" I hereby declare that I have read through this report entitle "Fuzzy Logic In Position Control System" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation and Automation)"

Signature : .....

Supervisor's Name : DATUK PROFESOR DR. MOHD RUDDIN AB. GHANI
FAKULTI KEJURUTERAAN ELEKTRIK
UNIVERSITI TEKNIKAL MALAYSIA MELAKA
KARUNG BERKUNCI 1200
75450 AYER KEROH, MELAKA

Date : 20/6/2012

FUZZY LOGIC IN POSITION CONTROL SYSTEM

MOHD AZRAYIE BIN ZAINODIN

A report submitted in partial fulfillment of the requirements for the degree of electrical engineering (control, instrumentation and automation)

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2012

I declare that this report entitle "Fuzzy Logic In Position Control System" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : MOHD AZRAIE BIN ZAINODIN

Date : 28.06.2012

In the Name of Allah, the most Beneficent, the most Merciful.

Al-Fatihah to my cousin Hafiz and my uncle Yazid.

To my grandfather and grandmother.

To my beloved mother, father, sisters and brother.

To my uncles, aunties and cousins.

To all my friends and my lecturers.

For their support.

And to my country of Malaysia and my state of Kelantan.

ACKNOWLEDGEMENT

Firstly, I would like to express my gratitude and thanks to my project supervisor, Datuk Prof. Dr. Mohd Ruddin B. Hj. Abd. Ghani for his guidance and advice towards completing this project. Besides, I would like to say thank you to all my friends for their support and help throughout this project.

Also my gratitude to all those who had directly or indirectly contributed toward the completion of this project.

Last but not least, to ally my beloved family members, who were there to support and advice when I needed most.

Thank you.

ABSTRACT

Fuzzy logic in position control system was a project that implemented fuzzy logic controller to control the position of the antenna azimuth rather than using the conventional controller such as PD controller that normally used to control the position of the antenna azimuth.

The objective of this project is to design a fuzzy logic for a position control system, to simulate the fuzzy logic that has been designed by using MATLAB software to get the output result and then to compare the fuzzy logic with a conventional PD controller in position control system.

This project began with analysis of the antenna azimuth block diagram to get the plant transfer function. Then the project was divided into two parts. First part is to design the PD controller to control the plant. Then the second part is to design the fuzzy logic controller to control the plant. The result that has been obtained by using the MATLAB software is analyzed and the comparison in performance is discussed in the final stage of this project.

In the end of the project, the fuzzy logic was improved to be more flexible and have a better performance compare to the PD controller in control the position of the antenna azimuth.

ABSTRAK

Logik kabur dalam sistem kawalan kedudukan adalah projek yang dilaksanakan pengawal logik kabur untuk mengawal kedudukan azimut antena dan bukannya menggunakan pengawal konvensional seperti PD pengawal yang biasanya digunakan untuk mengawal kedudukan azimut antena.

Objektif projek ini adalah untuk merekabentuk logik kabur bagi sistem kawalan kedudukan, untuk mensimulasikan logik kabur yang telah direka dengan menggunakan perisian MATLAB untuk mendapatkan hasil output dan kemudian membandingkan logik kabur dengan pengawal konvensional PD dalam kawalan kedudukan sistem.

Projek ini bermula dengan analisis gambarajah blok antena azimut untuk mendapatkan fungsi tumbuhan pemindahan. Kemudian projek ini telah dibahagikan kepada dua bahagian. Bahagian pertama adalah untuk merekabentuk pengawal PD untuk mengawal kilang. Kemudian bahagian kedua adalah untuk merekabentuk pengawal logik kabur mengawal loji. Hasil yang telah diperolehi dengan menggunakan perisian MATLAB dianalisis dan perbandingan prestasi dibincangkan di peringkat akhir projek ini.

