

**FUZZY LOGIC CONTROLLER AND ITS APPLICATION**

**NORHAFIZAH BINTI BURHAM**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

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**NORHAFIZAH BINTI BURHAM**

**This report is submitted in partial fulfillment of the requirements for the award of Bachelor  
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UNIVERSITI TEKNIKAL MALAYSIA MELAKA  
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**I dedicate this to both of my lovely parents and family, a person that love and need most for giving me a support, all my lecturers, all my friends and last but not least the people that contribute directly and indirectly.**

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## ABSTRACT

Fuzzy logic controller is one type of intelligent controller. Fuzzy logic is much just like human operator or closer in spirit to human thinking and natural language than the traditional (classical) logical system. Basically, fuzzy logic have an effective means for describing the approximate, inexact natural or ambiguous of the reality problem. The fuzzy logic controller is useful for control processes that too complex to analyze by conventional quantitative techniques. This thesis is concern with fuzzy logic controller and its application. The first stages of this project are to study in detail the capability and ability of fuzzy logic compare to other controller that use in non linear system. The second stage is to design the fuzzy logic controller using the fuzzy logic toolbox software. Lastly, design the system especially the non linear system and apply the fuzzy logic controller in this system. The simulation work is done using a MATLAB/SIMULINK platform.



## ABSTRAK

Pengawal fuzzy Logik adalah sejenis pengawal yang bijaksana. Fuzzy Logik menyerupai pertuturan manusia atau menghampiri pemikiran manusia dalam bahasa pertuturan berbanding dengan klasik logik sistem. Secara umumnya, fuzzy logic mempunyai keupayaan untuk menghurai segala penghampiran, ketidaktepatan dan keserabutan dalam segala masalah yang timbul. Pengawal Fuzzy logic sangat berguna untuk mengawal sesuatu proses yang kompleks untuk dianalisis melalui teknik-teknik yang biasa. Tesis ini akan memberi fokus tentang Pengawal Fuzzy Logik dan aplikasinya. Peringkat pertama projek ini adalah untuk mengkaji segala kebaikan dan keupayaan Fuzzy Logik berbanding pengawal yang lain dlm mengawal system yang tidak linear. Peringkat kedua pula adalah merekabentuk pengawal Fuzzy Logik menggunakan “Fuzzy Logic Toolbox” yang terdapat dalam MATLAB. Terakhirnya, merekabentuk satu sistem terutamanya sistem yang tidak linear dan mengaplikasikan Pengawal Fuzzy Logik dalam sistem ini. Segala kerja simulasi akan dilakukan menggunakan MATLAB/SIMULINK

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## **LIST OF ABBREVIATIONS**

<b>MISO</b>	-	<b>Multiple Input Single Outputs</b>
<b>FLC</b>	-	<b>Fuzzy Logic Controller</b>
<b>SISO</b>	-	<b>Single Input Single Output</b>
<b>PID</b>	-	<b>Proportional Integral Derivation</b>
<b>LMI</b>	-	<b>Linear Matrix Inequality</b>

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## **CHAPTER I**

### **INTRODUCTION**

#### **1.1 Project Overview**

Fuzzy Logic is a one of type intelligent controller that can control one system just like a human operator without much information. The ideas of fuzzy logic propose by Mamdani and Assilian (1972). The fuzzy logic control has the capability to control linear and non linear system. But the fuzzy logic is the best utilize to control the non linear system, the ill-complex defines system or the system that difficult to approach mathematically.

The goal of this project is to design the fuzzy logic controller that can be applied for any system especially for the ill-complex defined system. Thus, using the simulation will show the performance of fuzzy logic compare to other controllers (e.g. PID controller, State Feedback controller, Linear Quadratic (LQ), and etc.)

## **1.2 Objectives**

The objectives of this project are:

1. To design a Fuzzy Logic controller
2. To apply this type of controller for an active suspension system

## **1.3 Problem Statement**

There are many types of controller that use to improve the capability of the system. The fuzzy logic controller is one of the intelligent controller that often use in many application such as the washing machine, rice cooker, air conditioner and other applications. Therefore, characteristic, capability and performance of fuzzy logic controller will be evaluated.

