



TECHNICAL UNIVERSITY of MALAYSIA, MELAKA

Design for Robot Welding Rotation Jig with Workspace

Thesis submitted in accordance with the requirement of the Technical University
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Manufacturing (Robotic & Automation)

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ABSTRACT

Jigs are work holders designed to hold, locate and support a work piece when robot welding is weld the work piece. Jigs are widely used in manufacturing sector such as in drilling machine and milling machine. In robot industry, jigs are commonly used for robot welding. The purpose is to hold the work piece when the robot welds the work piece because range of robot welding is limited. This project involves a design rotation jig for robot welding and simulates the rotation jig and robot welding using the robot simulation software called Workspace. Rotation jig is designed to improved the versatility and extend the range of robotic arc welding system. Workspace is being used to simulate the rotation jig and robot welding. This project is been started by study a general consideration to design a jig and study about Workspace programming for simulate the robot welding and rotation jig. Information from the study, rotation jig has been designed. In the workspace programming, robot welding can be uploading from the robot library and can be simulated with a rotation jig to. From the simulation, errors can be tackled and this can help improve quality and productivity.

ABSTRAK

Jig adalah sesuatu alat yang direka untuk memegang dan menyokong bahan kerja apabila robot pengimpal mengimpal bahan kerja. Jig digunakan secara meluas di dalam sektor pembuatan seperti contoh, jig digunakan pada mesin penggerudian dan mesin pengisaran. Didalam industri robot, jig digunakan untuk robot pengimpal. Tujuan jig digunakan didalam industri robot adalah untuk memegang dan menyokong bahan kerja semasa robot pengimpal melakukan kerja. Ini adalah kerana robot pengimpal mempunyai darjah kebebasan yang terhad. Kerja yang terlibat untuk menyiapkan projek ini adalah merekabentuk jig yang boleh berputar untuk kegunaan robot pengimpal dan melakukan simulasi terhadap robot pengimpal dan jig berputar dengan menggunakan perisian simulasi iaitu "Workspace 5". Jig berputar direka untuk meningkatkan kualiti dan membantu robot kimpalan mengimpal kimpalan yang tidak dapat dicapai oleh lengan robot. Projek ini dimulakan dengan mempelajari dan menimbang syarat-syarat umum untuk merekabentuk jig. Segala maklumat yang telah dikumpul akan digunakan untuk merekabentuk jig. Robot tidak direka, tetapi diambil daripada perpustakaan perisian simulasi iaitu "Workspace 5". Daripada aktiviti simulasi yang telah dilakukan, banyak masalah yang timbul akan dapat diatasi.

CHAPTER 1

INTRODUCTION

1.1 Background of Project

Technology in this world is growing rapidly. All country in this world wants to be an advanced in all of kind of things. Today, sophisticated machine and robots are being developed to replace human in the work field. Machine such as robots are capable to do a critical and dangerous jobs. Robots is not like a human that have a limitation when do a job, robots can do anything without having any difficulties or tired like human when do a job. Robots also can improved productivity, reduce a failure, and also improved a quality. This project is specified to design a rotation jig for a robot welding. Rotation jig are designed to holding are workpice or product that wants to be welding. Rotation jig are also designed for automatic welding of parts and specified for high accuracy separate setting, high overall performance, improved a quality of welded seams and to simplify the welding work that need to be weld in the difficult or critical angle.

This project also is been done to looks an advantages a simulation for a robot welding before some application is been done. With a simulation software, errors can be reduced, increased a flexibility, decreased risks of disinvestments are achieved through superior planning and quicker adaptation rates in the production.

1.2 Gantt Chart

Table 1.1 Gantt Chart (PSM 1)

CONTENTS	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	
Project Selection									SEMESTER BREAK								
Search information about robot welding, rotation jig																	
Gathering the information about jig and general consideration to design a jig																	
Write a literature review																	
Study and learning about Catia																	
Design a first rotation jig																	
Study and learning about Workspace programming																	
Design a second rotation jig																	
Gathering all information and sources																	
Start to make a draft report																	
Preparation for final draft report																	
Preparation for final slide presentation and submission report																	

Table 1.2 Gantt Chart (PSM2)

CONTENTS	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	
Analysis the designs of rotation jig	■								SEMESTER BREAK								
Made an improvement for first rotation jig design		■	■														
Made an improvement for second rotation jig design				■	■												
Make a comparison between first design and second design of rotation jig						■											
Simulating Robot and Rotation Jig Using the Pendant							■	■			■	■	■	■	■	■	■
Simulate the Robot and Rotation Jig Using Create Geometry Point (GP) on an Edge							■	■			■	■	■	■	■	■	■
Test the simulation whether suitable or not															■	■	
Start to make a draft report											■	■	■	■	■		
Preparation for final draft report												■	■	■	■	■	
Preparation for final slide presentation and submission report																■	■