Di akhir projek, logik kabur telah dibuktikan lebih fleksibel dan mempunyai prestasi yang lebih baik berbanding dengan pengawal PD dalam kawalan kedudukan azimut antena.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

PARAMETERS

Schematic Parameters		
Parameter	**Definition**	**Configuration 3**
V	Voltage across Potentiometer (Volts)	10
N	Turns of Potentiometer	1
K	Preamplifier gain	1
K_1	Power amplifier gain	100
a	Power amplifier pole	100
R_a	Motor resistance (Ohms)	5
J_a	Motor inertia constant (Kg-m^2)	0.05
D_a	Motor dampening constant (N-m s/rad)	0.01
K_b	Back EMF constant (V-s/rad)	1
K_t	Motor torque constant(N-m/A)	1
N_1	Gear teeth	50
N_2	Gear teeth	250
N_3	Gear teeth	250
J_L	Load inertia constant (Kg-m^2)	5
D_L	Load inertia constant (Kg-m^2)	3
Block Diagram Parameters		
Parameter	**Definition**	**Configuration 3**
K_{pot}	Potentiometer gain	3.18
K	Preamplifier gain	1
K_1	Power amplifier gain	100
a	Power amplifier pole	100
K_m	Motor and load gain	0.8
a_m	Motor and load pole	1.32
K_g	Gear ratio	0.2

CHAPTER 1

INTRODUCTION TO PROJECT

1.1 Introduction

In this chapter, the introduction to the Fuzzy Logic in antenna azimuth position control will be discussed such as problem statement, project objectives and also the project scope.

1.2 Problem Statement

Proportional Derivative or PD controller was first published by Russian American engineer, Nicolas Minorsky in 1922 while observe the helmsmen control the ship based on current error and current rate of change. This system then was trial for USS New Mexico as an automatic steering system. Now the PD was widely used in industrial control system especially to control the temperature, pressure, flow rate, speed, position and so on. But PD when used alone can give poor performance when the PD loop gains must be reduced so that control system does not overshoot or oscillate.

Thus the need of controller that are easy to used and also can give better performance than PD are always welcomed. One of the controllers that have this specification is Fuzzy Logic. Nowadays, we can see the increase of research and studies in Fuzzy Logic especially

in it application in control system. The aim of this project is to design the Fuzzy Logic for antenna azimuth position control and then to analyze the result by compare it with the PD controller to see which one get the better performance.

In this project, the MATLAB software will be used to simulate the result and then the data will be analyze to compare the response of Fuzzy Logic and conventional PD controller in position control of antenna azimuth. We also can observed and consider the Fuzzy Logic potential as an ideal controller by refer to it performance during this project.

1.3 Project Objectives

The objective of this project is:

I. To design a Fuzzy Logic for a position control system of antenna azimuth.
II. To simulate the Fuzzy Logic that has been designed by using MATLAB software to get it output result.
III. To compare the Fuzzy Logic with a conventional PD controller in position control system for antenna azimuth.

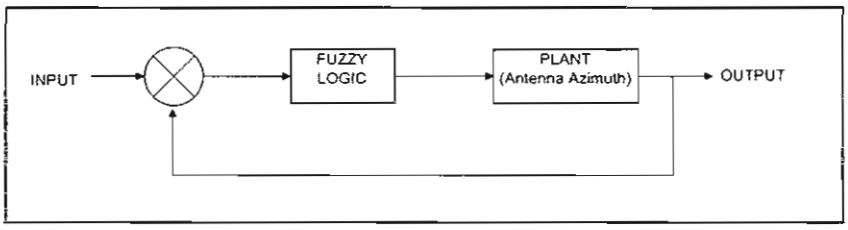

Figure 1.1: Basic block diagram of control system

1.4 Project Scope

Below show the scope of this project:

I. Study the Fuzzy Logic system and the step to design the fuzzy logic system.
II. Study and get the transfer function for the antenna azimuth.
III. Design and simulate the Fuzzy Logic to control the position of the antenna azimuth by using MATLAB software.
IV. Compare the result from the Fuzzy Logic with the PD controller.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this section, the article review, journal and other research material will be reviewed in order to get the general idea about the project design, conception and other information regarding the project. This chapter also will explain the theories used in order to implement the project.

2.2 Antenna Azimuth Position Control System Analysis and Controller Implementation

This project was developed by Liu Xuan, Jenniffer Estrada and Jonathan DiGiacomandrea in 2009 [3]. This project discussed about the problem that was presented to the development team to analyze and implement a controller for the antenna azimuth position control system. The open loop and closed loop characteristic of the system will be analyzed and determined the most stable and implementable controller for the system.

