UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF 3-AXIS ROUTING MACHINE CONTROL SYSTEM

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

by

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FACULTY OF MANUFACTURING ENGINEERING

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SESI PENGAJIAN: 2008/09 Semester 2

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DECLARATION

I hereby, declared this report entitled "Development of 3-Axes Routing Machine Control System" is the result of my own research except as cited in references.

Signature : .....

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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 & Automation) with Honours. The member of the supervisory committee is as follow:

Supervisor

(Mr. Ismail Bin Abu Shah)

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ABSTRACT

'Development of 3-Axes Routing Machine Control System' is a one of the student project that assists and supervised by one supervisor. These processes begin with involve data collection process and information from journals, books and internet. This project involves three (3) important elements that is electrical, mechanical and pneumatic process that include inspection and testing the result in the end of operation. In this project, accentuation of project result is given more attention. These because the objective of this project is to integrate the device such as X-robot, Y-robot, router bit, Z-axis pneumatic cylinder, vacuum system and regulator; and to verify accuracy of cutting process. Result of the device integration and cutting process will be inspect and tested by using Coordinate Measuring Machine (CMM) to be analyze. In this project it more to controlling the system of operation. The circuit for each part such as electrical, mechanical and pneumatic is draw to show the conceptual of the controlling system and the suitable components to be applied in this project also be analyzed to make sure the all component able to work properly in control system built.

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ABSTRAK

'Development of 3-Axes Routing Machine Control System' merupakan satu projek yang dijalankan oleh pelajar, dibantu dan diselia oleh seorang penyelia. Proses ini bermula dengan melibatkan proses pengumpulan data dan maklumat daripada jurnal, buku dan internet. Projek ini melibatkan tiga (3) elemen yang penting iaitu proses elektrikal, proses mekanikal dan juga proses pneumatik yang merangkumi proses pemeriksaan dan pengujian keputusan dihujung operasi. Di dalam projek ini, penekanan terhadap hasil projek amat diberi perhatian. Ini kerana objektif projek ini adalah untuk menggabungkan beberapa alatan seperti X-robot, Y-robot, alat menggerudi dalam memilih laluan, silinder pneumatik paksi - z, sistem vakum dan alat atur; dan juga untuk mengesahkan ketepatan proses pemotongan. Hasil daripada penggabungan alatan-alatan tersebut dan proses pemotongan akan diperiksa dan diuji dengan menggunakan Mesin Pengukuran Koordinat untuk di analisa. Di dalam projek ini, penekanan lebih diberikan kepada mengawal sistem operasi. Litar untuk setiap bahagian seperti elektrikal, mekanikal dan juga pneumatik dilukis untuk menunjukkan konsep sistem kawalan dan alatan-alatan yang sesuai digunakan di dalam projek ini juga dianalisa untuk memastikan semua alatan-alatan mampu untuk bekerja dengan baik di dalam sistem kawalan yang dibina.

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DEDICATION

Special dedication to:

My father, Abu Bakar bin Hamid; mother, Salbiah bte Abd. Rahman; sisters, Noor Amirahwati, Noor Haslinawati, Noor Farah Shahidah, Nor Farah Iddayu; brother, Mohd. Farid, my supervisor, Mr. Ismail bin Abu Shah and also to all my friends especially who had helped me for finish up this project. Without yours concern, understanding and support, this project and success difficult to achieve.

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Finally, I hope that with this project it can be used to help and improve human life standard. Not just in the industrial but for everyday life.

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LIST OF ABBREVIATIONS

AC	-	Alternating Current
CMM	-	Coordinate Measuring Machine
CPU	-	Central Processing Unit
DC	-	Direct Current
DCC	-	Direct Computer Control
DOF	-	Degree of Freedom
I/O	-	Input/Output
MDI	-	Manual Data Input
MM	-	Millimeter
PC	-	Personal Computer
PCB	-	Printed Circuit Board
PIC	-	Programmable Intelligent Controller
PLC	-	Programmable Logic Controller
PSM	-	Projek Sarjana Muda
RPM	-	Revolution per Minute
DC	-	Direct Current
BLDC	-	Brushless Direct Current

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CHAPTER 1
INTRODUCTION

1.1 Background

In the modern world, application of robots can't be deny because it given more advantages to human especially in daily human job. By using robots, our daily job such as cleaning window or cutting grass can be easily done by robot. That one of the advantage of robots even application of robot sometimes also has the disadvantages but in globalization era, robots are needed. This situation happen because when we going to be more modern, advance technology will be used that sometimes can be effect on human self to do. Example of application robots that really needed is

a) **Task that human cannot perform**

   Ex: Space and underwater exploration

b) **Task that humans do not want to perform.**

   Ex: Repetitive precision-boring, tedious work such as assembly line work, ship cleaning.

c) **Tasks that are dangerous for humans**

   Ex: Chemical-related work, hot work, explosive material manipulation and other conditions harmful to humans.

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Above situation really needed application of robots, that why time by times, wiser peoples or engineer work harder in order to create and develop robots to improve and helping human to do task.

