM) digunakan untuk mengawal kelajuan motor DC. Kaedah yang akan digunakan dalam sistem ini adalah pendawaian elektronik asas. Langkah pertama perlu dilakukan adalah mengenalpasti keperluan. Ini dikenal pasti untuk memastikan bahawa robot masih boleh berfungsi dengan cara yang tepat. Seterusnya ialah pemilihan komponen elektrik yang diikuti dengan membuat pengaturcaraan untuk sistem. Walau bagaimanapun, disebabkan arus bocor dalam sistem, mikropengawal pembakaran dan ia berlaku semasa bahagian memuktamadkan. Hanya 4 isyarat boleh menghantar kepada Mikropengawal itu. Oleh itu kemas kini maklumat pembangunan telah melampirkan dalam syor itu pada masa hadapan..

ABSTRACT

Development of Control Panel for Aristo arm Robot is based on open loop system. By applying the Direct Current (DC) as power supply to the the Aristo Arm Robot the system can be move. In this development will be using a concept of teach pendent and control panel. To integrate these systems, PS 12 pins will be use. The main problem in this development is according to Pn. Silah Hayati bt. Kamsani, one of the robotic lecturer major in Mechatronic, since 2005 until now, the Aristo Arm Robot has not been used. The functions were not utilized rightly, but instead it was just rather a displayed item in the Robotic Lab. From information given by En.Faizul, which is one of the technicians in the robotic lab, the main hard drive of this system has been corrupted ever since this robot was bought. There for, the problem encounter in this development can be summarize as uncertainty of whether the robot can move or otherwise, corrupted Hard Disk and lastly control Panel was malfunction and no signal can be traced. In order to analyze this problem, a research has been done on type of robot, Degree of freedom Hardware and software system. According to the research made by Mrs. Urmila Meshram, Mr. Pankaj Bande and Prof. R. R. Harkare, in their paper of Hardware and Software Co-design for Robot Arm Position Control Using VHDL & FPGA, 2006 in order to make the control panel, drive circuits and the Sensor circuit plays important role. Pulse Width Modulation (PWM) is used to control the speed of DC motor. However in this development, sensor circuit will be made by the next student. The method that will be applied in this system is a basic electronic wiring. First step is need to be done is identify the requirement. This identified to ensure that the robot still can be functioning at the right manner. Next is selecting the electrical component followed by making the programming for the system. At the end of this development, the control panel should able to be use. However, due to current leakage in the system, the microcontroller is burn and it is happened during the finalize section. Only 4 signals can be transmit to the Microcontroller. Therefore update development information has been attaching in the future recommendation.

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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 in Bachelor of Manufacturing Engineering (Automation and Robotics). The members of the supervisory committee are as follow:

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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TAJUK: **Development of Control Panel for Aristo Arm Robot**

SESI PENGAJIAN: 20011/12 Semester 2

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DECLARATION

I hereby, declared this report entitled "Development of Control Panel for Aristo Arm Robot" is the results of my own research except as cited in references.

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DOF	-	Degree of Freedom
CNC	-	Computer Numerical Control
CIM	-	Computer Integrated Manufacturing
FMS	-	Flexible Manufacturing System
PLC	-	Programmable Logic Controller
PCB	-	Printed Circuit Board
PID	-	Proportional Integral Derivative
R	-	Revolute
P	-	Prismatic
i	-	Connection between 2 link
i+1	-	Connection between 2 link
n	-	Bil of quantity

CHAPTER 1
INTRODUCTION

In this first Chapter, the overall flow of the project is explained thoroughly. First, the background of the project is explained. This is followed by the problems encountered, which is described in details in the Problem Statement section. Next, the aim of the project is laid-out, followed by defining the objectives that should be achieved. Then, the scope of the project in this development is explained in details, and lastly, this chapter concludes with the Research outline.

1.1 Background

Robot is an integral part in automating the flexible manufacturing system, which has been one of the greatest demands today. Robots are now functioning more than a machine, as it has become the solution of the future, replacing the cost of labour wages and more specifically, it meets customers' demand. Although the cost of acquiring robotic system is expensive, however with today's rapid technology development and high demand in meeting the ISO (International Standard Organization) standards, human power are no longer needed to fulfil these demands. Research and development of future robots is moving rapidly due to the constantly improving and upgrading of the quality standards of products. (Omar, 2007)

Robots and automation evolved together to replace human-power in performing routine tasks that can be claimed as dangerous, dull, and hazardous. Nowadays, technology and automation have greatly increased the production capabilities. This has improved product quality and lower production cost. It only takes a few people to program or monitor the corn outer and came out with routine maintenance (Omar, 2007).

