



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**DESIGN AND ANALYSIS OF GRIPPER MECHANISM FOR  
EGG HANDLING ROBOT MANIPULATOR**

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

by

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## BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

**TAJUK: Design and Analysis of Gripper Mechanism for Egg Handling Robot Manipulator**

**SESI PENGAJIAN: 2011/12 Semester 2**

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
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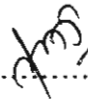
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## APPROVAL

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) (Hons.). The member of the supervisory is as follow:



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## ABSTRAK

Kini penggunaan mesin secara automatik semakin meluas. Setiap bahagian mesin memainkan peranan yang penting untuk menjamin kebolehan sesuatu mesin itu berfungsi. Dalam projek ini, bahagian gripper dikaji dan dianalisis untuk mendapatkan tenaga yang sesuai untuk dicengkam pada telur ayam. Berdasarkan masalah yang diketahui, projek ini diusul dengan tujuan untuk memudahkan kerja-kerja pada mesin pencengkam. Mesin pencengkam bertindak sebagai objek penting dalam sesuatu mesin samada dalam proses angkat dan letak dan proses cantuman. Rekabentuk yang baik dapat menghasilkan mesin yang berfungsi dengan baik dan secara tak langsung meningkatkan ketepatan sesuatu produk. Projek ini bertujuan memudahkan kerja dalam industri dan ia tertumpu pada bahagian pencengkam. Projek ini direkabentuk berpandukan pada beberapa kekangan dan juga mengikut kesesuaian bentuk telur ayam tersebut. Ujikaji dijalankan dengan kaedah simulasi dan ujikaji pada mesin. Keputusan yang dicapai kemudian dibandingkan dan dianalisis untuk mendapatkan nilai tenaga yang terbaik untuk mesin pencengkam ini.

## ABSTRACT

Now the use of automatic machines is widely expanded. Each part of the machine plays an important role to ensure the ability of a machine and its works. In this project, the gripper is reviewed and analyzed to obtain the suitable force to grip the egg. Based on the identified problems, this project proposed to facilitate the work that used the gripper machine. Gripper part is important in a machine, whether in assembly process and pick and place process. A good design can produce a well-functioning machine and indirectly increasing the reliability of a product. This project aims to facilitate the work in the industry and is focused on the gripper. This project is designed based on a number of constraints and the suitable factors used with the egg since the egg has an oval shape. Experiment is conducted by actual experiment on the Force Plate Machine. The results obtained are then compared and analyzed to get the best value force to grip the egg without crack or break.

## **DEDICATION**

To my beloved parents because being the understandable person to me in completing this project. Also to my supervisor, Dr. Fairul Azni Bin Jafar that had guides me to completing this project. Not forget to the entire technicians that help me in conducting the experiments step-by-step. Lastly, this dedication is especially to all my friends and people around me that help and support me from the beginning of this project.



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# CHAPTER 1

## INTRODUCTION

Lately, there has been an initiative in the manufacturing community to use the automated technology to solve problems in the industry due to the efficiency and capability to increase output and ensure the safety of workers. Gripper is one of the end-of-arm tooling components that are widely used in machinery part. Mostly it is used in pick and place, assembly operation and packaging process. In industry, there was variety of objects that grip by different types of gripper. The design of the end-of-arm tooling for a robotic assembly system is of the highest importance. This is the piece of the workcell that physically interacts with the environment. In order to fix it with the objects, there are several considerations that will be appoint out in this project. Therefore, this project is aimed to design and analyse the gripper mechanism for egg handling robot manipulator. There are several ways to design a gripper to manipulate many different types of parts. If the parts are of similar shape and size, then it could be possible to design different features into the jaws themselves that would accommodate various parts.

### 1.1 Project Motivation

The small industry in Malaysia has grown up especially in food industry. The important issue that had been highlighted is the cleanliness of the product. Most of the manufacturers produce their product not in proper way. Even though the production is in maximum quantity, unfortunately they missed out about the quality of the food cleanliness in producing the products.