The first robot was developed in 1738 by Jacques de Vancousan, whose the first man is built's mechanical duck made of more than 4,000 parts. The duck could quack, bathe, drink water, eat grain, digest it and void it. In 1805, Maillardet had developed Doll that can functional like girl robot that can wrote either in French or English and also could draw landscapes.

After that days, the development of robots was continues until many creation and types of robots was develop. In 1950's to 1960's the new technology, Computer Technology Advances and Control Machinery are developed. At the times one question arises, Is the computer an immobile robot?

By following to Robotic Industries Association, they stated that an " industrial robot is a re-programmable, multifunction manipulator designed to move material, parts, tools or specialized devices through variable programmed motion to perform a variety of task". Development of robots actually is combination from a few fields. That is mechanical engineering, electrical engineering and computer science but not all people realize about this field combination because they expect, development of robot is only combination of mechanical and electrical engineering but in reality it is combination of 3's field that related to each other and plays important role in robot development.

In this project, student will give more concentration on cutting operation by integration of a few devices. Result from the cutting operation will be tested later by using CMM unit.

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1.2 Problem Statement

As the other project, this project also has the own problem and the main problem that will consider are previously cutting operation will cause defect due to inaccuracy and material deformation especially for non straight cutting process. So in this project student are trying to teach the router to follow desired path that controlled manually so that when cutting operation performed, no defect will occur and get the result as wanted.

Beside that, the second problem that faced by the student is difficulties to achieve flexibility of routing complexity cutting pattern of PCB board where student need to teach the XY-robot to make it can easily move in degree of freedom (DOF). Student will trying to make the XY-robot move in degree of freedom smoothly with less contact with the PCB board and at the same time get the router flexibility.

1.3 Objective

The main objectives that have to be in consideration for this project; stated as below:

a) To integrate device of X-robot, Y-robot, router bit, Z-axis pneumatic cylinder, vacuum and regulator.
b) To verify the accuracy of cutting operation.

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1.4 Scope

The task will be started by studying about the component related to the machine before student can build up it The function and the reason why the component were choose are one of the aspect that need given more priority because it will affect the result later. This because in this project, student needs to control the router manually because previously exist router cannot be controlled manually. Before this if the PCB were cut by manually whether use knife or by hand, defect will occur around the cutting path.

In addition, selection of system also is one of the important factors. Example, for this project student are using PC based control as the main compare to PIC or PLC because popcom software is easier to used in personal computer and it also more suitable and easy to understand. For PLCs, it quite difficult because it involve wiring process and not suitable enough for this project.

Besides, in this project student also will use concept Degree of Freedom (DOF) where the XY-robot will be taught to move in linear motion to look out the flexibility of router with the cutting pattern of PCB and able to cutting PCB without leave any defect on workpiece.

1.5 Conclusion

At the end of this chapter, student is able to determine the project title, problem statement, objective and scope of the project. This element is important to student to know the way of their project and it helps student to collect data or information that related with project title.

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CHAPTER 2
LITERATURE REVIEW

2.1 Development

2.1.1 Definition of Development

Nowadays, application of robot has playing important role in human daily life. Its not only has given many advantages but it also has improve human life. That way in this modern world, more company such as Honda has to compete with other company in order to develop new type of robot or machine that can give more advantages to human life and fulfill human requirement. However every creation of robot/machine is started with one process that called as development process. What is development process? This project, will involve with development process before 3-axes routing machine control system can be built.

In engineering field, development process consists of 3 important steps that will affect the machine look. By referring to Jr. Gordon (2003), 3 steps that involve in development process is design, analysis and manufacture/fabricate. Engineering design is the first step need to be completed before can start to develop 3-axes routing machine control system. According to Jr. Gordon (2003), Forman Thomas Tredgold (1987) has define "design is the art of directing the great sources of power in nature for the use and convenience of man"

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Design is a transformation of concepts and ideas into useful machinery (Jr. Gordon 2003).and for this project the machinery is refer to this project machine, 3-axes routing machine control system. The way how the 3-axes routing machine concept and ideas converted into machinery is very important because from design process machine looks is able to see and from the design too, process to convert it into machinery become easier. However before can start to design the machine, knowledge about the material selection, manufacturing process involve and process variable need to be priority

After that, in designing such machine must have correctly design of product. This is accomplished by combining material, environment properties with structure design requirement. Failure to design correct design, will give the bad impact on development of 3-axes routing machine control system.

After finishing design process, development of 3-axes routing machine will continued with analysis process. The first step in this process is to determine about it liability requirement, quality, assembly and so on. These because before can continued with manufacture step, design suitable to manufacture this machine need to know and if it founded not suitable or difficult to manufacture, the design need to be changed or repaired. During making design process, consideration in the analysis of current machine design and manufacture principle for material considered for the product need to give more attention. Failure to follow the practical design and manufacturing principle can result in a machine that is well designed but difficult or too costly to manufacture (Jr. Gordon 2003).

