



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**Determination of 3-Dimensional Robot Workspace and
Safe Working Area Using Computer Software**

Thesis submitted in accordance with the partial requirement of the
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By

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Faculty of Manufacturing Engineering
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This PSM submitted to the senate of UTeM and has been as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotics & Automation) with Honours. The members of the supervisory committee are as follow:

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(Mr. Muhamad Arfauz Bin A. Rahman)

Abstract

The widely used of industrial robots in manufacturing industries has brought in a new challenge of safety aspects for workers and robots. Injury rates may increase without a proper safety system for industrial robot workspace. This project is designed and developed with the purpose of decreasing the injury rates happened in the industries. The main objective of this project is to design and develop a computer program to determine 3D robot workspace and safe working area. In this project, the emphasis is on safety and several aspects during installation of the industrial robot to ensure the safety of the robot working area. Few variables and specific dimensions are needed during installation of the industrial robot and to determine the robot work envelope.

In order to design and develop this computer program, a research and study on industrial robot and its specification are carried out and described briefly in this report. Other than that, a study on a computer program and drawing software is done to enhance a knowledge and information used in this project. The result of research and study are chosen and used as a reference in designing and developing the computer program. Solid Work software is used to create 3D robot workspace while Microsoft Visual Basic. Net is chosen to program a computer program. In this project user can interact with the developed user interface to get the result.

4 user level interfaces are developed to guide the user using the program. These user level interfaces guide the user using the program step by step until they get the result is obtained. User selects the brand of robot, model of robot, size of tooling and

configuration of robot. The program will show the space of the robot safe working area. By using this program, it can shorten the time for installing the industrial robot.

ABSTRAK

Pada masa ini, robot industri telah digunakan secara meluas dalam industri pembuatan di mana ianya telah membawa cabaran atau impak baru dari segi aspek keselamatan untuk pekerja dan robot itu sendiri. Kadar kemalangan akan meningkat tanpa sistem keselamatan yang cukup untuk ruang kerja robot industri. Oleh itu, projek ini direka bertujuan untuk mengurangkan kadar kemalangan yang berlaku di dalam industri. Objektif utama projek ini adalah untuk merekabentuk dan memperkembangkan program komputer dalam menentukan ruang kerja robot dalam bentuk 3D dan kawasan kerja yang selamat. Dalam projek ini, keselamatan dan beberapa aspek yang perlu dipertimbangkan semasa memasang robot industri adalah amat dititikberatkan dalam menjamin keselamatan pada masa akan datang. Beberapa pembolehubah dan nilai-nilai ukuran yang tertentu adalah perlu dititikberatkan semasa memasang robot industri dan dalam menentukan ruang kerja robot industri itu sendiri.

Dalam merekabentuk dan memperkembangkan program komputer untuk menentukan ruang kerja robot dalam bentuk 3D dan kawasan kerja yang selamat, beberapa penyelidikan dan kajian tentang robot industri dan spesifikasinya telah dibuat dan diterangkan dalam laporan ini. Selain daripada itu, kajian tentang program komputer dan perisian lukisan juga telah dibuat untuk menambah pengetahuan dan informasi yang akan digunakan dalam melaksanakan projek ini. Hasil penyelidikan dan kajian telah dipilih dan akan digunakan sebagai rujukan dalam merekabentuk program komputer untuk menentukan ruang kerja robot dalam bentuk 3D dan kawasan kerja yang selamat. Solid Work adalah pilihan untuk melukis ruang kerja untuk robot dalam bentuk 3D. Manakala Microsoft Visual Basic.NET dipilih untuk memprogramkan program

komputer dalam menentukan ruang kerja robot dalam bentuk 3D dan kawasan kerja yang selamat. Paparan pengguna adalah hasil projek ini di mana pengguna boleh berinteraksi dengannya untuk memenuhi kehendak atau keperluan.

Dalam program ini, 4 paparan pengguna telah direkabentuk untuk memandu pengguna menggunakan program ini. Paparan pengguna ini menunjukkan setiap langkah untuk menggunakan program ini sehingga mereka dapat keputusan. Pengguna akan memilih jenama robot, model robot, size alat dan pengaturan robot. Selepas itu, program ini akan menunjukkan kawasan selamat robot. Dengan menggunakan program ini, pengguna boleh memendekan masa memasang robot industri. Selain daripada itu, yang paling penting ialah mengelakkan kemalang semasa menjalankan robot.