1.3 Objective of the Project

In this project, the main objective are to design the rotation jig for a robot welding and simulate the robot welding and rotation jig using a Workspace programming. The other objective in this project are-:

- Study and understanding a general consideration to design a jig
- Study and understanding a working principle and type of robot welding
- Study and understanding a Workspace programming and other robot simulation programming

1.4 Scopes of the Project

The scope of this project are-:

- Design a rotation jig for robot welding
- Simulate the rotation jig and robot welding using Workspace programming

1.5 Aims of the Project

The aims of this project are to shown the advantages of using a rotation jig for robot welding. This project also showed the advantages of using a robot simulation programming to simulate the robot before upload the programming to the robot. This to make sure the errors can be tackled.

CHAPTER 2

LITERATURE REVIEW

2.1 History of Robots

Science fiction has no doubt contributed to the development of robotics, by planting ideas in the minds of young people who might embark on careers in robotics, and by creating awareness among the public about the technology. We should also identify certain technological developments over the years that have contributed to the substance of the robotics. Table 1 presents a chronological listing which summarizes the historical development in the technology of robotics.

Some of the early developments in the field of automata deserve mention although not all of them deal directly with robotics. In seventeenth and eighteenth centuries, there were a numbers of igneous mechanical device that had some of features of robots. Jacques de Vaucanson built several human sized musicians in the mid 1700s. Essentially these were mechanical robots designed for a specific purpose, entertainment. In 1805, Henri Maillardet constructed a mechanical doll which has capable of drawing pictures. A series of cams were used as the programs to guide this device in the process of writing and drawing. Maillardets writing dolls is on display of the Franklin Institute in Philadelphia, Pennsylvania. These mechanical creations of humans form must be regarded as isolated inventions reflecting the genius of men who were ahead of their times. There were other mechanical inventions during the industrial revolutions, created by minds of equal genius, many of which were directed at the business of textile production. These included Hargreaves spinning jenny (1770), Crompton's mule spinner (1779), Cartwright's power loom (1785), the Jacquard loom (1801), and others.

In more recent times, numerical control and telecheries are two important technologies in the development of robotics. Numerical Control (NC) was developed for machine tools in the late 1940s and early 1950s. As its name suggests, numerical control involves the control of the actions of machine tools by means of numbers. It is based on the original work of John Parsons who convinced of using punched card containing position data to control the axes of machine tool. He demonstrate his concept to the United State Air Force, which proceeded to support a research and development projects at the Massachusetts Institute of Technology. The MIT project used three-axis milling machine to demonstrate the prototype for NC in 1952. Subsequent work at MIT led the development of APT (Automatically Programmed Tooling), a part programming languages to accomplish the programming of the NC machine tool. It is interesting to note that the Jacquard loom and the player piano, developed around 1876, can be considered to precursors of the modern NC machine tool. Both operated using form a punched paper tape as program to control the action of the respective machine.

The field of telecheries deals with the use of a remote manipulator controlled by human being. Sometime called a teleoperator, the remote manipulator is a mechanical device which translates the motion of the human operator into corresponding motion at a remote location. A common use of a teleoperator is in the handling of dangerous substance, such as radioactive materials. The human can remain in a safe location, yet by peering through a leaded glass windows or by viewing on closed circuit television, the operator can guide the movements of the remote arm. Early telecheries device were entirely mechanical, but more modern systems use a combination of mechanical system and electronic feedback control. Work on teleoperator design for handling radioactive materials dates back to the 1940s. Telecheries device were used by the Atomic Commission starting around the same time.

It is the combination of numerical control and telecheries that forms that forms the basic for the modern robots. The robot is mechanical manipulators whose mentions are controlled by programming techniques very similar to those used in numerical control. These are two individuals who must be credits with the recognizing the confluence of these two technologies and the potential it might offer in the industrial applications. The

first was a British inventor named Cyril Walter Kenward who applied for a British patent for a robotics device in March 1954. This patent was issued in 1957.

