

**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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Faculty of Manufacturing Engineering
April 2008


UNIVERSITI TEKNIKAL MALAYSIA MELAKA (UTeM)
BORANG PENGESAHAN STATUS TESIS*
JUDUL: KINEMATIC ANALYSIS OF 6-AXIS COMAU ROBOT
SESI PENGAJIAN: 2007/2008

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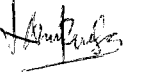
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DECLARATION

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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APPROVAL

This Bachelor's Project submitted to the senate of UTeM and has been accepted as fulfilment of the requirement for the Degree of Bachelor of Manufacturing Engineering (Robotics and Automation) with Honours.

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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

Analisis kinematik adalah jantung dalam kajian ini. Analisis kinematik pada robot COMAU yang mempunyai 6 darjah kebebasan ini dilakukan melalui dua kaedah iaitu pengiraan secara manual dan penggunaan perisian MATLAB. Kajian lampau telah dilakukan untuk mencari ulasan kesusasteraan yang berkaitan dengan analisis kinematik terhadap robot industri. Tujuan utama kajian ini dijalankan adalah untuk mencari nilai-nilai bagi sesebuah tanagn robot menggunakan kaedah Denavit-Hartenberg (D-H) dan seterusnya, nilai-nilai ini di sahkan dengan menggunakan perisian MATLAB. Memandangkan kajian ini telah habis dijalankan, tujuan utama kajian ini boleh di anggap sebagai berjaya dan mencapai sasaran yang telah ditetapkan. Ini adalah kerana sepanjang kajian ini, kesemua nilai-nilai pada robot COMAU berjaya dikenalpasti melalui pengiraan secara manual. Selepas itu, nilai-nilai yang telah diambil itu berjaya dibuktikan kesahihannya melalui perisian MATLAB. Walaubagaimanapun, tidak semua nilai-nilai yang di kira sama 100%. Ada terdapat kesalahan dan kesilapan serta perbezaan di dalam pengiraan untuk kinematik lanjutan bagi kedudukan bekerja. Jawapan yang diperolehi di dalam perisian MATLAB adalah tidak sama dengan pengiraan secara manual. Keadaan ini berlaku atas sebab kesalahan di dalam pengiraan secara manual atau pun melalui perisian MATLAB.

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 Zhafran 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 through out 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

TABLE OF CONTENTS

Declaration.....	ii
Approval.....	iii
Abstract.....	iv
Abstrak.....	v
Dedication.....	vi
Acknowledgements.....	vii
Table of Contents.....	viii
List of Figure.....	xi
List of Table.....	xiv
List of Abbreviations, Symbols, Specialized Nomenclatures	xv
1. INTRODUCTION.....	1
1.1 Background.....	1
1.2 Problem Statement.....	2
1.3 Scope.....	3
1.4 Objective.....	4
1.5 Gantt Chart.....	5
2. LITERATURE REVIEW.....	6
2.1 Robots.....	6
2.1.1 Definition of Robots.....	6
2.2 Industrial Robots.....	8
2.2.1 End-Effector.....	9
2.2.2 Robot Degree-of-Freedom.....	10
2.2.3 Types of Robot.....	12
2.2.4 Famous Brands of Industrial Robot.....	20
2.2.4.1 MOTOMAN Robots.....	20

2.2.4.2	FANUC Robots.....	21
2.2.4.3	PUMA Robots.....	22
2.2.4.4	ABB Robots.....	24
2.2.4.5	COMAU Robots.....	25
2.2.5	Robot Programming Method.....	26
2.3	Robot Kinematics.....	31
2.3.1	Importance of Robot Kinematics.....	32
2.4	The Denavit-Hartenberg Convention.....	32
2.4.1	Arm Parameter.....	33
2.4.2	Examples of 6-Axis PUMA Robot.....	36
2.5	Robot Analysis Software.....	38
2.5.1	RobotWorks Software.....	38
2.5.2	Visual Components – 3DCreate Software.....	39
2.5.3	MATLAB Software.....	40
2.5.4	COSMOSMotion Software.....	41
2.6	Previous Studies on Kinematics Analysis of Robots.....	42
2.6.1	Bart De Vylder. Forward and Inverse Kinematics of the Teach Robot.....	42
2.6.2	Geoffrey Riggs and Bruce Macdonald. A survey of Robot Programming System.....	44
2.6.3	V. Kumar. Introduction to Robot Geometry and Kinematics.....	45
2.7	Conclusion.....	46
3.	METHODOLOGY.....	47
3.1	Introduction.....	47
3.2	Planning of Study.....	47
3.3	Data Gathering.....	50
3.4	Literature Review.....	50
3.5	Site Visit.....	51
3.6	Experiments.....	51
3.6.1	Denavit-Hartenberg (D-H) Convention.....	51
3.6.2	Arm Parameters.....	52

