KINEMATIC ANALYSIS OF
6-AXIS COMAU ROBOT

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA
UNIVERSITI TEKNIKAL MALAYSIA MELAKA (UTeM)

Kinematic Analysis
Of 6-Axis COMAU Robot

Thesis submitted in accordance with the partial requirements of the
Universti Teknikal Malaysia Melaka (UTeM) for the
Bachelor of Manufacturing Engineering (Robotic and Automation)

By

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JUDUL: KINEMATIC ANALYSIS OF 6-AXIS COMAU ROBOT

SESJI PENGAJIAN: 2007/2008

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DECLARATION

I hereby, declared this Bachelor's Project entitled "Kinematics Analysis of 6-Axis COMAU Robot" is the result of my own research except as cited in references.

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ABSTRACT

Kinematic analysis is the heart of this research. Kinematic analysis of a 6 degree-of-freedom COMAU robot will be carried out using manual calculation and using MATLAB software. Studies on past researches are performed in order to search for literature review on kinematics analysis of industrial robot. The main objective of this research is to find the robot arm parameters using the Denavit-Hartenberg (D-H) convention and then these parameters will be verified using MATLAB software. Since this research is done, the objective is assumed to be achieved. This is because this study is able to get the parameters of the COMAU robot by manual calculation. After that, the parameters that obtained before have been successfully proof correct and can be trusted using MATLAB software. However, not all the parameter is able to get 100% tally to each other. There are some errors and differences from each other. This condition occurs since there must be some faulty in manual calculation or MATLAB calculation.
ABSTRAK

DEDICATION

For my beloved parents:
Khadari bin Haji Romli
Rosina bt Lazim

And for my adored brother and sisters:
Khairul Anam bin Khadari
Ummul Hidayah bt Khadari
Muhammad Zafran bin Khadari
Ummul Umairah bt Khadari
ACKNOWLEDGMENTS

First at all, Alhamdulillah and praise to Allah. I manage to complete my Final Year Project – Projek Sarjana Muda. I also would like to offer thanks and deepest gratitude from the bottom of my heart for all the support, encouragement and inspirations I obtained throughout the duration of this project. The help rendered to me priceless, be it from the smallest of its kind to the largest. They include;

My supervising lecturer, Puan Syamimi binti Shamsudin of which we had a good working relationship, and who offered tremendous help and encouragement,

My family, who inspired me whether through the storm and carry on,

My friends and peers who are good companions in times of need.

Wassalam.

Khairunnisa bt Khadari
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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

D-H  -  Denavit-Hartenberg
MATLAB  -  Matrix Laboratory
PLC  -  Programming Logic Controllers
DOF  -  Degrees of Freedom
SCARA  -  Selective Compliant Articulated Robot Arm
ISO  -  International Organization for Standardization
CNC  -  Computer Numerical Control
DC  -  Direct Current

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CHAPTER 1
INTRODUCTION

1.1 Background

Nowadays, robots, becomes more and more important and useful in human daily life. It can be said that half of human being life is depending on the machines that can be assume as a robot. These robots are giving a lot of advantages and make the daily life more easily day by day since all of the technology is using less of man power.

This phenomenon also not limited to a household or human life only, but this technology also is rapidly increasing in the industrial field. Robots, machines with precise motion capabilities, repeatability, strength, and endurance, have been successfully applied in structured environments having little uncertainty, especially in manufacturing applications. Robots are designed to have the features appropriate to their functionality and they have done a good job for all time. However, as the world have move very fast to the forward, technology also have change year by year. So, the robots and all the machines that in the field of robot should be updated not only in hardware but also in the software system.

Based on the above statement, a development in hardware together with the software system needs to be done. But today's trend is different. The development in software is a new way in programming system. This is because not many types of software are powerful enough to control the system. One of the software that can be trust to control this feature is Matrix Laboratory or known as MATLAB. If the development successful by using MATLAB, will be more meaning to human being. This is because the
development by using software is very little if compared to the development in hardware. So it will be a profitable for human to expands their power in technology development and make our technology move one step forward in the automation world.