The second person who must be mentioned in this context is George C. Devol, the Americans inventors, who must be credited with two inventions that led to the development of modern robots day. The first was a device for recording electrical signals magnetically and playing them back to control a machine. The device is dated around 1946 and the US patent for it was issued in 1952. The second invention was titled “Programmed Article Transfers” and the US patent for this device was issued in 1961. Although Devol’s patent followed Kenward’s by several years, it was Devol’s work that established the foundation for the modern industrial robot. What made Devol’s inventions into an industry in the United State rather than in the United Kingdom was the presence of a catalyst in the person of Joseph Engelberger.

Joseph F. Engelberger graduated from Columbia University with a graduate degree in physic in 1949. As a student, he had read with fascination several of Asimov’s novels. By the mid 1950s he was the chief engineer for an aerospace division of a company located in Stamford, Connecticut. The division was in the business of making controls for jet engines. Hence, by the time a chance meeting took place in 1956, Engelberger was predisposed by education, avocation, and occupation toward the nation of robotics. As fate would have it, Joseph Engelberger met George Devol at a cocktail party held in Fairfield, Connecticut. During the conversation, Devol told Engelberger about his invention of the programmed article transfer device, and the two subsequently began discussing the possibility of commercializing the invention.

Through the financial backing of the Consolidated diesel Electric Company (now Condec Corp), Engelberger and Devol started to develop plans and prototype for the universal helper, or “Unimate”. In 1962, the Unimation Company was founded as a joint venture between Consolidated Diesel Electric and the Pullman Corporation. Engelberger became president of the company and has promoted the development and the application of robotics ever since.

The first recorded installation of a Unimate robot was at the Ford Motor Company for unloading a die casting machine. More application followed, slowly at the first , using robot not only from Unimation, but also from a number of other companies in the United

State, Europe, and Japan. Some of the more significant robot installations are included in table 1.

There were many other worthwhile contributions to the fields of robotics, although space limits our including all of them. It is appropriate to note some of the pioneering work at Stanford University and Stanford Research Institute on computer oriented robot language. In 1973, the experimental language called WAVE was developed. This was followed by the development of the AL language in 1974, another language designed for research. The first commercial robot language was VAL, developed by Victor Scheinman and Bruce Simano for Unimation, Inc. The language was first used to program Unimation's PUMA robot, a relatively small jointed arm robot whose design was based on studies of assembly automation that had been done by General Motor. PUMA stands for Programmable Universal Machine for Assembly.

The Stanford work on robot language, and much of the subsequent work that has been done in robotics, is largely based on developments in computer technology. Although computers were certainly available at the birth of the robotics industry, it was not until the mid to late 1970s that the economics were right for the use of a small computer controls. Indeed, the field of robotics is often considered to be combination of machine tool technology and computer science.

Table 2.1 Chronology of development related to robotics technology including significant robot application

Year	Developments
Mid-1700s	J. de Vaucanson built several human sized mechanical doll that played music
1801	J. Jacquard invented the Jacquard loom, a programmable machine for weaving threads or yarn into cloth.
1805	H. Maillardet constructed a mechanical doll capable of drawing pictures.
1946	American inventor G. C. Devol developed a controller device that could record electrical signals magnetically and play them back to operate a mechanical machine US patent issued in 1952.
1951	Development work on teleoperates (remote control manipulator) for handling radioactive material. Related US patent issued to Goertz (1954) and Bergsland (1958)
1952	Prototype Numerical Control machine demonstrated at the Massachusetts Institute of Technology after several years developments. Part programming language called APT (Automatically Programmed Tooling) subsequently developed and released in 1961
1954	British inventors C. W. Kenward applied for patent for robot design. British patent issued in 1957.
1954	G. C. Devol develops design for “programmed article Transfer.” US patent issued design in 1961
1959	First commercial robot introduced by Planet Corporation. It was controlled by limit switches and cams.
1960	First “Unimate” robot introduced, based on Devol’s “programmed article transfer.” It used numerical control principles for manipulator control and was hydraulic drive robot.
1961	Unimate robot installed at Ford Motor Company for tending a die casting
1966	Trallfa, a Norwegian firm, built and installed a spray painting robot.