3.7	COMAU Robot.....	53
3.7.1	Technical Specification.....	56
3.8	Robotics Toolbox for MATLAB.....	57
3.8.1	Steps to Use Robotics Toolbox.....	58
3.9	Examples of Two-Link Planar Manipulator using Robotics Toolbox.....	60
4.	KINEMATIC ANALYSIS & RESULTS.....	63
4.1	Introduction.....	63
4.2	COMAU Robot: SMART NS 16-2.65.....	63
4.2.1	Robot Mechanical Features.....	65
4.2.2	Robot Work Envelope.....	66
4.3	Robot Kinematics Analysis.....	68
4.4	Verification of the Arm Parameter and Calculation.....	86
4.4.1	MATLAB Software.....	86
4.4.1.1	Calibrated Position.....	87
4.4.1.2	Working Position.....	94
4.4.2	Inverse Kinematics.....	101
4.4.2.1	Calibrated Position.....	102
5.	DISCUSSION, CONCLUSION AND RECOMMENDATION.....	112
5.1	Introduction.....	112
5.2	Discussion.....	112
5.3	Conclusions.....	115
5.4	Recommendations.....	117
5.4.1	Current Study on Kinematics Analysis.....	117
5.4.2	Further Study.....	118
	REFERENCES.....	119

LIST OF FIGURES

2.1	KUKA Robots doing vehicle underbody assembly	7
2.2	A diagram of end-effectors	8
2.3	A diagram of roll, pitch and yaw	9
2.4	An articulated robot with 7 DOF in a kinematics chain	10
2.5	Cartesian Robot	11
2.6	Gantry Robots	13
2.7	Cylindrical Robots	14
2.8	Spherical Robots	15
2.9	Articulated Robots	16
2.10	SCARA Robots	17
2.11	Parallel Robots	18
2.12	MOTOMAN Robot	20
2.13	FANUC Robot	21
2.14	PUMA Robot	22
2.15	ABB Robot	24
2.16	COMAU Robot	25
2.17	A robot programming	27
2.18	Categories of manual programming systems	27
2.19	A diagram of text-base system	28
2.20	A diagram of graphical programming system	29
2.21	Categories of automatic programming systems	30
2.22	Denavit-Hartenberg Frame Assignment	33
2.23	PUMA 500	36
2.24	PUMA industrial robot with 6 revolute joints	36
2.25	D-H frame assignment for the PUMA robot	37
2.26	RobotWorks Software	38

2.27	3DCreate Software	39
2.28	Matlab Software	40
2.29	COSMOSMotion Software	41
2.30	A diagram of Teach-Robot	43
2.31	The six-degrees of freedom of PUMA 560 robot manipulator	45
2.32	The six degree-of-freedom T3 robot manipulator	46
3.1	Flow Chart for Planning of Study	49
3.2	D-H Frame Assignment	52
3.3	Types of COMAU Robot	53
3.4	SMART NS	54
3.5	CG4	54
3.6	MATLAB 7.0.4 Software	58
3.7	The command windows in MATLAB	59
3.8	Windows of two-link planar manipulator	60
3.9	A graphically display the pose of PUMA robot	61
3.10	A Puma 560 line segments linking the origins of the link reference frames	62
4.1	COMAU Robot	63
4.2	COMAU Robot Manipulator	63
4.3	The Angles Placements for COMAU Robot	64
4.4	Work Envelope (Front View)	66
4.5	Work Envelope (Top View)	67
4.6	Work Envelope (Side View)	67
4.7	COMAU Robot Manipulator	68
4.8	Frame Assignment x, y and z	69
4.9	Frame Assignment – Joint Angle	69
4.10	Frame Assignment – Joint Distance	70
4.11	Full Frame Assignment For COMAU Robot	70

4.12	COMAU Robot in Calibrated Position	74
4.13	COMAU Robot Working Position	77

LIST OF TABLES

1.1	Gantt Chart	5
2.1	Four Arm Parameter	34
3.1	Four Arm Parameter	52
3.2	Types of COMAU Robot	55
3.3	Technical Specifications of COMAU Robot	56
3.4	Two-link Planar Manipulator	60
4.1	Four Arm Parameter	71
4.2	The Arm Parameter of the COMAU Robot Manipulator	72

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

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.

