UNIVERSITI TEKNIKAL MALAYSIA MELAKA

SYSTEM DEVELOPMENT OF PARALLEL ROBOT WITH INDUSTRIAL CONTROLLER

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

by

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2010

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **SYSTEM DEVELOPMENT OF PARALLEL ROBOT WITH INDUSTRIAL CONTROLLER**

SESI PENGAJIAN: 2009/10 Semester 2

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DECLARATION

I hereby declare that this report entitled **"**System Development of Parallel Robot with Industrial Controller**"** is the result of my own research except as cited in the references.

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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 and Automation). The members of the supervisory committee are as follow:

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(Main Supervisor)

ABSTRACT

The 4-DOF Zlatonov and Gosselin platform parallel robot is the further invention follows by the Stewart-Gough Platform. The Stewart-Gough Platform is a spatial mechanism in which a moving platform is connected to a fixed base with six extensible limbs by spherical joints. The Zlatonov and Gosselin platform is capable to manipulate the performance as the Stewart-Gough Platform but in fewer axes presented. First, this project report will introduce over view of variety types of robot, especially the parallel robot and the device that are being developed. Then, it is follow by the introduction of the basic of concept for the 4-DOF Zlatonov and Gosselin platform parallel robot. In this section the declaration of the objectives, the scopes of the project, the problems statement and the expected outcome will be state. It was discussed the study has been done of the 4-DOF Zlatonov and Gosselin platform parallel robot. The Methodology used to solve the design and fabrication problem is depending by using the CAD/CAM SolidWorks software. The fabrications processes involved in this project where to build 4-DOF platform robot station with motors attachment. The motors controlled by its drive using PLC device. Finally, the complete improvement design of 4-DOF Zlatonov and Gosselin platform parallel robot is presented in 3D modeling by using SolidWorks. After that is follow by some suggestion and recommendation for this project.

ABSTRAK

Robot selari 4 darjah kebebasan Zlatonov dan Gosselin merupakan sesuatu rekaan cipta robot selari yang berlanjut daripada ciptaan platform Stewart-Gough. Platform Stewart-Gough ini adalah ruangan berpandu robot mekanisma ini kerana rekaan platform robot ini adalah bersambungan dengan tapak robot melalui 6 lengan berselari. Platform Zlatonov dan Gosselin, berupaya melakukan pengawalan yang secekap akan platform Stewart-Gough, malahan dengan bilangan lengan yang kurang. Bahagian pertama akan memperkenalkan secara am tentang kepelbagaian teknologi robot, terutamanya robot selari dan alatan yang telah dibangunkan. Selain itu, dinyatakan teliti dengan konsep asas robot selari 4 darjah kebebasan Zlatonov dan Gosselin ini. Bahagian ini juga menerangkan tentang objektif, skop, masalah yang dihadapi serta kaedah yang digunakan untuk mengatasi masalah tersebut.Seterusnya, kajian selidik (ilmiah) akan dipaparkan .Bahagian ini akan membincangkan dengan lebih terperinci mengenai kajian yang telah dilakukan. Pada bahagian ini ia akan menerangkan dengan terperinci mengenai formula yang digunakan untuk mengatasi masalah rekebentuk. Di samping itu, mengenai cara pembinaan yang digunakan untuk menghasilkan robot selari ini dan cara mengatasi masalah rekabentuk. Cara yang digunakan adalah menggunakan perisian 3D SolidWorks. Process pembuatan terlibat di dalam projek ini di mana robot selari 4 darjah kebebasan Zlatanov dan Gosselin ditempatkan di stesennya bersama motor. Motor itu dikawal dengan PLC. Akhir sekali rekaan siap bagi robot selari 4 darjah kebebasan Zlatonov dan Gosselin yang selepas menambah baikan akan dipersembahkan diruangan ini. Diikuti dengan kesimpulan dan cadangan.