DEDICATION

I dedicate this work:

To my caring father,

Mr. Chew Lin Hock

To my lovely mother,

Mrs. Chian Gek Sin

To my beloved brothers and sisters

To my supervisor,

Mr. Arfauz bin Abd Rahman

And the other person those are my constant sources of encouragement.....

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

3D	-	3 Dimensional
PSM1	-	Projek Sarjana Muda 1
PSM2	-	Projek Sarjana Muda 2
R.U.R	-	Rossum's Universal Robots
DOF	-	Degree of Freedom
AC	-	Analog Current
DC	-	Digital Current
ABB	-	Asian Brown Boveri
ME	-	MOTOMAN Robotics Europe AB
YEC	-	YASKAWA Electric Corporation
OOP	-	Object-Oriented Programming
IDE	-	Integrated Development Environment
OOED	-	Object-Oriented/Event-Driven
TOE	-	Task, Object, Event
IPO	-	Input, Processing, Output
CAD	-	Computer Aided Design
OLE	-	Object Linking and Embedding
API	-	Application Programming Interface
VBA	-	Visual Basic Application

CHAPTER 1

GENERAL INTRODUCTION

1.1 Introduction

In this world, there were about 750,000 robots working in industry worldwide [1]. The industrial robots were more advanced than before, they has increased in capability and performance through controller and the language development. Beside that, the mechanisms, sensing system and drive system also improved [1].

Robotics systems have involved installing robots in controlled access locations with in a manufacturing environment. The safety principles used in manufacturing safety standard is to ensure the operator is out of the working envelope while the robot arm is operated. Especially when the robot power up and capable of moving and limiting maximum velocities during maintenance and programming task. The robotic system with the safety devices and safe workplace are shown in Figure 1.1[27].