## **1.2 Problem Statements**

While well designed grippers can increase throughput, improve system reliability, compensate for inaccuracy in the robot itself, and perform value added functions to the assembly, poorly designed grippers can drop or damage parts, hold parts inconsistently, and decrease system and flexible feeder throughput. Some grippers unable to produce suitable force in handling fragile objects especially an egg. Therefore, this project is proposed to overcome the identified problems and also try to help the small industry facing this problem.

## **1.3 Objectives**

The objectives of this project are:

- i. To design the most suitable gripper for egg handling robot manipulator.
- ii. To analyze the suitable value of force to apply in the gripper.

## **1.4 Project Scope**

The scope of this project is more on design and analysis. However, the whole machine will not be covered due to the focusing only on the gripper mechanism. Therefore, the work is to design the gripper by considering the force applied to the gripper in order to avoid the egg crack and broken. In addition, the scope of this project also comprises the small industry on producing the food product such as bahulu, cake, cupcake and many more that involved the high production.

## **1.5 Project Limitation**

This project is trusted to be a big project and it is going to be patent to those who interested with the mechanism. However, in order to complete this project, it is not possible to invent the whole machine because limitation of time during the PSM.

## **1.6 Report Structure**

Chapter 1 is discussing about the introduction of the project, includes the motivation, problem statement, objective project scope and project limitation.

Chapter 2 is explaining about the literature review of the project. Basically it covers the gripper mechanism, the egg handling and the proposal of this project.

Chapter 3 is discovering in the methodology of the project. There is explanation on the planning and method that is going to be used in completing this project.

Chapter 4 is discussing about the result and discussion after the experiment on the project had been done. It consists of experiment procedure, result and the analysis on the force applied to the eggs.

Chapter 5 is describes the conclusion on the overall project. After all the data had been analysed, some recommendations are proposed for future work to improve the result of this project.



## **CHAPTER 2**

### **LITERATURE REVIEW**

A robotic gripper is an essential component of a robotic manipulator. It serves as the robot's hand and allows the robot to manipulate objects. Recently robotic gripper is widely used for different tasks in various fields. Variety of robotic grippers is developed in high flexibility and multi-function. It can be driven hydraulically, electrically and pneumatically. It is also made to withstand stress. While the human arm has limits as to how much work it can do, a robotic gripper can work for hours on end, as long as its joints work properly and it isn't put under too much stresses. There are three types of robot grippers according to how their respective grips are made, namely the clamp, air hand and vacuum. From heavy industrial work to gripping and displacing numerous small objects at a very fast rate, a robotic gripper does wonders with heavy-duty tasks (Robotic Gripper Mechanisms, 2009).

#### **2.1 Gripping**

Handgrip is a measure of strength of several muscles in the hand and forearm. Gripping is the force applied by the hand to pull on or suspend from objects and is a specific part of strength. There are different types of gripping process, those are prehensile and non-prehensile (K. Shyamal et. al., (2009).

### **2.1.1 Prehensile**

- i. Palmar grip – use of palms: baby holding a bottle during feeding
- ii. Cylindrical grip – grasping cylindrical object: human finger
- iii. Spherical grip – gripping round objects
- iv. Lateral grip – grip object in sideways motion: gripping a book
- v. Opposing (tip) grip – use of index finger and thumb: writing using a pen

### **2.1.2 Non-Prehensile**

- i. Does not depend on thumb. Type:
  - a) Hook movement: Carrying a briefcase/pull drawer
  - b) Spread movement: Carry object that have holes of openings of some kind (spread/expand your hand in a glass and try carrying it)

## **2.2 Gripper**

Robot gripper is a type of end of arm tooling. It is used to pick up items and can be customized for different application. It is also used to hold or clamp a part much like a human hand. They are typically used between a pick and place or a robot and the part being handled. Grippers have wide range of sizes jaw and gripping forces for most any industrial application. There were several types of robot grippers and it is used for a nearly endless variety of purposes, and depending on the purpose of the robot, the end-effectors or "gripper" on its arm can be one of many different designs. Whether it lifting from within, gripping from outside, or trying to raise something impossible for the human body to lift, there's a grip for that. (Dogan B., 2010).

