UNIVERSITI TEKNIKAL MALAYSIA MELAKA

MECHANISM DEVELPOMENT OF GRIPPER FOR 5KG PAYLOAD

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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FACULTY OF MANUFACTURING ENGINEERING

2010

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PSM

JUDUL:
MECHANISM DEVELOPMENT OF GRIPPER FOR 5 KG PAYLOAD

SESI PENGAJIAN: 2009-2010

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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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Supervisor
En Khairol Anuar Bin Rakiman
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ABSTRAK

Projek ini adalah berkaitan mekanisma dan pembangunan pencengkam dengan muatan 5kg. Penghasilan pencengkam memerlukan beberapa kajian dan analisis rekaan-rekaan yang telah wujud seperti penggunaan bahan, proses pembuatan dan sebagainya. Projek terdahulu telah dibuat dari segi reka bentuk dan analisa berkenaan pencengkam. Dalam projek ini, ia lebi fokus kepada proses yang terlibat di dalam pembangunan pencengkam proses seperti memilih proses bahan, proses yang terlibat dan proses pemasangan yang digunakan dalam penghasilan pencengkam. Komponen pencengkam yang dihasilkan digabungkan sehingga sebuah pencengkam yang lengkap dihasilkan. Kemudian ujian terhadap fungsi dan keupayaan pencengkam telah dibuat untuk memastikan pencengkam dapat bertahan dan berfungsi sepenuhnya.

ABSTRACT

This project is about on mechanism and development of gripper with 5kg payload. Gripper production need some study and analysis already existing designs such as material utilisation, manufacturing process etc. In chapter 1, it covering about introduction, project objective and scope the. Formerly, projects were made early in gripper design and analyzing about the gripper structures and functionability. In this project, its focusing on involved process research in gripper development process like material selection process, involved process and assembly process applies in gripper development. The gripper component is begin with fabrication of gripper mechanism following with the gripper assembly until the complete gripper was developed. Then the testing of gripper function and ability has been made to make sure the gripper is sustained and fully functional.

DEDICATION

To my beloved family and friends.

ACKNOWLEDGEMENT

There are many people who deserve thanks for the contributions they have made to this project. Firstly, I would like to express my endless grateful to my Final Year Project's Principal Supervisor, Encik Khairol Anuar Bin Rakiman. He directed and instructed me through every phase of the project, and his guidance has been invaluable. He also spent time and effort helping to resolve new issue by giving advice and suggestion as the project developed and checking the report a number of times.

I would like to thank my beloved parent, for their abiding love and endless patience. Their support has been constant and enduring through the process of this project. They deserve an enormous amount of recognition for their moral support throughout this project. I am also grateful for all of my friends, who had giving their help and idea in completing this project. Finally, I am deeply indebted to the lab technician and all of the people that had directly or indirectly helped me during the period of completing the project. Thank you.

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CHAPTER 1

INTRODUCTION

1.1 Overview

The design of the end-of-arm tooling for a robotic assembly system is very important for reducing errors and decreasing cycle times. This is the piece of the robotic parts handler or assembler that physically interacts with the environment. While many factors may be blamed for the common failures of workcells, the culprit is very often the grippers. Well designed grippers can increase throughput, improve system reliability, compensate for robot inaccuracy, and perform value added functions to the assembly.

According to dictionary of McGraw-hill（2003）, gripper is define as a component of robot that grasp an object, generally through the use of suction cups, magnets, or articulated mechanism. Gripper provides the capacity to do a wide variety of manipulative task. Robotic hand or gripper is the integral part in most of the robot application. A robot arm itself can serve no purpose until a load or a tool is suspended from or attached to it. The robotic application in assembly and material handling is growing more rapidly in industrial environment. Thus, design of robotic gripping mechanism always becomes the key element for a specific operation.

Guo et al, (1992) explained that the main function of a gripper is to grasp and to release workpieces during the material transfer route. Generally, the gripper for industrial robots is a specialized device that is used to handle only one or a few objects of similar shape, size and weight in a repetitive operation, which requires minimum gripping dexterity and is limited in its versatility. However, in other applications, the robot gripper will be required to handle many different objects of varying weights, shapes, and material. Then, we shall refer to a more universal or versatile grippers. Gripper types will be discussed furthers in literature review.

Arthur G. Erdman (1986) mention that the design of the gripper systems is not a trivial task. Unfortunately, the finalized parts and assembly sequence are often given to the designer, who must then devise grippers to handle the parts and perform the assembly. It is much more desirable for the design of the grippers to occur concurrently with the design of the rest of the system. Often a small feature added to a part can greatly increase the reliability of the gripper. Other times, a proper gripper design can simplify the overall assembly, increase the overall system reliability, as well as decrease the cost of implementing the system.