DEDICATION

Specially dedicated to
my beloved parents who have encouraged, guided and inspired me
throughout my journey of education

ACKNOWLEDGEMENT

I would like to take this opportunity to express my deepest gratitude to my project supervisor; Mr. Ahmad Yusairi Bin Bani Hashim who time spent guiding me and determinedly assisted me during the whole course of this project. I am really appreciated the suggestions, opinions advices and motivations given from him during the meeting. My outmost thanks to my family who has given me support throughout my academic years. Without them, I might not be success to complete my study and finish my PSM project. My grateful thank to all my friends for the opinions, advices, supporting and assist given to me. I am much appreciated and remember for your help. It is my honor to study with all of you. Thank you.

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CHAPTER 1

INTRODUCTION

1.1 Overview

This chapter is about introducing the research of this project. The project is research and development about concept the manipulator with 4 Degree of Freedom called DOF. The DOF typically refer to the axis or the leg of the robot. Also, it is will state the problems occur during the development, the objectives of this project and expected result at the end of the semester.

1.2 Introduction

Nowadays, the technology has grown very fast especially in electronic field. Take example like computer, from 5 years from now, our nowadays computer will be far away behind. As technology grown fast, it is also not except for the robot sector. Robots are widely use in various sector to make people easy.

A sci-fi action thriller inspired by the novels written by Isaac Asimov. In the year 2035, robots are an everyday household item, and everyone trusts them, except one, slightly paranoid detective, Del "Spoon" Spooner, who is faced with an unprecedented murder mystery. He must investigate the suicide or murder of the man who invented the robots.

While most robots today are installed in factories or homes, performing labor or life saving jobs, many new types of robot are being developed in laboratories around the world. Much of the research in robotics focuses not on specific industrial tasks, but on investigations into new types of robot, alternative ways to think about or design robots, and new ways to manufacture them. It is expected that these new types of robot will be able to solve real world problems when they are finally realized.

Robots are designed for many purposes. In manufacturing, they are used for welding, riveting, scraping and painting. They are also deployed for demolition, fire and bomb fighting, nuclear site inspection, industrial cleaning, laboratory use, medical surgery, agriculture, forestry, office mail delivery as well as a myriad of other tasks. Increasingly, more artificial intelligence is being added. For example, some robots can identify objects in a pile, select the objects in the appropriate sequence and assemble them into a unit.

Most industrial robots equipped with serial technology, where each axis is in line relative to the preceding one. The parallel robot on the other hand has three or more prismatic or rotary axes which function parallel to one another. Examples of parallel robots are Tricept, Hexapod and Delta Robots. Both Tricept and hexapod robots use linear motors to control the position of the tool. This type of robot also becomes more popular because of its in high speed, high-accuracy and precision positioning with limited workspace, such as in assembly of PCBs. It is also as micro manipulators mounted on the end-effector of larger but slower serial manipulators.

The result of the parallel design is a robot that has increased stability and arm rigidity, with faster cycle times than serial technology. As such there is less flexing of the arms which results in high repeatability. In addition, with serial linked robots, the end-of-arm flexing errors are cumulative, whilst in a parallel link structure they are averaged. However, one disadvantage of parallel robots is they tend to have a relatively large footprint-to-workspace ratio, for example, the hexapod parallel robot, easily take up a sizable work area. The exception is the Triceps robot which requires less space. Another limitation of the parallel configuration is that it has a small range of motion due to the configuration of the axes when compared to a serial link machine.

In the future robots are smarter and cheaper. People interact with robots using natural language, facial expression, and hand gestures. Robots can also see, have overcoming general object recognition and are capable of great dexterity and have unusual range of motion and movement. Imaging robots in the future are capable of social interactions: little children hug their robots, robots walk the dogs, people can talk to their robots, and robots drive the cars and buses. Robots control all the production lines including home production: cooking, cleaning, and health monitoring.

1.3 Problem Statement

The previous design of this parallel robot was about to complete. It is needed to design and develop the holder for the robot. There are many factors to be determined before it was develop the robot‟s holder in order to maintain its stability and fully function. The holder must be able to hold the motor where the motor should be joining with robot‟s spindles. Besides that, the wiring of the PLC box that connects with motors was not complete yet.

1.4 Objective

The main objectives of this project are to:

i. Identify the problem statement.
ii. Design robot‟s holder.
iii. Develop robot‟s holder.
iv. Asses robot attach to its station with motors function.

