

SUPERVISOR DECLARATION

“I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Automotive)”

Signature:

Supervisor: HERDY RUSNANDI

Date: 30 MEI 2012

STUDY AND DESIGN OF ROBOT GRIPPER USING SMA ACTUATOR

MOHD ADIRAN ASWAD BIN ISMAIL

This report submitted in partial fulfillment of the requirements for the award
bachelor's degree in mechanical engineering (automotive)

Faculty of Mechanical Engineering
Universiti Teknikal Malaysia Melaka

MEI 2012

DECLARATION

“I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged.”

Signature:

Author: MOHD ADIRAN ASWAD BIN ISMAIL

Date: 30 MEI 2012

To my beloved father and mother, my supervisor Mr. Herdy Rusnandy and friends.

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Alhamdulillah, I am very grateful to Allah s.w.t because I have finished this Projek Sarjana Muda report in time.

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ABSTRACT

Nowadays, robots have been widely used in the proper industry. Robot is required because it is easier and speeds up the work done by men. Gripper is a connector between the robot and object. It functions to taking, holding and placing. Usually, it involves repetitive tasks. Actuation is usually provided using hydraulic fluid pressure, pneumatic pressure and mechanical. The common after market is highly in cost and high in maintenance. The main objective of this project is to study and design of robot gripper using SMA actuator. SMA is a different with other actuator in some aspect. SMA actuator is less expensive than others. Advantages in SMA actuation are high power to weight ratio, high corrosion resistance and safe. Additionally, SMA does not require further processing as it can just be cut and used. In this project, prototype of robot gripper with single axis and external grip is developed and manufactured. Robot gripper is designed for a specially defined hold and place operation. Its task is to hold a cylindrical workpiece and place it. SMA actuator is used for power generation. Spring and pulley system is used to make the system smooth and perfect. Structures of robot gripper are manufactured from acrylic. The prototype of robot gripper is able to work and function as well.

ABSTRAK

Pada masa kini, robot telah digunakan secara meluas dalam industri. Robot diperlukan kerana ia dapat memudahkan dan mempercepatkan kerja-kerja yang dilakukan oleh manusia. Penggenggam adalah penghubung antara robot dan objek. Ia berfungsi untuk mengambil, memegang dan meletakkan. Biasanya, ia melibatkan tugas yang berulang-ulang. Sistem penggerak biasanya menggunakan tekanan bendalir hidraulik, tekanan pneumatic dan mekanikal. Biasanya harga sistem penggerak ini mempunyai harga yang tinggi dan penyenggaraan yang tinggi. Objektif utama projek ini adalah untuk mengkaji penggerak SMA. SMA adalah berbeza dengan penggerak yang lain dalam beberapa aspek. Penggerak SMA lebih murah daripada yang lain. Antara kelebihanannya ialah kuasa yang tinggi kepada nisbah berat, ketahanan hakisan yang tinggi dan selamat untuk digunakan. Selain itu, SMA tidak memerlukan proses yang banyak, hanya potong dan terus boleh digunakan. Dalam projek ini, prototaip penggenggam robot dengan paksi tunggal dan cengkaman luar dihasilkan dan dikeluarkan. Penggenggam robot direka untuk operasi yang khusus iaitu memegang dan memindahkan. Tugasnya adalah untuk memegang bahan ujikaji yang berbentuk silinder dan memindahkannya. Spring dan sistem takal digunakan untuk membuat sistem lebih lancar dan sempurna. Struktur penggenggam robot ini diperbuat daripada akrilik. Prototaip penggenggam robot boleh bekerja dan berfungsi dengan baik.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter describes the main focus of this project such as problem statement, scope, objectives and introduction of the robot.

Nowadays, robots have been widely used in the proper industry. For example in the automotive industry, robots are used to make work that is done repeatedly such as weld and paint car. Robot is required because it is easier and speeds up the work done by men. Gripper is a connector between the robot and object. Its function is to take, hold and place. Usually, it involves repetitive tasks.

In this project, a robot gripper using SMA actuator will be designed and fabricated. Shape memory alloy (SMA) is a newer way to create motion. These metals will change in shape and hardness when heated or cooled. Shape memory alloys have been made using different combinations of metal elements.