### **2.2.1 The Clamp**

Using a pincer-, scissors- or hook-arrangement, and the "Clamp" style of gripper acts like a human hand. The item to be manipulated is positioned between two extrusions which contract, trapping the item between them. This design is perfect for robots handling lightweight and/or odd-shaped items like empty boxes, packing material, toys and lumps of irregularly shaped material like rock or metal.

### **2.2.2 The Air Hand**

The "Air-Hand" gripper uses an expanding piece of dense rubber material to press against the interior of an item and lift it that way. Think of dropping an un-inflated balloon inside of a cup, and then inflating it until it is tight against the sides of the cup. This design is great for just that; robots designed to manipulate cups, buckets, hollow tubes or any other material that has an easily accessible hollow spot.

### **2.2.3 The Vacuum**

Using strong suction cups to lift an item, the "vacuum" is used to lift large, flat, smooth sheets of material like wood panelling, metal, plastic and glass. The robot arm moves into position and securely plants one or more airtight suction cups to the material, and then activates a powerful inward suction force. The vacuum requires less power than either of the other two designs, but is also more prone to mishaps due to misaligned suction cups that fail to achieve an airtight seal.

## 2.3 Gripper Mechanism

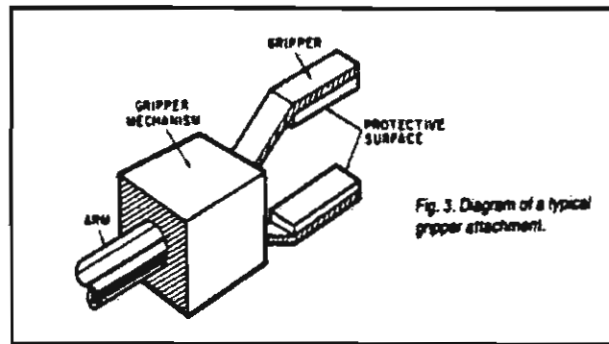


Figure 2.1: The Gripper Mechanism

(Source: <http://www.uspto.gov/web/patents/classification/uspc901/defs901.htm>)

### 2.3.1 Mechanical Finger Grippers – based on method of actuation

#### i. Linkage Grippers

There is no cam, screw, gear. There is movement only because of links attached to input and output. There must be perfect design of mechanism such that input actuator's motion is transformed into the gripping action at the output.

#### ii. Gear and Rack Grippers

Movement of input due to gear motion which makes connecting links to go in motion to make gripping action at the output link.

#### iii. Cam-actuated Grippers

Reciprocating motion of the cam imparts motion to the follower, thus causing fingers to produce a grabbing action. A variety of cam profiles can be employed- constant velocity, circular arcs, harmonic curves etc.

#### iv. Screw-Driven Gripper

Operated by turning screw, in turn giving motion to connecting links and thus giving gripping motion to output. Screw motion can be controlled by motor attached.

v. **Rope & Pulley Grippers**

Motor attached to the pulley makes the winding and unwinding motion of rope in turn it set gripper action into motion via connecting link.

**2.3.2 Vacuum and Magnetic Grippers- sub-classification is based on type of the force-exerting elements**

a) **Vacuum Grippers**

For non-ferrous components with flat and smooth surfaces, grippers can be built using standard vacuum cups or pads made of rubber-like materials. Not suitable for components with curved surfaces or with holes.

b) **Magnetic Gripper**

Used to grip ferrous materials. Magnetic gripper uses a magnetic head to attract ferrous materials like steel plates. The magnetic head is simply constructed with a ferromagnetic core and conducting coils.

**2.3.3 Universal Grippers - sub-classification is inflatable fingers, soft fingers & three fingered grippers**

a) **Inflatable Grippers**

Used for picking up irregular and fragile objects without concentrated loading. In the initial position before gripping, the lever, are opened up, the bellows are in a compressed condition because the gas pressure in the bags, with the spheres is close, even a slight pressure of the object on a bag is sufficient enough to cause the bag wall to be deeply depressed and surround the object. When the degree of the surrounding is adequate the lever motion ceases, and pressure in the bags is reduced by bellows, diaphragm device vacuum pump, causing bags to harden without changing shape and hence gripping the object. To release the object operation is done in reverse.

b) Soft Grippers

Consists of multi-links and a series of pulleys actuated by a pair of wires. The soft gripper can actively conform to the periphery of objects of any shape and hold them with uniform pressure.

c) Three Fingered Grippers

The clamping movement of two-fingered type normally executes (a) beat movement (b) bite movement (c) parallel movement of the jaw. They are capable only of grasping or releasing movement.