There are various types of robots that can be found either in the industries or in the studies field. These robots worked tremendously, which gives benefit in the industries, as it could do more jobs with minimal human supervision. With regards to the area of a student's research, a robot can either be used as one item for an analysis, a research or a model. One of the most common robots that are frequently used in both categories is the arm robot, which is also known as the articulated robot.

The common design of an arm robot or articulated robot is based on the human arm. This consists of a shoulder, an elbow, an arm and a wrist, all joint together. To move these joints, motors are needed. In order to control these movements, encoders and sensors are used. A gripper is also needed here, which uses a pneumatic system for it to work.

Nowadays, there are diverse types of arm robots that can be found in the industries and in the studies field. This depends on the demands of industries or work fields that require a specific robot to perform a task. The *Comau* Arm *Robot* is one of the on-demand robots. Other than that, the *Fanuc, Kuka, and Nachi* robots are also the types of robots that have been used in the industries. However, for this project, the Aristo 6-axes are chosen as the main item in this study.

The Aristo arm robot consists of a 6 Degree of Freedom (DOF). It is produced by MTAB Advance Manufacturing Technology in India. MTAB is a company with 25 years experience providing a solution in Technical Training System; and have been manufacturing advanced CNC training machines in India by creating diversified product portfolios in areas of FMS/CIM, robotics, CAD/CAM & virtual reality software, PLC and automation, robots and electronics range of products. This company has also been providing robots to various industries worldwide. In MTAB manufacturing, they also do provide a mini robot, which can provide 5-axes of DOF and a SCARA robot. This depends on the customers' requirement and the type of jobs that were needed to be done. *Aristo* is one of the products that are originated from MTAB (MTAB, 2010).

1.2 Problem Statement

According to Pn. Silah Hayati bt. Kamsani, one of the robotic lecturer major in Mechatronic, since 2005 until now, the Aristo Arm Robot has not been used in a proper manner. The

functions were not utilized rightly, but instead it was just rather a displayed item in the Robotic Lab. It was such a waste to have such a good model of robot for students to use as analysis and implement it in their studies. Hence, the main target to achieve in this project is to ensure that the robots are fully utilized and applied in the students' analysis or future research. However, the development of this project does have some range of percentage and it will continue for future development.

From the information given by En.Faizul, which is one of the technicians in the robotic lab, the main hard drive of this system has been corrupted eversince this robot was bought. Therefore, the data such as input or output cannot be obtained. Furthermore, all the required data such as the movement and monitoring data embedded in the hard drive were lost. In order to ensure the target is achieved, a new control panel with a monitoring system is built. Since an eager motivation to develop this project successfully, few problems should be eliminated in order to ensure the project runs flawlessly. From the past reading based on this Aristo Arm Robot, the robot is claimed to have 6 motors to perform 6 movements for 6-axes. Since the existence of this robot, no testing has been done to prove that this robot is in good condition. Moreover, with a corrupted hard disk, it is rather difficult to trace back whether this robot can function properly. In other words, there were several problems identified, and it's safe to summarize that these problems were encountered while running this project:

1. Uncertainty of whether the robot can move or otherwise
2. Corrupted Hard Disk
3. Control Panel was malfunction – No signal can be traced

1.3 Project Aims

The main aim of this project is to develop a part in the Control Panel for 6 axes Aristo Arm robot. These selections of the components are to improve the Robot's capabilities and performance. In addition to this, this development will also be regarded as the first platform for future development in the scope of a Control Panel. In order to solve the problem encountered, the followings are applied:

1. Construct a prototype of control panel, to test the robot functioning.

2. Select the right component, which will be used to construct the control.
3. Identify the needs and work flow between Microcontroller and the robot panel.
4. Understand the programming flow for controlling the robot.

1.4 Objective

The main objectives in completing this project are to the rebuilt the Aristo Arm Robot control panel, and simultaneously to perform an analysis in the Reliability of the Robot performance.