1.2 Problem Statement

In this project, a kinematics analysis needs to be carried out on the robot arm parameter using Denavit-Hartenberg (D-H) algorithms. This D-H algorithm has been widely used in robotics in obtaining the kinematics solutions of robot manipulator. The D-H algorithm also has provided a systematic matrix method, based on the homogeneous transformation theory, to describe the position and the orientation of each link or the tool tip with respect to its neighboring link in static situation. (Zhihong, 2005)

Other than that, this project will also verify the robot arm parameters using MATLAB software. Short for "Matrix Laboratory", MATLAB is a numerical computing environment and programming language. Created by The MathWorks, MATLAB allows easy matrix manipulation, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs in other languages. Although it specializes in numerical computing, an optional toolbox interfaces with the Maple symbolic engine, allowing it to be part of a full computer algebra system. (Sigmon, 1993)

Both of D-H algorithm and MATLAB are used for an analysis to verify whether the calculation using the D-H Algorithm matches the MATLAB results. MATLAB is built around the MATLAB language, sometimes called M-code or simply M. The simplest way to execute M-code is to type it in at the prompt, >>, in the Command Window, one of the elements of the MATLAB Desktop. In this way, MATLAB can be used as an interactive mathematical shell and also can help in calculating the robot arm parameter in this analysis.
Some experiments also will be done using the 6-axis COMAU robot to know the angle that it can reach to maximum point. Student also will learn how to manage or control the robot by using teach pendant that are available in the Robotics Laboratory.

This project will be able to sharpen one’s skill in conducting a robot and also in MATLAB software. Using software needs more patience because it needs time to learn it. Student also needs to do the try and error methods to identify the best method to use in calculating the kinematics of the robot arm parameter. By using MATLAB also, student will be able to build one system that can do a motion study or kinematics analysis. Student can define the maximum angle of the robot and from there an analysis of kinematics can be done.

1.3 Scope

The scopes of the project are calculating the arm parameter of the 6-axis COMAU robot using Denavit-Hartenberg (D-H) Convention and then verify the arm parameter into MATLAB software. From the parameters obtained from manual calculation, we will able to model the robot in MATLAB environment.

Chapter 1 will discuss about the background of the project, project scope, problem statement and objectives gain from the problem statement.

Chapter 2 will discuss all the literature review that are gained from journals, text books, internet, thesis and articles that are related to the project.

Chapter 3 is the methodology of the project. This will included the style or method used to finished up the project.
1.4 Objectives

The goal of this project is to carry out Kinematics Analysis On the 6-Axis COMAU Robot. In the end of this project, the following objectives should be achieved:

i. Literature review on the past researches or journals on kinematics analysis of industrial robot.

ii. To find the robot arm parameter by using Denavit-Hartenberg (D-H) convention.

iii. To verify the robot arm parameter by using MATLAB software.
1.5 Gantt Chart

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Table 1.1: Gantt Chart for PSM I and PSM II
CHAPTER 2
LITERATURE REVIEW

2.1 Robots

A robot is a mechanical or virtual, artificial agent. It is usually an electromechanical system, which, by its appearance or movements, conveys a sense that it has intent or agency of its own. The word robot can refer to both physical and virtual software agents, but the latter are usually referred to as robots to differentiate.

2.1.1 Definition of Robots

Robot is a word that is both a coinage by an individual person and a borrowing. It has been in English since 1923 when the Czech writer Karel Capek's play R.U.R. was translated into English and presented in London and New York. R.U.R., published in 1921, is an abbreviation of Rossum's Universal Robots; robot itself comes from Czech robota, “servitude, forced labor”, from rab, “slave”. The Slavic root behind robota is orb-, from the Indo-European root orbh-, referring to separation from one's group or passing out of one sphere of ownership into another (Wikipedia, 2006).

The Oxford English Dictionary, 2003 defines a robot as a one of the mechanical men and women in Capek's play; hence, a machine (sometimes resembling a human being in appearance) designed to function in place of a living agent, esp. one which carries out a variety of tasks automatically or with a minimum of external impulse. A robot also is a person whose work or activities are entirely mechanical; an automaton.
The International Organization for Standardization also has a definition. Under ISO 8373, a robot is: "An automatically controlled, reprogrammable, multi-purpose manipulator programmable in three or more axes, which may be either fixed in place or mobile for use in industrial automation applications" (Lewis, 1996).

The terms of robot actually can be defined in serious terms as machines with precise motion capabilities, repeatability, strength and endurance, have been successfully applied in structured environments having little uncertainty, especially in manufacturing applications (Lewis, 1996). Robots also are programmable manipulators that can follow a sequence of steps directed by a computer program. Accurate motion and force sensors, advanced servo-level control systems and programmable logic controllers (PLC) have allowed uses in processes including welding, assemble tasks, spray painting, palletizing, machine loading and elsewhere (Groover et al. 1986).

Gregory Dudek, the director of the Centre for Intelligent Machines at McGill University in Montreal, sets three criteria for robots; they have to have a way of making measurements of the world, they have to have a way of making decisions and they have to have a way taking actions.

This is means that robots are a something or mechanical human that can do any job or task given to them without any error. If should be like a real human but more accurate and precise than human being.