1968	A mobile robot named “Shakey” developed at SRI (Stanford Research Institute). It was equipped with a variety of sensors, including a vision camera and touchsensors, and its can move about the floor.
1971	The “Stanford Arm”, a small electricity powered robot arm, develop at Stanford University.
1973	First computer type robot programming language developed at SRI for research called WAVE. Followed by the language AL in 1974. The two languages were subsequently developed into the commercials VAL language for Unimate by Victor Scheinman and Bruce Simano.
1974	ASEA introduced the all electric drive Irb6 robot
1974	Kawasaki, under Unimation license, installed arc welding operation for motorcycle frame.
1974	Cincinnati Milacron introduced the T ³ robot with computer controlled.
1975	Olivetti “Sigma” robot used in assembly operation. One of the vary first assembly applications of robotics.
1976	Remote Center Compliance (RCC) device for part insertion in assembly developed at Charles Stark Draper Labs in United States.
1978	PUMA (Programmable Universal Machine for Assembly) robot introduced for assembly by Unimation, based on designing form a General Motor study.
1978	Cincinnati Milarcon T ³ robot adapted and programmed to performed drilling and routing operations and aircraft components,under Air Force ICAM (Intergrated Computer Aided Manufacturing) sponsorship.
1979	Development of SCARA type robot (Selective Compliance Arm for Robotics Assembly) at Yamanashi University in Japan for assembly. Several commercial SCARA robot introduced around 1981
1980	Bin packing robotics system demonstrated at University of Rhode Island. Using machine vision, the system was capable of picking parts in random orientations and position out of a bin.
1981	A “direct drive robot” developed at Carnegie Mellon University. It used

	electric motor located at the manipulator joints without the usual mechanical transmission linkage used on most robots.
1982	IBM introduced the RS-1 robot for assembly, based on several years in house development. It is a box frame robot using an arm consisting of three orthogonal slides. The robot language AML, developed by IBM, also introduced to program the RS-1.
1983	Report issued on research at Westinghouse Corp. under National Science Foundation sponsorship on “adaptable programmable assembly system” (APAS), a pilot project for a flexible automated assembly line using robot.
1984	Several off line programming systems demonstrated at the Robot 8 show. Typical operation of these system allowed robot programmed to be developed using interactive graphics on a personal computer and then downloads to the robot.
1987	International Federation of Robotics (IFR) was founded
1990	Cincinnati Milacron was acquired by ABB of Switzerland. Most small robot manufacture went out of the market. Only a few large companies which primarily produce industrial robots remained.
1993	An eight legged robot called Dante was to reach the lava lake of constantly erupting volcano of Mt Erebus in Antarctica and study its gases.
1996	Honda introduced their “Human” robot in Tokyo in December 1996. It stands 6 feet tall and weighs about 210 kg. It can operate completely independently on power for 15 minute.
1999	Sony introduced the electronic robot AIBO in Japan. AIBO means “companion” in Japanese and it also an acronym for Artificial Intelligence robot.

2.2 What is A Robot?

A manipulator that has a number of links attached serially to each others with joints, where each joint can be moved by some type of actuator. The hand of the manipulator can be moved in space and be placed in any desired location within the workspace of the system. Each one can carry a certain amount of load, and central controller controls the actuator of each system. In general, robots are designed and controlled by a computer or a similar device. The motion the robot are controlled through a controller that is under the supervision of the computer, which itself is running some type of program. Thus, if the program is changed, the action of the robot will be changed accordingly. The attention is to have a device that can perform many different tasks and thus is very flexible in what it can do, without having to redesign the device. Therefore, the robot is designed to be able to perform any task that can be programmed simply by changing the program. The simple manipulator cannot do this without an operator running it all the time.

2.3 Definition of Robots

There are various ways of defining a robot. The robot Institute of America (1979) uses the following as an widely accepted industry standard:

“A robot is a reprogrammable, multifunction manipulator designed to move material, parts, or specialized device through variable programmed motions for performance of a variety of tasks”.

This definition is very restrictive in that it included neither mobile robots or the type of science fiction character we would call an android. Perhaps a comprehensive definition would be McKerrow’s (1986). Robotics is the discipline that involves:

- a. The design, manufacture, control, and programming of robots.
- b. The use of robots to solve problems.
- c. The study of the control processes, sensors, and algorithms used in humans, animals and machines.
- d. The application of these control processes and algorithms to the design of robots.

Others common definition found in literature for robots are as follows:

- Robotics is the intelligent connection of perception to action
- An intelligent robot is a machine able to extract information from its environments and use knowledge about its world to move safely in a meaningful and purposeful manner.
- A robot is a system that its exist in the physical world and autonomously senses its environments and acts in it.
- Robotics is where Artificial Intelligent (AI) meets the real world.
- Robotics is one branch of Artificial Intelligence.
- An automatic device that performs function normally described to human or a machine in the form of a human.

A clear distinct must be made between robotics engineering and the science of robotics. Robotics engineering is concerned with the design, construction, and application of robots. While robots are built during the course of scientific research, the goal of robotics science is not development of machine, but to understand the physical and information processes underlying perception and action. Once basic principles are established, they can be used in the design of robots.