To produce a good prototype is a challenge and requires high skill. In solving a problem that arises during the project, aspects of uncertainties should be considered as a bit of interest will be affecting the overall operation of the project. Therefore, this aspect must be considered in order to avoid more problems arising in implementing the project.

1.1 Problem Statement

Nowadays, due to the technological advances, devices for handling parts for the industries of optics, medicine, electronic and information technology have been developed. Accordingly, the development of a gripper is also required. To develop gripper, many studies have been conducted to capable of carrying out fine handling. Actuation is usually provided using hydraulic fluid pressure, pneumatic pressure and electric motor. Since the common after market gripper that highly in cost, the project study and design robot gripper using SMA actuator is come out. This is a very different and much newer way to create motion from electricity. These special metals undergo changes in shape and hardness when heated or cooled and do so with great force. SMA actuator is less expensive than others. Advantages in SMA actuation are high power to weight ratio, high corrosion resistance and safe. Additionally, SMA does not require further processing as it can just be cut and used. It is light weight and silent in operation.

1.2 Objective

- 1) Robot gripper using SMA actuator as a preliminary prototype.
- 2) To investigate the use of SMA wire as an actuator.
- 3) To design and fabricate an SMA wire actuated prototype robot gripper.

1.3 Scope

In order to develop a robot gripper, scopes are required to guide and assist the development of the project. The scope should be planned and identified to achieve the objective of the project successfully. In this project making, there are several things which can be considered. These criterions are listed below:

- 1) To study mechanical behavior of shape memory alloy as an actuator.
- 2) To design and develop a prototype of a robot gripper using SMA actuator.
- 3) To study the performance of the prototype.