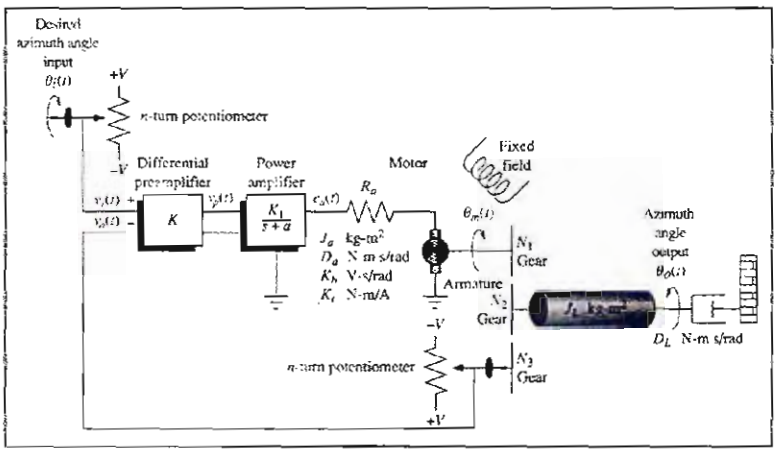

Figure 2.1: Schematic of antenna azimuth [3]

In doing this project, a few assumptions are used in the analysis:

I. The gain of the preamplifier is assumed to be one for simplification of analysis and any gain that needed to be implemented will be in the compensator controller

II. There are no disturbances or interferences in the signals between parts of the controller system

III. The transfer functions given for the amplifier and preamplifier are accurate representation of the system currently in use

IV. The system is well described in the provided project data, that is values for modeling the motor, gears, load, Preamplifier, Power Amplifier, potentiometer and voltage references are accurate

The configuration 3 was used as the block schematic and diagram parameters in this project. This configuration can be referred in the page xiii. The first section of this project starts with the analysis of the control system of the antenna azimuth. There are five subsystem of the overall system, each with its associate transfer function.

Then the Discrete PID controller was implemented in the system to provide ample stability and response characteristics.

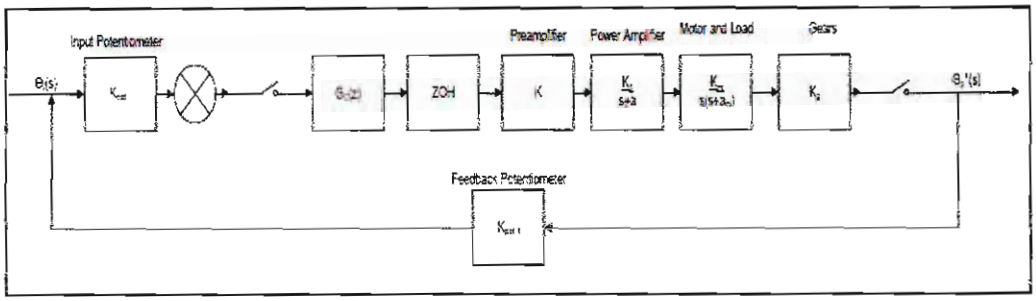

Figure 2.2: Discrete PID implementation in the system [3]

2.3 Antenna Azimuth: An Introduction to Position Control Systems

This case study was included in the book of Control System Engineering Fifth Edition by Norman S. Nise [2]. This case study have presented with a lot of theoretically information regarding the antenna azimuth position system.

It is state in this case that a position control system converts a position input command to a position output response. The purpose of this system is to have the azimuth angle output of the antenna, follow the input angle of the potentiometer [2].