1.5 Scope of Project

This project is system development of the previously partial developed parallel robotic system. The scope of this project include to study and know the definition of robot, its type, its characteristic, parallel robot and its characteristic, and basic about Zlatanov-Gosselin Parallel Robot. It is to design robot holder where it is should be attach to its station. The holder should be able to hold the motors and mounted to robot‟s leg. The three AC servomotors are control with PLC device placed in the control box. It is need to wiring the PLC and motors drive to make it function.

1.6 Expected Result

In the end of this project, the holder for the robot must be design and fabricate. The robot should be attached to its station with motor mounted to the robot‟s leg. It is expected to mount the motor‟s shaft with robot‟s spindle. It is should wiring the PLC and turn on the motor.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

This chapter will provide an overview of the robot, the type and its application. It is briefly explain about robot mechanism especially about the Parallel Robot which related for better explain for this project. This section also will introduce about Stewart Platform, which is original idea of this 4-DOF parallel manipulator. It also will provided summary of the past studies, researches about the concept, designs and implementation of many types of parallel robots that have been conducted. The source of the literature reviews usually refer to the information obtained from valid sources such as books, articles of relevance, published paper or any other source deemed appropriate. Since the manipulator already develops, the continuous progress of this project which is to place the manipulator to its station. It is has to design and fabric the holder for the manipulator. Through the literature reviews it is able to learn the concept to doing the project. The literature will be review is the introduction of robot, development, characteristic, advantage and drawback. Also the theory of Zlatanov-Goesselin parallel robot. The design method and material selection must be review to help the development process. The process related and all the related process in this project should be review.

2.2 Robot

2.2.1 History of Robot

There are no specific information and sources about history of robot development. Many ancient mythologies include artificial people, such as the mechanical servants built by the Greek god Hephaestus (Vulcan to the Romans), the clay golems of Jewish legend and clay giants of Norse legend, and Galatea, the mythical statue of Pygmalion that came to life. In Greek drama, Deus Ex Machina was contrived as a dramatic device that usually involved lowering a deity by wires into the play to solve a seemingly impossible problem.

In the 4th century BC, the Greek mathematician Archytas of Tarentum postulated a mechanical steam-operated bird he called "The Pigeon". Hero of Alexandria (10–70 AD) created numerous user-configurable automated devices, and described machines powered by air pressure, steam and water. Su Song built a clock tower in China in 1088 featuring mechanical figurines that chimed the hours.

Al-Jazari (1136–1206), a Muslim inventor during the Artuqid dynasty, designed and constructed a number of automated machines, including kitchen appliances, musical automata powered by water, and the first programmable humanoid robots in 1206. The robots appeared as four musicians on a boat in a lake, entertaining guests at royal drinking parties. His mechanism had a programmable drum machine with pegs (cams) that bumped into little levers that operated percussion instruments. The drummer could be made to play different rhythms and different drum patterns by moving the pegs to different locations.

Leonardo da Vinci (1452–1519) sketched plans for a humanoid robot around 1495. Da Vinci's notebooks, rediscovered in the 1950s, contain detailed drawings of a mechanical knight now known as Leonardo's robot, able to sit up, wave its arms and move its head and jaw. The design was probably based on anatomical research recorded in his Vitruvian Man. It is not known whether he attempted to build it. In 1738 and 1739, Jacques de Vaucanson exhibited several life-sized automatons: a flute player, a pipe player and a duck. The mechanical duck could flap its wings, crane its neck, and swallow food from the exhibitor's hand, and it gave the illusion of digesting its food by excreting matter stored in a hidden compartment. Complex mechanical toys and animals built in Japan in the 1700s were described in the Karakuri zui (Illustrated Machinery, 1796)

The Japanese craftsman Hisashige Tanaka (1799–1881), known as "Japan's Edison" or "Karakuri Giemon", created an array of extremely complex mechanical toys, some of which served tea, fired arrows drawn from a quiver, and even painted a Japanese kanji character. In 1898 Nikola Tesla publicly demonstrated a radio-controlled torpedo. Based on patents for "teleautomation", Tesla hoped to develop it into a weapon system for the US Navy.