## 2.4 Robot Manipulator

A robot manipulator component is consisting of four main parts:

a) Arm (links and joints):

- i. Rigid bodies (links) connected by joints
- ii. Joints: revolute or prismatic
- iii. Drive: electric or hydraulic
- iv. End-effector mounted on a flange or plate secured to the wrist joint of robot

b) Robot Configuration:

- i. Cartesian
- ii. Cylindrical
- iii. Spherical
- iv. Articulated
- v. SCARA (Selective Compliance Assembly Robot Arm)

c) Motion Control Methods:

- i. Point to point control:
  - a) A sequence of discrete points
  - b) Spot welding, pick-and-place, loading & unloading
- ii. Continuous path control:
  - a) Follow a prescribed path, controlled-path motion
  - b) Spray painting, arc welding, gluing

- d) Robot Specifications:
  - i. Number of Axes:
    - a) Major axes, (1-3) :position the wrist
    - b) Minor axes, (4-6) :orient the tool
    - c) Redundant, (7-n) :reaching around obstacles, avoiding undesirable configuration
  - ii. Degree of Freedom (DOF)
  - iii. Workspace
  - iv. Payload (load capacity)
  - v. Precision vs. Repeatability

## **2.5 Egg Handling**

Eggs from the backyard chicken flock can be a convenient and nutritious source of protein, plus they offer the added reward of producing food. To ensure egg safety and quality, home producers should manage chickens and handle eggs properly. Dirty eggs can be a health hazard. Eggs with dirt and debris can be cleaned with fine sandpaper, a brush, or emery cloth. If eggs need to be washed, the temperature of the water should be at least 20F warmer than the egg. This will prevent the egg contents from contracting and producing a vacuum. It will also prevent microscopic bacteria from being pulled by vacuum through the pores of the egg. A mild, non-foaming, unscented detergent approved for washing eggs can be used. A dishwashing liquid that is free of scents and dyes is acceptable. Eggs can be sanitized by dipping in a solution of 1 tablespoon household bleach to 1 gallon of water before storage (Bunning, 2010).

### **2.5.1 Quality of the Egg**

Candling is the process of using light to help determine the quality of an egg. Automated mass-scanning equipment is used by most egg packers to detect eggs with cracked shells and interior defects. During candling, eggs travel along a

conveyor belt and pass over mechanical sensors integrated with computerized systems for segregation of defective eggs. Manual scanning techniques involve conveying the eggs over a light source where the defects become visible and the defective eggs are segregated. Hand candling-holding a shell egg directly in front of a light source is done to spot check and determine accuracy in grading. Advanced technology, utilizing computerized integrated cameras and sound wave technology, is also being applied for the segregation of eggs (Bunning, 2010).

### **2.5.2 Transporting the Egg**

The U.S. Department of Commerce's 1990 Sanitary Food Transportation Act requires that vehicles be dedicated to transporting food only. On August 27, 1999, FSIS made effective a rule requiring:

- i. Shell eggs packed for consumers be stored and transported under refrigeration at an ambient (surrounding) air temperature not to exceed 45°F;
- ii. All packed shell eggs be labelled with a statement that refrigeration is required; and
- iii. Any shell eggs imported into the United States, packed for consumer use, include a certification that they have been stored and transported at an ambient temperature of no greater than 45 °F.
- iv. FDA's Egg Safety Rule requires those transporting eggs to maintain an ambient temperature of 45 °F beginning 36 hours after lying of the eggs.

### **2.6 Factor in Designing Gripper**

In a way to designing a gripper, there are several factors that must take into considerations to have a good and reliable gripper. (Refer Table 2.1)