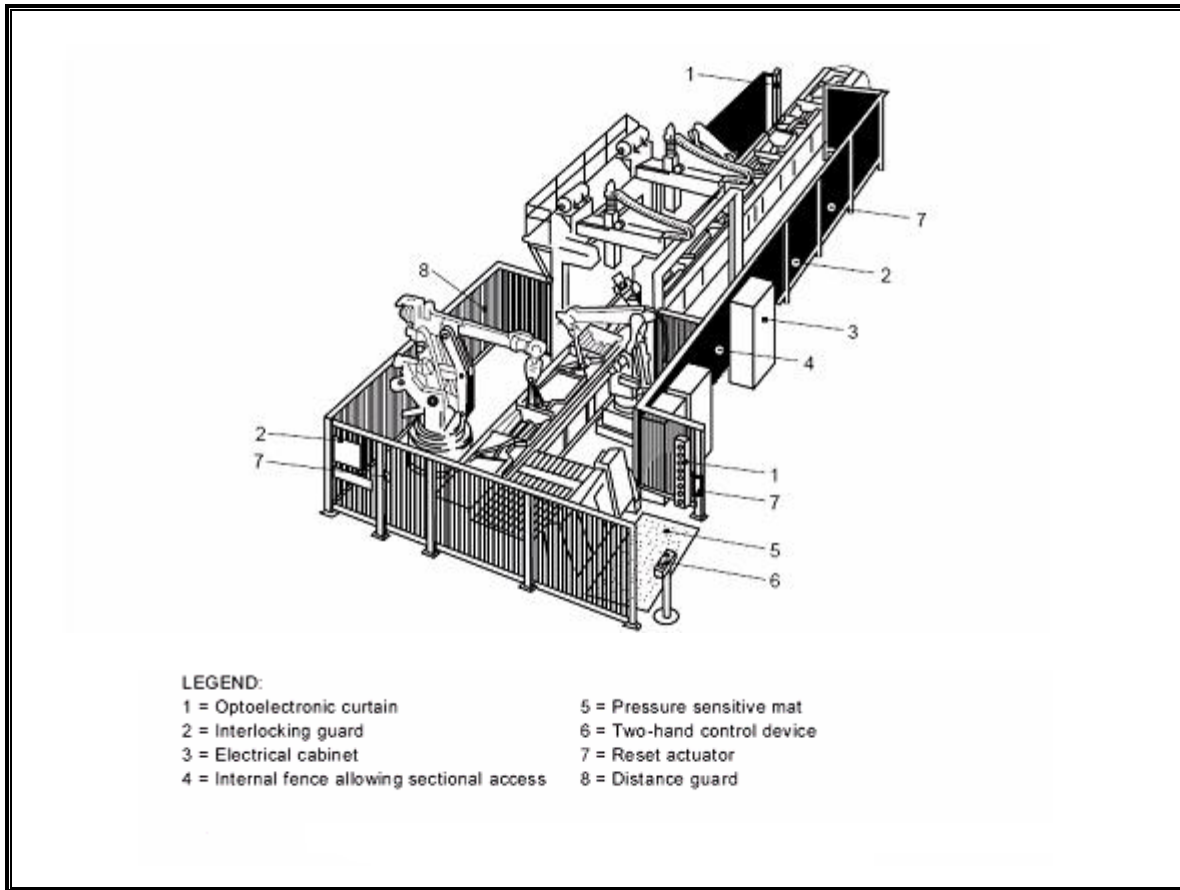


Figure 1.1: Robotic System

The industrial robot use in manufacturing industries makes a new challenge of safety system and robot installation. This valid is for all the people in the industries especially the worker who works in the robot working envelope. Injury rates for worker may be increased without proper safety system, robot installation software, safety workspace and safe working area. So, the need of safety system and robot installations software is important and necessary. All of these things are to ensure the hazard can be minimized and eliminated to an acceptable limit.

This project is created, designed, and developed a program to determine the robot safe working area and then reduce the risk of hazard in the workplace. Therefore, software also will be created on purpose to determine the 3D robot workspace and safe working

area. This software is expected to help the industry to set up the location of robot arm and improve the facility design and reduce hazards in the workspace.

The 3D robot workspace and safe working area is used to avoid the accident during the operation of robot. By using this software, the safe working area of a robot can be determined. After that, draw a layout and build a fence to prevent the operator close to the robot. Beside that, it also have few arrangement for robot, the robot can arrange in a few arrangement depend the location in the factory. By using this software, we can save time, because it is faster than using calculator to get the exact distance of the safe working area. The figure 1.2 show the floor marking of the robot arm workspace

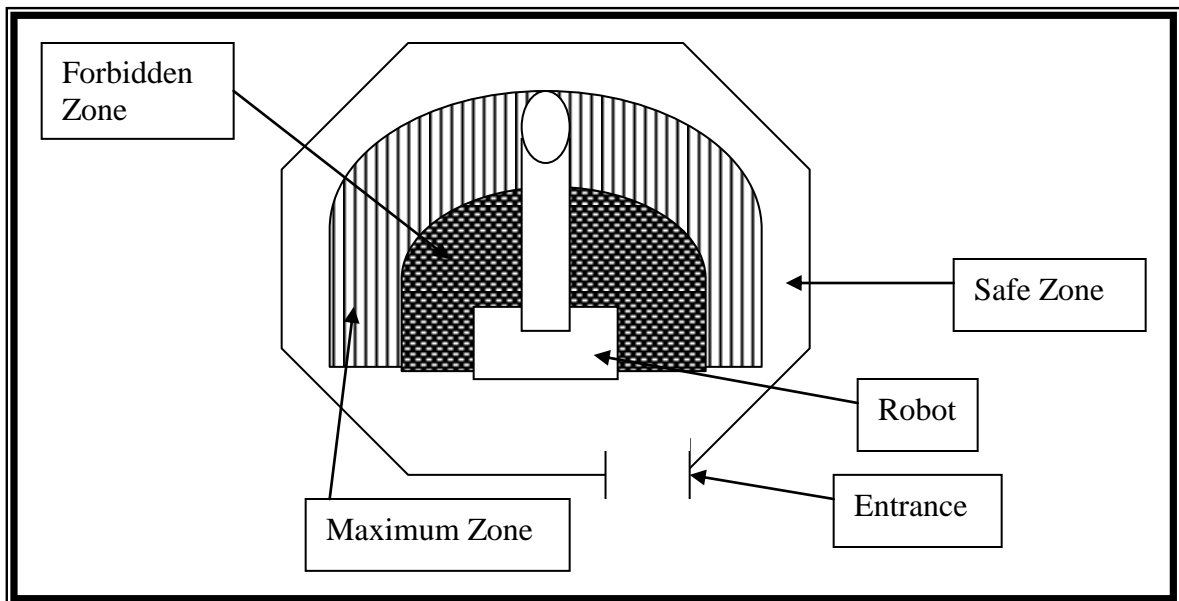


Figure 1.2: Safety Floor Marking of Robot Work Cell

- Forbidden Zone : the area outside the work cell and has no restrictions on human movement.
- Maximum Zone : is the area inside the work cell but out of reach of the robot arm.
- Safe Zone : is the area inside the robot work envelope and it cannot be entered while the robot is in the automatic or run mode.