In 1926, Westinghouse Electric Corporation created Televox, the first robot put to useful work. They followed Televox with a number of other simple robots, including one called Rastus, made in the crude image of a black man. In the 1930s, they created a humanoid robot known as Elektro for exhibition purposes, including the 1939 and 1940 World's Fairs. In 1928, Japan's first robot, Gakutensoku, was designed and constructed by biologist Makoto Nishimura.

The first electronic autonomous robots were created by William Grey Walter of the Burden Neurological Institute at Bristol, England in 1948 and 1949. They were named Elmer and Elsie. These robots could sense light and contact with external objects, and use these stimuli to navigate.

The first truly modern robot, digitally operated and programmable, was invented by George Devol in 1954 and was ultimately called the Unimate. Devol sold the first Unimate to General Motors in 1960, and it was installed in 1961 in a plant in Trenton, New Jersey to lift hot pieces of metal from a die casting machine and stack them.

2.2.2 Definition of Robot

The word robot made its debut in 1921, in the play R.U.R. (Rossum's Universal Robots) by Karel Capek. It comes from the word "robota", a Czech term for forced labour. But definitions of what a robot actually is vary widely. According to the Alan Mackworth, the director of the University of British Columbia Laboratory for Computational Intelligence and president of the American Association for Artificial Intelligence, state that it's a machine that can sense and act and react in the world and possibly involves some reasoning for performing these actions, and it does so autonomously. By that definition a thermostat would be a robot. Though it's not 'aware' it has a goal, that awareness isn't required.

Rodney Brooks, the director of the Massachusetts Institute of Technology computer science and artificial intelligence laboratory, state a robot is something that has some physical effect on the world, but it does it based on how it senses the world and how the world changes around it. 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, and they have to have a way of making decisions. In other words, something like a computer, you could call that thinking informally and they have to have a way taking actions. For Joseph Engelberger has been called the father of robotics said that "I can't define a robot, but I know one when I see one."

Oxford English Dictionary defines "robot" as an "apparently human automaton, intelligent but impersonal machine." This seems too simplistic, and begs too many questions. According to the Australian Robotics and Automation Association, there is no standard definition. But the ARAA suggests that a robot has "three essential characteristics:"

- It possesses some form of mobility
- It can be programmed to accomplish a large variety of tasks
- After being programmed, it operates automatically.

The ARAA further notes that: "The International Organization for Standardization (ISO) has developed an international standard vocabulary (ISO 8373) to describe 'manipulating industrial robots operated in a manufacturing environment'. According to this standard such a robot must possess at least three programmable axes of motion." This technical definition helps ISO keep track of how many robots there are in industrial settings, but seems too limited as a general definition.

According to The Tech Museum of Innovation, "A robot is a machine that gathers information about its environment (senses) and uses that information (thinks) to follow instructions to do work (acts)."

In my view, A "Robot" is a mechanical or organic semi or self controlled machine that perform physical tasks from which humans are capable of, and that it must consist of the basic human sense like vision, recognize, move and etc. It is mean the robot should have sensor, motor, controller and other.

There are several types of robots that have been created and discovered. Each type has different function, axes, Degree of Freedom (DOF), workspace and etc. Below the Table 1.1 shows that the categorized of robot.

Over the last decade, engineers have harnessed the continual gains in computer processing to increase the "IQ" of the robot, allowing it to process exponentially more commands. Robots can carry bigger and heavier things. Robots can improve quality and production. The gains in processing power have remarkably improved precision in robots. Precision robots account for the explosive production of miniaturized electronic components and devices. The robotics industry has leveraged the power of the microprocessor to improve upon traditional industrial robot applications like spot welding and painting.

In a clear indication that the robotics industry is becoming less dependent on the automotive sector, material handling and spot welding are the dominant robotic applications; they are used in a wider range of industries. Faster processing power has improved not only the speed of robots, but also their ability to sense and negotiate the task at hand. Robots are capable of packaging delicate materials or assembling electronics components too tiny for human fingers to manipulate. Robots