1.5 Scope

There is some sequence that should be followed, to achieve the objectives in this project. Hence, the scopes of The Development in Aristo Arm Robot Control Panel are identified as follows:

1. First, understanding the axis in MTAB Aristo Arm Robot is crucially required. This is to determine the degree of freedom in this robot is functioning.
2. Second, comprehend the right electrical component to use for the development of the control panel. This scope is used to acknowledge the main system that is applied during the development. This will also identify and determine the cost planning in this robot.
3. Third, understand the use of Microcontroller and Motor Driver MB01A system in this development. The use of these controllers in this development is vital for the connection and communication between the Control Panel, as well as the computers in monitoring systems that will be developed in future. Therefore this scope plays an important role.
4. Finally, the needs of a simple coding for simple control system for Aristo Arm Robot will be recognize. In this development, since there will be more than one type of coding used, therefore a further study is needed.

1.6 Report Outline

As an overall outline, this report is organized in sequence as shown below:

I. **Chapter 1:** The background of the project is stated. The problem statement is also identified in this chapter, together with the objectives defined to achieve. The scope of the project is also outlined clearly.

II. **Chapter 2:** The literature review of this research study is critically discussed. This is done based on the findings of journals, thesis from other researchers, and other related research materials. In this chapter, the idea of other researchers are acknowledged, grasped and shared to support the implications in this study.

III. **Chapter 3:** The research methodologies are explained in this chapter. A flow chart and Gantt chart are provided.

IV. **Chapter 4:** This chapter explains the result and analysis process in this project.

V. **Chapter 5:** Next a conclusion of this project is elaborate thoroughly. A future recommendation and future developments are also suggested.

VI. **Chapter 6:** Discussion will be stated in this chapter

VII. **Chapter 7:** Finally Future recommendation will be stated clearly in order for future development in this project

CHAPTER 2
LITERATURE REVIEW

In this chapter, we will discuss about the recent research done by other researchers. Each main idea is described in details according to the relation to the topic of interest. The explanation is based on the topic related to the other various researches. The main source of these work were all based from journal, conference or text books.

2.1 History of Robotic

The word *robot* was originated from the Czech word *robota*, which means 'slave laborer'. A Czechoslovakian dramatist, Karel Capek, coined and first used the word robot in his play entitled *Rossum's Universal Robots* in early 1920s; Capek (year) described the robot as perfect, tireless worker with arms and legs. In Capek's play, the robot served and helped human being well, but the robot was not at the level to replace the human beings. Then, the word robot has been widely used by people to describe some electro-mechanical systems, which may be fully or partially automatically operated. The term *robotics* was coined by Isaac Asimov in his short science fiction in 1940s, which he defined robotics as a study of robots. In 1988, the word robotics was included in the Webster's New World Dictionary (Zhihong, 2005).

There are many definitions that can be found either in the dictionary or encyclopaedia to describe the meaning of robotic. For example, in the Robot Institute of America, the definition used may reflect the modern robot system (Holland, J.M and W. Sams & Co. 1983): *A robot is*

a re-programmable multifunctional manipulator design to move material, tools, or specialized devices through variable programmed motions for performance of a variety of tasks (Author, Date). On the other hand, according to the Brooks (2009), *Robots are programmable physical machines that have sensor and actuators and are given goals for what they should achieve in the world.* According to Brooke, 2009 he stated that the perception algorithms process the sensor input, the control program decide how the robot should behave given its goals and current circumstances, and the commands are sent to the motors to make the robot operate in the world. Some robots are mobile, but others are rooted to a fixed location (Brooks, 2009).

2.1.1 Type of Robot

There are various types of robot that has been used either in the industries or in related researches. However, the main systems of the robots are approximately the same towards each other. The differences between these robots are the movements and workspace that were involved in a certain robot system. Below are the types of robots and its brief explanations regarding these robots.

2.1.1.1 Cylindrical

Referring to the figure 2.1.1.1, a typical cylindrical robot has a rotary joint and two prismatic joints (RPP). Therefore the robot motion are consists of linear and rotary movements. The workspace for this robot is actually between the two concentric cylinders with the same height. While the annular volume between the two cylinders is the zone in which the robot may operate between fully retracted and fully extended (Zhihong, 2005).