## **1.4 Scope of the project**

The scopes of this project are:

1. To study the theory of fuzzy logic controller
2. To study the capability of fuzzy logic controller to control nonlinear system
3. To design the fuzzy logic controller for an active suspension system

## **1.5 Project Methodology**

In order to achieve the goal of this project, the understanding of conceptual of fuzzy logic controller must be done at the first place. The theories that include in the research will focus more on the fuzzy logic theoretical such as fuzzy set, fuzzy set operation, fuzzy logic components and etc. Fuzzy logic components include fuzzification, inference engine, knowledge based and defuzzification. Furthermore, the capability and the ability of fuzzy logic controller in controlling non-linear system will be study in detail.

After all theories have been studied, then the designing phase began. The first step was to design the Fuzzy Logic controller with its membership function and rule based. For this task, the Fuzzy Logic Toolbox in MATLAB was used. So, all the MATLAB commands and tools need to be learnt and understand. Then, continue with the mathematical modeling for suspension system. Based on the pre-designed fuzzy logic controller and mathematical model of suspension system, the design step for simulation model began. All of simulation model will be done using MATLAB Simulink program. In this program, all the designs were represented in block diagram which is simpler than construct them in schematic diagram.

Next, all simulation models will be simulated in MATLAB Simulink to obtain performances data for both systems; with or without fuzzy logic controller. This data will be analyzed in terms of transient response and settling time in order to observe the robustness of fuzzy logic controller and its capability of handling non-linear system like suspension system.

## **1.6 Thesis Structure**

This thesis consists of five chapters that will explain and discuss more details about this project. The first chapter will discuss about the project overview which are the project background, objectives, problem statements, scopes and research methodology.

The second chapter is the literature review about various systems that use fuzzy logic as the controller. From this literature review, the research about the fuzzy logic controller that applies for various systems can be learnt especially the performance and effectiveness of fuzzy logic. Furthermore, the theory of fuzzy logic controller will be discussed too.

The third chapter is all about the Fuzzy Logic Toolbox. The main focus of this chapter is to explain on how to use MATLAB Simulink program using Fuzzy Logic Toolbox. It will include all component of this program such as FIS Editor, Membership Function Editor, Rule Editor and Rule Viewer.

The fourth chapter is about the implementation of fuzzy logic controller in suspension system. The simulation will be done using MATLAB Simulink for both systems with or without fuzzy logic controller. The simulation results for both systems will be obtain and analyzed to observe the best performances.

The fifth chapter is regarding the discussion, recommendation and the conclusion of the project. For future improvement, recommendations and suggestions that can improve the performances and stability of this system or even the implementation of system into real hardware are included.

## **CHAPTER II**

### **FUZZY LOGIC CONTROLLER**

#### **2.1 Introduction**

This chapter will discuss the literature review about the fuzzy logic controller, basic concept of fuzzy logic controller (FLC) including the theory and definition of fuzzy set, membership function, and the concept of fuzzy control system. In addition, this chapter will discuss the procedure and methodology of designing fuzzy logic controller.



## **2.2 Literature review**

Fuzzy Control of Mechanical Vibrating System is about the Fuzzy logic is used to control active hydropneumatic suspension. The ability of fuzzy logic were discuss that can improve the reduction of the body acceleration caused by the car body when road disturbance from uneven surface, pavement point and etc which is act the tires of running the cars. The fuzzy controller used in this designing has three inputs which are body acceleration, body velocity and body deflection velocity and one output is desired actuator force. The simulation result is to compare the active and passive suspension system. In the end of this research are the active suspension system is proposed to achieve both ride comfort and good handling. The aim was achieve by simulation result that the active suspension system based on fuzzy logic controller shows the improved stability of the one-quarter-car model.

Robust Speed Fuzzy Logic Controller for DC Drive was discusses the robust fuzzy speed control for a DC drive is considered. The basis of the heuristic reasoning the main features of the robust speed controller are supposed and the fuzzy logic controller that can control the DC drive was designed. The comparison between PI controller and Fuzzy Logic Controller to control the DC Drive were approved. In the end of this paper, the robust fuzzy speed control for a DC Drive was examined. The fuzzy logic controller is able to overcome the disadvantage of usual PI-controller in sensitiveness to inertia vibration and sensitiveness to variation of the range of reference speed alteration.