1.2 Objectives of the Project

The objectives of this project are as follows:

1. To evaluate current computer program to determine robot workspace and safe working area.
2. To design and develop 3D robot workspace and safe working area.

1.3 Scopes of the Project

Scopes of this project includes:

1. Identify and evaluate the suitable computer software to create a program to determine 3D robot workspace and safe working area.
2. Design and develop the computer software to determine 3D robot workspace and safe working area using the chosen software.

1.4 Layout of the Thesis

The general introduction about this project is provided in Chapter 1 that discusses about the problem statement carried out for this project named “Design and Develop a computer program of 3D Robot Workspace and Safe Working Area”, objectives and scopes of this project briefly. Layout of this report is also presented in this chapter.

Chapter 2 provides a literature review and past studies in area relating to robot, industrial robot and work envelope for the robot in the industry, computer program and drawing

software. This chapter is also as a reference to implement this project. List of brand and type of industrial robot is presented in this chapter that will be used and applied in this project. Computer program and drawing software will be chosen and used to create, program and execute this project become success.

All of the method and analysis of the data used to implement this project is presented and described briefly in this chapter named Methodology chapter or Chapter 3. Flow chart of research methodology from start to end of this project is presented and explained briefly. Beside that, the sources of the data and information are described in research tool. And then project research planning for PSM1 and PSM2 that has been fixed in Gantt chart are outlined in this chapter.

The fourth chapter is on design and development of the computer program. The emphasis of this chapter is the output of this project and it also includes the analysis done during the implementation of this project and presentation of the user interface.

Chapter 5 provides a general discussion on the results of this project, stressing the significance and several implications of the findings of the project undertaken. Overall of this project will be described and concluded in the last chapter (chapter 5). Beside that, any suggestion to improve and develop this project in the future will be outlined in this chapter. All the result and finding drawn from this research will be concluded in this chapter.

1.5 Concluding Remark

Introduction chapter brief about the PSM title; Determination 3-Dimensional robot workspace and safe working area using computer software. On the other hand, it also state out the objectives and scope of the PSM project. Reader have a basic understand about this project after had a reading.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Nowadays, robotics technologies are widely use in our lifestyle in determining and fulfill our need. The real application of robot in industry started early 1950's. General motors installed its first industrial robot to enhance the productivity of production lines. The initial use of industrial robot is to replace workers from unhealthy and hazardous environment [5]. However, it has also brought some new safety problems for them especially when workers are in working envelop of the robot. The accident rates will be increase if there are not proper or lack of safety integration between workers and robot. Beside that, during installation and locate the industrial robot at any workspace, the working envelop of the robot should be considered and emphasized so that the accident rates can be decrease. There are many brand of industrial robot in this new era technologies such as ABB, KUKA, FANUC and any others that are use in the industries with different application and working envelope. However, industrial robot should be programmed first to perform its job or application. Then, it wills perform its application according to the programming and works in its working envelope.

2.2 Robot and its components

2.2.1 Robot

A robot can be defined as a reprogrammable, multifunctional manipulator which designed to move materials, parts, tools or special devices through variable programmed motions for performing a variety of tasks [6].

In general, robots are designed to be controlled by a computer or similar device. The device is a multiple-motion device with one or more arms and joints so that is capable of performing many different tasks like a human. The controller is used to control the motions of the robot, but it is under the supervision of the computer, which the controller runs some type of program. Thus if the program is changed, the actions of the robot is changed accordingly. The purpose is to design a device that can perform many different tasks and it is flexible while doing the tasks without having to redesign the device. Thus the robot is designed to be able to perform any task that can be programmed simply by changing the program. A robot may include a feedback-driven connection between sense and action, not under direct human control. The action may be in the form of electromagnetic motors or actuators (also called effectors) that move an arm, or open and close grips. Every mechanical point on a robot is a degree of freedom (DOF) except in the gripper or tool, which some form of drive induces motion in a robot part. The motion can be of a pivoting nature or a reciprocal motion.