1.4 Flowchart

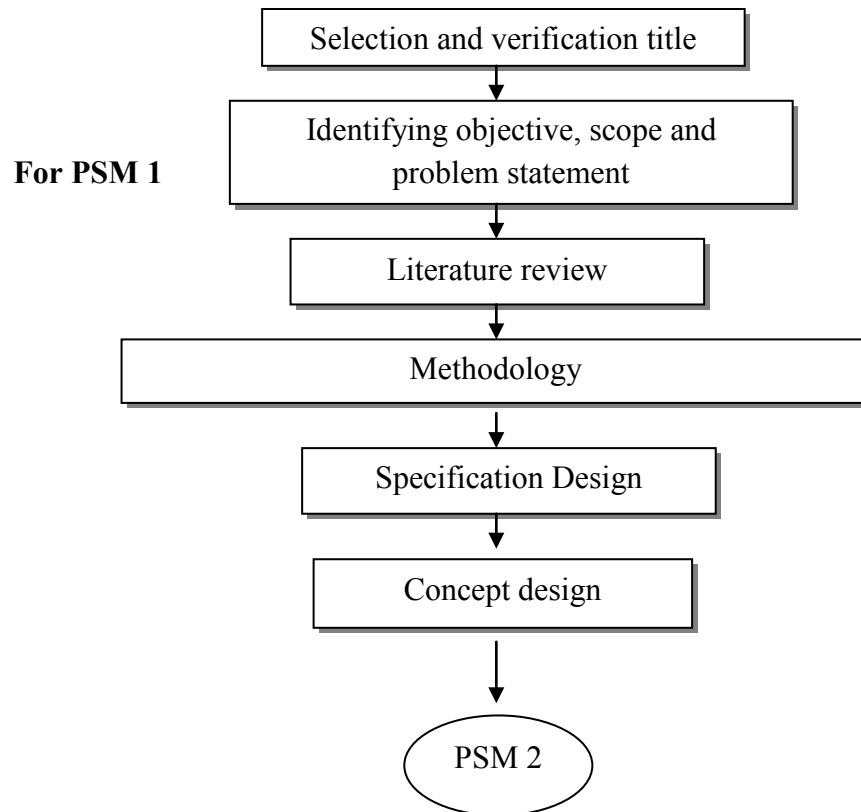


Figure 1.1: flowchart for PSM 1

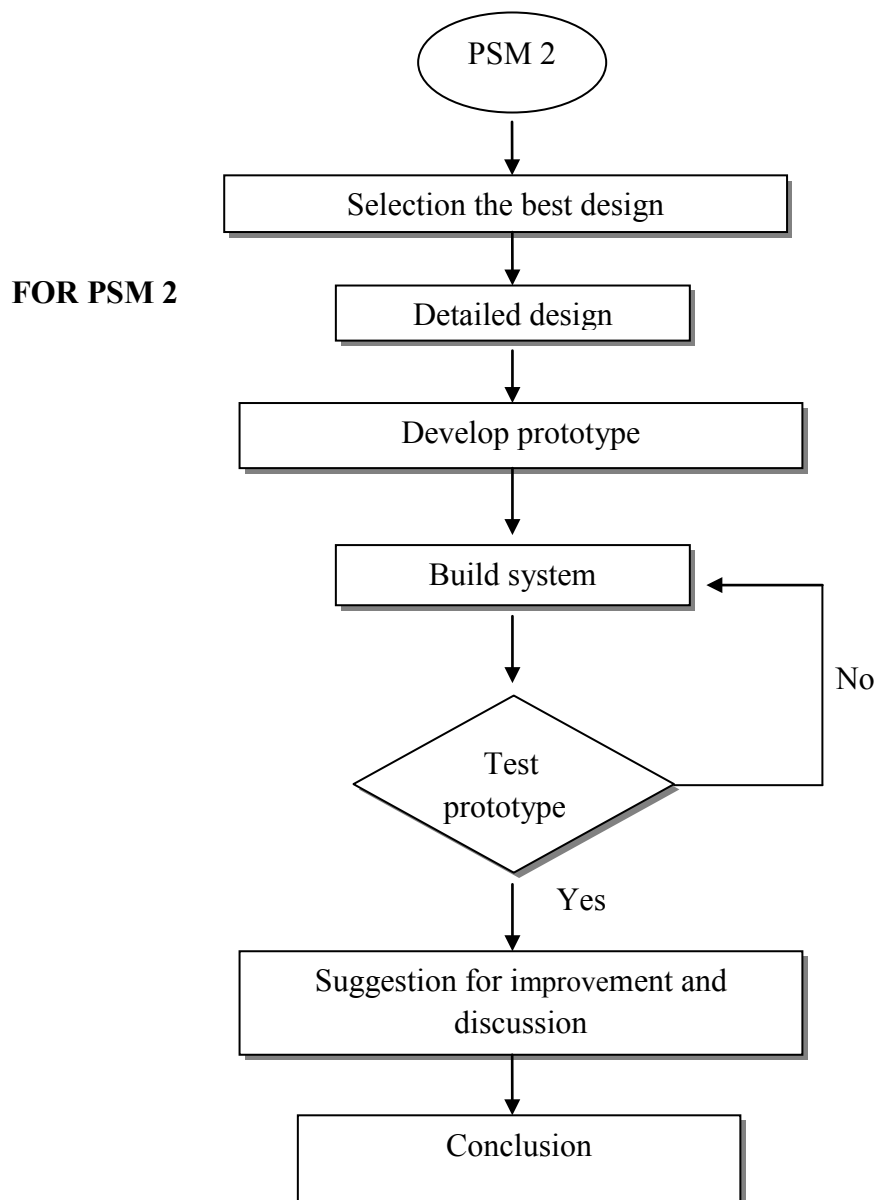


Figure 1.2: flowchart for PSM 2

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter will describes the studies had been made by the individual or group of projects. This study was selected based on scientific operations related to the robot gripper to be designed. In addition, this chapter also will describe the components that will be used in this project. This study was carried out to ensure this project will proceed smoothly and orderly.

2.1 Preliminary Research

2.1.1 Gripper

The gripping mechanism is an important thing to the gripper. Greg, C.C. and Roger, D. Q. (1998). Described a gripper should have the following elements to make it function properly.

a) Light and simple

The gripping mechanism must be light so as not add the load to the robot gripper.

b) Easy to operate

When have a complex mechanism, the gripper cannot function properly.

c) Reliable and can be operated repeatedly

Can function and able to operate repeatedly. Gripper should have high resistance to support and lift the loads.