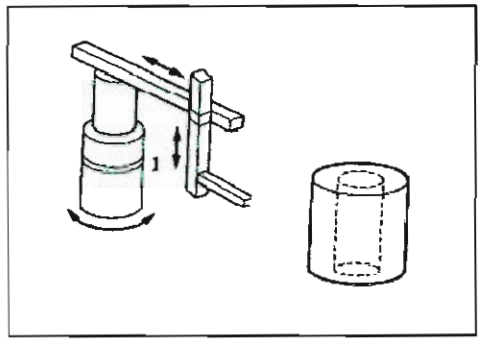

Figure 2.1.1.1 Cylindrical Robot

The motion of the main arm is up-and-down. The robot can perform this motion by extending a cylinder that is built into the arm. In most cylindrical robots, the up-and-down motion is provided by a pneumatic cylinder, and the rotation is generally provided by a motor and gears. Any part of the robot that is moved by the cylinders will generally move until it hits a stop. The location of this stop is determined by placing stop blocks or location pins. The cylinders are moved by pneumatic energy (air pressure) that's controlled by simple solenoid valves. The controller determines the motion of the rotation by energizing the motor until the encoder determines the correct amount of movement has occurred. Additional movements can be achieved by attaching a wrist to the end of the arm cylinder. In some robots, the wrist is complex enough to provide one or more additional Degrees of Freedom (DOF). These are called pitch (up-and-down motion at the wrist), roll (rotational motion at the wrist), and yaw (side-to-side motion at the wrist). Wrists are available with one, two, or three of these motions depending on the expenses of the robot and the application it's used for (An Industrial-Electronics network, 2008).

2.1.1.2 Cartesian

According to Zhihong, 2005 he stated that all Cartesian robots have a common feature, which is the first three joints corresponding to the major axes are prismatic (PPP). In figure 2.1.1.2 below, the advantages of Cartesian robots stated that the configuration and design of these robots are simple. In this robot, the three prismatic joints are decoupling and the motion controls in a Cartesian space can easily be carried out. The large Cartesian robots, which resemble

overhead gantry cranes, are called Gantry Robot (Man Zhihong, 2005). He also stated that, a two axis, two drive mechanisms, two belt designs Cartesian robot wherein each axis is independently controlled and all applied forces are along the centerline of the robot structure. This unique design allows for the use of a low cost control system, since the 'multi-axis motion controller' is not required. The Co-location of the drive systems allows support of the robot from one end. Cantering of forces acting on a carriage assembly, allows for the reduction of the weight of the robot for a given payload.

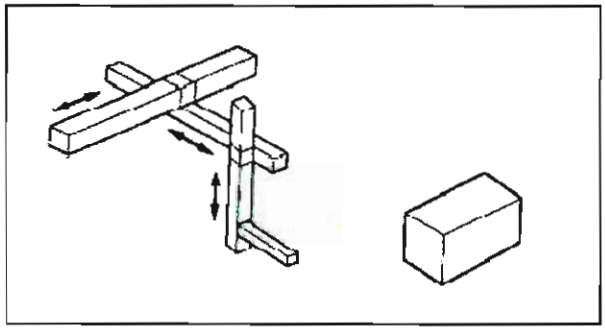

Figure 2.1.1.2 Cartesian Robot

2.1.1.3 Spherical

A spherical robot is shown in this figure 2.1.1.3. In this robot, the position of the wrist is determined by two rotations and one translation through two rotary joints and a prismatic joint (RRP). By implying theoretically, if two rotational angles could change between 0 and ±360 degrees, the work-space should be between a spherical and a cylinder. In a practice, the minimum height of arm above floor level is *h*. Therefore, the work-space is between a semi-spherical surface and a cylinder (Zhihong, 2005).

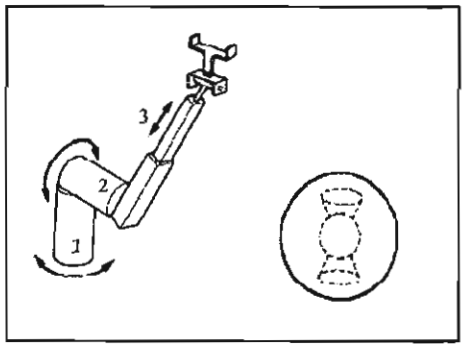

Figure 2.1.1.3 Spherical Robot