Next after complete to design and pass in analysis, development process will continued with the last step that is manufacture/fabricate but before to manufacture, machine individual manufacturing limitation need to be recognize because each machine has its own manufacturing limitation and because of that the best solution to overcome the limitation need to be find out.

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By following to the objective of this project, to verify the accuracy of cutting movement, 3 process above must be do well and by recognize the manufacturing limitation, the desired machine with special specification are able to produce.

In addition, to overcome manufacturing limitation, a greater understanding of the material variables and physical properties of the machine is very important (Jr. Gordon 2003). Beside that, in order to manufacture the machine, correct method of manufacture such as welding, riveting, cutting material must be do with caution because wrong process or equipment will cause the material physical properties are affected or the design changed.

2.2 3-Axes

According to Norton (2004), in three dimensional space there may be rotation and translation that will related with axis of x, y and z. For two-dimensional space only 2 axis will related that is x and y-axis. 3 axes of movement basically are derived from Degree of Freedom principle. Degree of Freedom is equal to the number of independent parameters (measurements) that are needed to uniquely define its position in space at any instance of time. DOF is defined with respect to a selected frame of references. To constrain an object always remain in the plane, three parameter (DOF) are required to completely define the position of the object on the plane, two linear coordinates (x, y) to define the position of any one point on the object.

Beside that, Zhihong (2004) define the number of degree of freedom is determined by the number of independent joint variables. In overall there have 12 DOF including positive (+ve) and negative (-ve) axis and rotation at each axis but this project only concern on 3 axes that is x–axis, y-axis and z-axis. Usually concept of DOF have used in many field especially in robotics (Zhihong 2004) and also applying in manipulator robot that the robot is created for special task that required many movements such as use in 3D MEMs (micro electromechanical system) micro assembly (Dechev *et al.* 2006).

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However these project not applying rotation concept as in 12 DOF but only concern about 3-axes of linear motion that presented by the hardware movement.

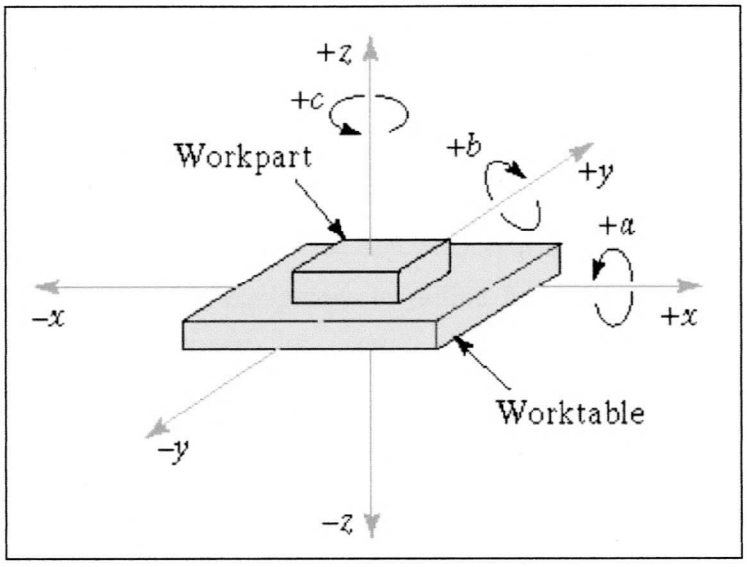

Figure 2.1: 12 Degree of Freedom (Grover 2008).

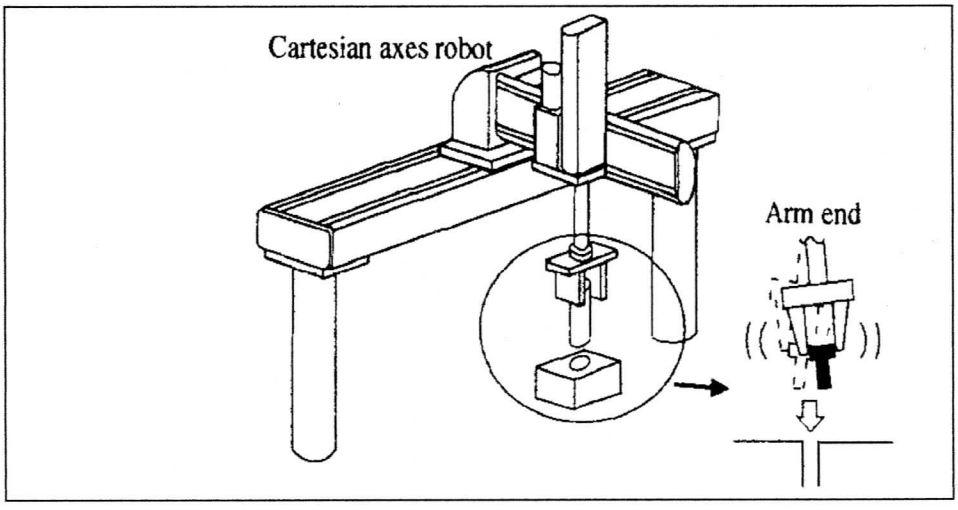

Figure 2.2: Cartesian axis robot (Yamamoto *et al.*1996).

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