The gripper is the mechanical interface between the robot and the work and the device with which the robot performs its programmed handling functions. Correctly selecting the gripper for an application is essential to the success of the application. Arthur G. Erdman (1986) explained that gripper selection is a may not be an easy task since there are wide variety of gripper types and configurations and many different factors to consider. Information on the factors which are relevant to the selection process is incomplete and tends to be qualitative. The material available and ease or manufacturing is also an important consideration.

The end of the manipulator is the part the user or robot uses to affect something in the environment (Spencer, 2005). For this reason it is commonly called an end-effector, but it is also called a gripper since that is a very common task for it to perform when mounted on a robot. It is often used to pick up dangerous or suspicious items for the robot to carry, some can turn doorknobs and others are designed to carry only very specific things like beer cans. Even for semi-autonomous robots where a human controls the manipulator, using the gripper effectively is often difficult. For these reasons, gripper design requires as much knowledge as possible of the range of items the gripper will be expected to handle. Their mass, size, shape, strength, etc. all must be taken into account.

In this study, a robot gripper that has been design by the previous students is required be to fully analyses for its physical properties when handling load. Solid Work will be use as the analysis software for finite element analysis to the gripper. Finally, the gripper has to go through workspace testing by using simulation software to observe its performance in real time working situation.

1.2 Problem Statement

The mechanism and development of robotic gripper is highly complex and environment dependent. To deal with complexity, the entire design project has to be broken down into several sub problems which are then treated independently as optimization problem. However, the constraints are generally dependent on each other. In this project, problem occur due finding the best way to fabricate the gripper. Furthermore, the existing design must be revised to mention the gripper able to grasp object with 5 kg payload.

The study of this project is focus on improvement and continuation work on the previous PSM project which is a 10kg payload gripper for Comau robot. Then, study of the manufacturing process of the gripper and fabricate it. Basically the gripper design has been carried out in the last PSM. Since the current task is design analysis on 5kg payload gripper for Comau robot, this mean there would be a little improvement to the previous design and finally the gripper is fabricate assemble on Comau Robot.

Often, very little time is spent in optimal kinematics structure design in the early stages of a design process. D. T. Pham (1988) describes that a time pressures sometimes force engineers to repeat topologies that have worked in similar application in the past rather than try to create better design. It is always encourages to follow the previous design unless the design analysis really proven that it was not good. Thus, modification and optimization are requires to upgrade the design to achieve a better performance.

Generally, a physical prototype is necessary to truly test a hand's ability to perform tasks, but this can be quite costly and design changes are not easy to make. Thus it would need a simulation system that able to load a gripper hand design, to interact with it and perform grasps of objects, and to visualize and evaluate the space of performance and error that might occurs. After simulation have been perform well, the design is fabricated and assemble it with Comau robot to done the task.

1.3 Objectives

The objective of this project is to fabricate and assembled gripper to perform a pick and place operation for 5kg payload boxes. Below are important objective has to be achieved:

a) To improve the design and relevent aspect.
b) To develop the gripper prototype
c) To carry out functional testing on the gripper

1.4 Scope

The scope is focused on related aspect in this project so that the objectives are able to accomplish. Scope on this project will cover up the below task:
a) Revisit the existing design
b) Develop, fabricate and assembly the gripper.
c) Testing the gripper performance and functional ability.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

Motion devices imitate the movements of people, in the case of the gripper, it is the fingers. S. H. Yeo (1988) said that gripper is a device that holds an object so it can be manipulated. It has the ability to hold and release an object while some action is being performed. The fingers are not part of the gripper, they are the specialized custom tooling used to grip the object and was referred as a “jaw”

In robotics, an end effector is a device or tool that's connected to the end of a robot arm where the hand would be. The end effector is the part of the robot that interacts with the environment. The structure of an end effector and the nature of the programming and hardware that drives it depend on the task the robot will be performing.

In manufacturing, a robot arm can accommodate only certain tasks without changes to its end effector's ancillary hardware and/or programming. If a robot needs to pick something up, a type of robot hand called a gripper is the most functional end effector. If a robot needs to be able to tighten screws, however, then the robot must be fitted with an end effector that can spin.

Maximum payload is the weight of the robotic wrist, including the EOAT and workpiece. It varies with different robot applications and models.

2.1.1 Operation

The most widely used gripper is the pneumatically powered gripper; it is basically a cylinder that operates on compressed air. When the air is supplied, the gripper jaws will close on an object and firmly hold the object while some operator is performed, and then the air direction will change and the gripper will release the object. Typical uses are to change orientation or to move an object in a pick-n-place operation.