There are two types of gripper are used in holding option:

- a) Internal grip
- b) External grip

This option can be considered based on these criteria as shown in Figure 2.1:

- Orientation of the parts
- Geometry
- The process to performed
- Space available

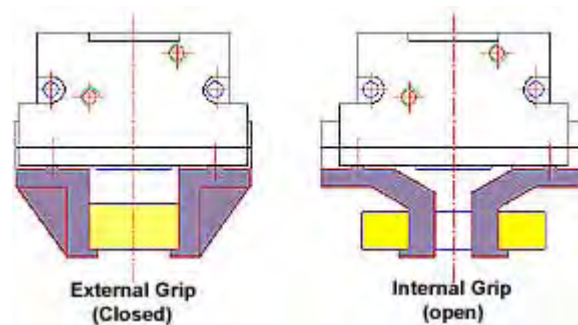


Figure 2.1: external and internal grip

(Source by <http://www.arobotics.com/technical/tutorials.aspx>)

The encompassing or retention finger shape also one of the part in gripper. This part is important because can increases stability and can reduces the necessary grip force while hold the object. There are three type of retention finger shape as shown in Figure 2.2:

- a) Encompassing
- b) Friction
- c) Retention

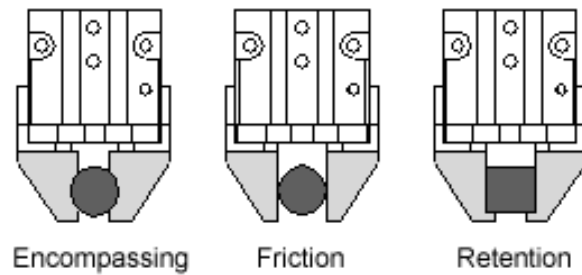


Figure 2.2: the encompassing finger shape

(Source by <http://www.omega.com/prodinfo/grippers.html>)

There are several types of basic gripper. Some of them are:-

- 1) Hand shaped – shaped like human hand. Refer to Figure 2.3 (a).
- 2) ‘Y’ shaped or scissor- shaped like ‘Y’ or a scissor. Refer to Figure 2.3 (b).
- 3) Claw headed – refer to Figure 2.3 (c).



Figure 2.3: (a) Hand shaped gripper

(Source by: <http://www.squidoo.com/RoboticMovieProps>)



Figure 2.4: (b) Y shaped gripper

(Source by: <http://www.geek.com/hwswrev/hardware/er1/>)



Figure 2.5: (c) Claw headed gripper

(Source by: <http://www.sparkfun.com/products/10332>)

2.1.2 Gripper in Industry

In industry, gripper usually connects to a device or multi-functional machine. It can be programmed over and over again. It is design to process part, tools or specific devices and move it in manufacturing process. There are a few reasons why it is used to perform:-

- (1) Repetitive work cycle.
- (2) Infrequent changeovers.
- (3) Hazardous work environment for humans.
- (4) Multi-shift operations.
- (5) Repetitive work cycle.
- (6) Part position and orientation are established in the work cell.

There are usually grippers are use in industry. The gripper designed for specific purposes and usually high in cost. There are:-

- (a) Computer Aided Manufacturing (CAM-operated hand)
- (b) Wide Opening Hand
- (c) CAM- Operated Hand With Inside and Outside Jaws
- (d) Special Hand with One Moveable

2.1.2.1 Computer Aided Manufacturing (CAM-operated hand)

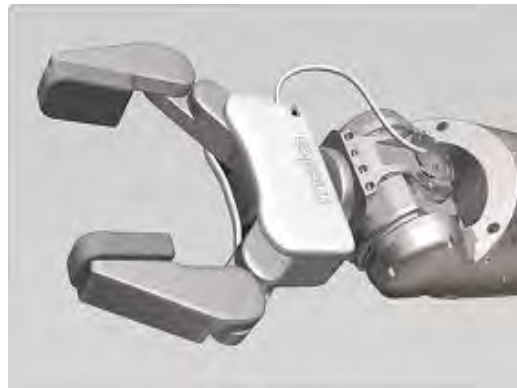


Figure 2.6: CAM gripper

(Source by: <http://www.robotsltd.co.uk/robot-cad-cam.htm>)

This type of gripper is easy to handle heavy objects. This gripper is designed to hold, the center of gravity in the gripper wrist. Short distance between wrist and center of gravity, can minimize the movement.