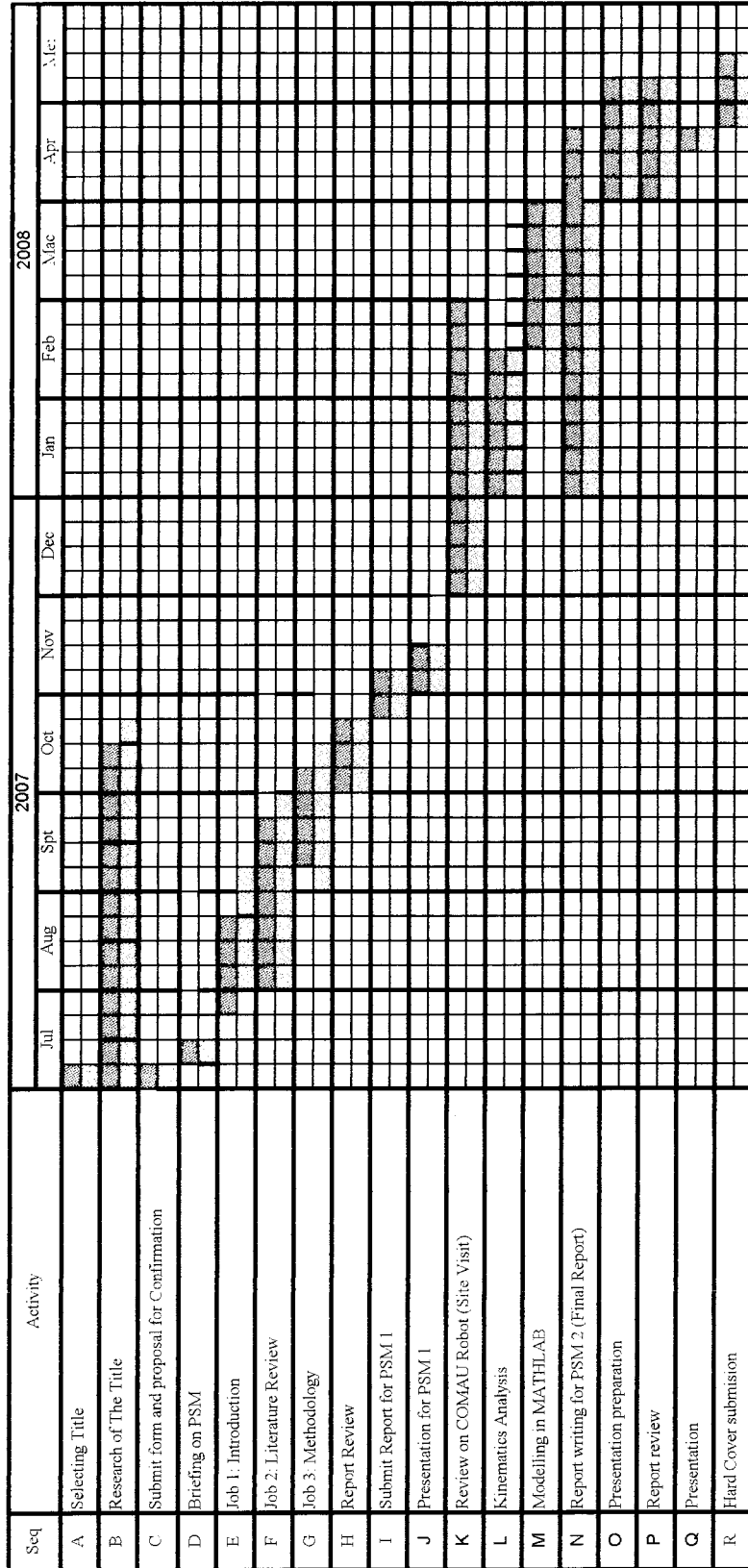
Chapter 3 is the methodology of the project. This will included the style or method used to finished up the project.

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



Legend:
 Planned
 Actual
 W: Week

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.