2.2 Gripping Action

2.2.1External:

This is the most popular method of holding objects, it is the most simplistic and it requires the shortest stroke length. When the gripper jaws close, the closing force of the gripper holds that object.

2.2.2 Internal:

In some applications, the object geometry or the need to access the exterior of the object will require that the object is held from the center. In this case the opening force of the gripper will be holding the object.

2.3 Types of Grippers

The most popular types of grippers are the 2 jaw parallel and 2 jaw angular gripper styles. Parallel grippers open and close parallel to the object that it will be holding, these are the most widely used grippers. They are the simplest to tool and can compensate for some dimensional variation. Angular grippers move the jaws in a radial manner to rotate the jaws away from the object and therefore require more space.

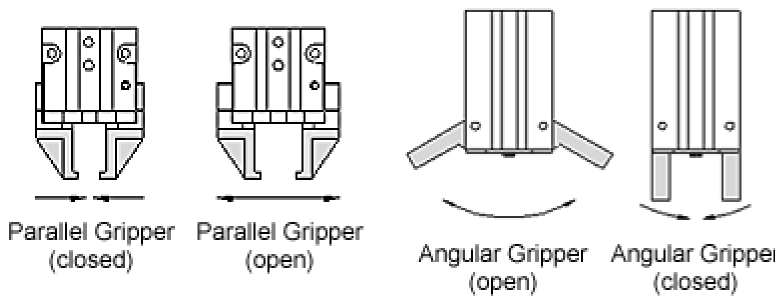

Figure 2.1: Type of Gripper (Yeo 1988)

2.4 Existing Gripper Analysis

2.4.1 Major Factors in Choosing a Gripper and Jaw Design

a) Part shape, orientation and dimensional variation

Two jaw parallel gripper is desired if the object has two opposing flat surfaces, since it can handle some dimensional variation. Jaws can also be designed to handle cylindrical objects with the 2 jaw concept. Keep in mind that retention or encompassing grip requires much less force.

Table 2.1: Summarize of part characteristics and associated end effector solutions

Part Characteristics		Gripper Characteristics
Size, weight	Large, heavy	• Grippers using wrap grips - taking advantage of friction or vacuum or electromagnetic holding
	Small, light	• Two-fingered gripper • vacuum cup if smooth surface • electromagnet if ferrous alloy
Shape	Prismatic	• Two-fingered parallel-jaw gripper; angular motion if all parts have approximately same dimensions
	Cylindrical	• if light: use parallel or angular motion two-finger gripper with V-jaw fingertips • if heavy: use wrap gripper - consider gripping on end with three-finger gripper if task or fixtures permit
	Flat	• Parallel or angular motion gripper or vacuum attachment
	Irregular	• Wrap grasp using linkages or bladder consider - augmenting grasp with vacuum or electromagnetic holding for heavy parts.
Surface	Smooth	• Good for vacuum attachments, simple electromagnets, two-fingered grippers with flat fingertips
	Rough	• Compliant material (e.g., low durometer rubber) on fingertips or compliant membrane filled with powder or magnetic particles. - grippers that use a wrap grasp are less sensitive to variations in surface quality.
	Slippery	• Consider electromagnet or vacuum to hold - grippers that use a wrap grasp are less sensitive to variations in friction
Material	Ferrous	• Electromagnet - concerns that do not rule out the presence of strong magnetic fields
	Soft	• Consider vacuum or soft gripping materials
	Very delicate	• Soft wrap grippers and vacuum grippers so can grip gently - compliant fingertips with foam rubber use to distribute the contact pressure • if the part is very light and fragile consider lifting it using the Bernoulli effect

b) Gripper Weight:

Grip force must be adequate to secure the object while a desired operation is performed on the object. The type of jaw design must be part of the force requirement. Keep in mind that you should add a safety factor to the amount of force that you select and air pressure is a factor to keep in mind.

c) Accessibility

This applies both to the work being performed on the object and the amount of room for the gripper jaws. If the work is to the exterior of the object then it may require an internal grip. Angular grippers are usually less expensive but require additional space for jaw movement.

d) Environmental

Harsh environment or clean room applications require grippers designed for those purposes.

e) Retention of the Object

When air pressure is lost, the gripper will relax its grip on the object and the object may be dropped. There are spring assist grippers designed for this type application.

2.4.2 Tolerance Analysis

Alan R. Parkinson (1991) in his articles mentioned that tolerance management is a key element in their programs for improving quality, reducing overall costs and retaining market share. The specification of tolerances is being elevated from a menial task to a legitimate engineering design function. New engineering models and sophisticated analysis tools are being developed to assist design engineers in specifying tolerances on the basis of performance requirements and manufacturing considerations. Koenderink and van Doorn (1987) performed a tolerance analysis to measure the extent to which certain information is available in velocity flow fields