SIMULATION STUDY OF TWO CHAMBERS SOFT ACTUATORS USING MARC

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A project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Engineering (Electrical-Mechatronics and Automatic Control)

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JUNE 2014

To my beloved parents for their encouragement and love.

ACKNOWLEDGEMENT

First of all, thanks to Allah, god and creator of this universe for His blessing in accomplishment of this research project. I would like to express my gratitude to my supervisor, Ir. Dr. Ahmad 'Athif Mohd Faudzi for his guidance and support. study.

Nevertheless, I would like to thanks my family for their support mentally and physically. Without them, it is impossible for me to go through this process smoothly and successfully within given period.

ABSTRACT

The Flexible Actuator (FA) is a type of pneumatic or hydraulic actuator that can bend, stretch, and twist in any direction by controlling the pressure in chambers of the actuator. This project aims to design and compare the thickness of several possible two chambers of soft actuators. The soft actuator is composed of two semi-circular chambers and reinforced with fiber from P1-silastic silicon RTV material. The best actuators among these designs will be used to simulate the two actuators. The two actuators will be constructed by connecting two links of actuators in parallel with a thin membrane between links. Finite Element Method (FEM) software – MARC will be used, in which geometrical and material non-linearity are considered, to validate the simulation result. Using MARC, three types of two chambers actuators design will be compared to select the best actuator with biggest bending angle. Next, two links of these actuators will be simulated.

ABSTRAK

Penggerak Fleksibel Aktuator (FA) adalah sejenis penggerak pneumatik dan hidraulik yang boleh dibengkok, diregangan, dan diputar dalam apa-apa jua araha dengan mengawal tekanan di dalam ruang penggerak. Projek ini adalah bertujuan untuk mereka bentuk dan membandingkan ketebalan beberapa jenis dua ruang penggerak lembut. Satu penggerak lembut tunggal adalah terdiri daripada dua ruang separuh bulatan dan diperkukuh dengan gentian dari P1-silastic bahan silikon RTV. Penggerak yang terbaik daripada reka bentuk ini akan digunakan untuk disimulasikan kedua-dua penggerak. Kedua-dua penggerak ini akan dibina dengan menyambungkan dua penhubung penggerak secara selari dengan membran yang nipis di antara pautan. Bagi Kaedah Unsur Terhingga (FEM) perisian-MARC akan digunakan, di mana geometri dan bahan bukan linear telah diombil kira untuk mensahihkkan keputusan simulasi, Dengan mengesahkan perision MARC, tiga jenis daripada akan dibar dingkan untuk memilih penggerak yang terbaik dengan sudut lentur yang terbesar. Seterusnya, dua penghubung penggerak ini akan simulasikan.

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LIST OF SYMBOLS

t_o	Thickness of the wall
t_c	Thickness of the center

LIST OF ABBREAVIATIONS

FEM	-	Finite Element Method
FEA	-	Finite Element Analysis
DOF	-	Degree of Freedom
FA	-	Flexible Actuator
FMA	-	Flexible Micro Actuator

CHAPTER 1

INTRODUCTION

1.1 Project Background

The Flexible Actuator (FA) is a type of penumatic actuator that can bend, stretch, and twist in any direction by controlling pneumatic pressure in chambers of the actuator. Its characteristics are simple in structure and ease of miniaturization, multi-degrees of freedom and smooth motion. A single soft actuator is composed of two semi-circular chambers and reinforced with fiber. Application examples include manipulators, robot hands, and movable pipe inspection robots. A robotic fin is idealized with five actuators, which are serially connected by thin flexible rubber membranes. Each actuator consist of two chambers.

1.2 Problem Statement

Traditional robots have rigid underlying structures that limit their ability to bend. For example, conventional robot manipulators have rigid links and can manipulate objects using only their specialized end effects. A variety of animals and

plants can perform a complex movement with soft structures without having rigid components. Therefore the soft fish fin has to be developed to ease the life with a high flexible performance. By mimicing soft motion fish fin, Therefore the soft actuator has to be composed of some links to have a high flexible performance.

1.3 Objectives

i) To design several types of two chambers soft actuators in MARC.
ii) To compare and to obtain the best bending characteristics from different rubber model.
iii) To connect two actuators in parallel with a thin membranefor fish fin development.

To achieve these objectives, various parameters involved such as thickness of the wall, thickness of the center, fiber and rubber material will be considered.

1.4 Scopes

The process of this project will start by simulating several actuators. The actuators will be simulated by using the rubber and fiber material in FEM-MARC and they simulated by differences in their wall thickness t_0 and thickness of center t_c.

Then 200 KPa pressure will be applied to all actuators. Actuators will be compared by their ability to bend and the actuator that has the most bending angles will be chosen for simulating two links actuators.

1.5 Significance of the Project

Rigid actuators are less flexible and have higher risk if there is a contact with human. Having a soft actuator can perform that task as the rigid actuator with higher flexibility and minimum risk. The soft fish fin can be composed of many links to perform a better bending.The need of flexible actuator is increasing. A fish fin that is made of Flexible Actuator can produce high bending with soft manipulation on the object.

This chapter is an introduction of this project, the literature review of this project is in chapter two. Chapter three is an explanation method of simulation of singel and two links actuators, the results are in the following chapter four and there will be a discustion about them. A conclution will be made in chapter five according to previous chapters and further research works about this project will be brought out as well in order to ease the reader for further studies and modifications onto the project.

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