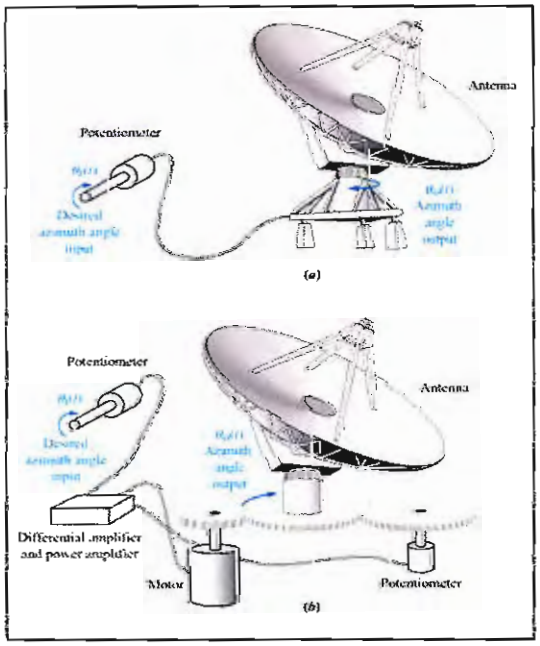

Figure 2.3: Antenna azimuth position control system [2]:

a)System concept, b) detailed layout

Antenna azimuth is a position control system converts a position input command to a position output response. The purpose of this system is to have the azimuth angle of the output antenna, Θo(t), follow the input angle of the potentiometer, Θi(t). The input command is an angular displacement. The potentiometer converts the angular displacement into a voltage. Similarly, the output angular displacement is converted to a voltage by the potentiometer in the feedback. The signal and power amplifiers boost the difference between the input and output voltages. The amplified actuating signal drives the plant [2].

The system normally operates to drive the error to zero. When the input and output match, the error will be zero and the motor will not turn. Thus, the motor is driven only when the output and the input do not match. The greater the difference between the input and output, the larger the motor input voltage and the faster the motor will turn [2].

2.4 Introduction to Fuzzy Logic Using MATLAB

This book was written by S.N.Sivanandam, S.Sumathi and S.N.Depa in 2007 [1]. This book gives the overview as well as theoretical information regarding the simulation of Fuzzy Logic by using the MATLAB software.

In this book the Fuzzy Logic simulation in MATLAB is show by the example to control the temperature in the reactor. Temperature control of the reactor where the error and change in error is given to the controller. Here the temperature of the reactor is controlled by the temperature bath around the reactor thus the temperature is controlled by controlling the flow of the coolant into the reactor [1]. Figure 2.4 show the membership function and the rule base using FIS editor.

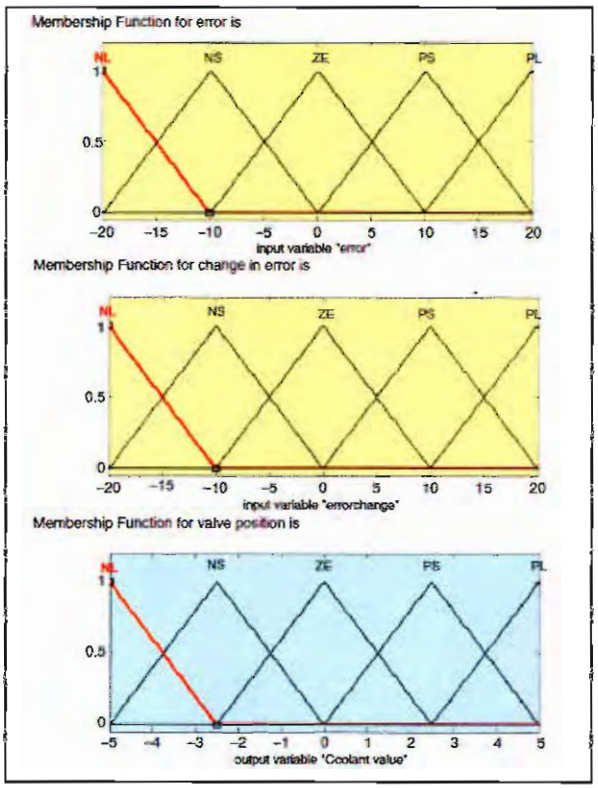

Figure 2.4: Fuzzy Logic membership function to control the reactor temperature [1]

ϵ	δc				
	NL	NS	NE	PS	PL
PL	ZE	PS	PL	PL	PL
PS	NS	ZE	PS	PL	PL
ZE	NL	NS	ZE	PS	PL
NS	NL	NL	NS	ZE	PS
NL	NL	NL	NL	NS	ZE

Figure 2.5: Fuzzy Logic rule base [1]

Then this membership functions and rules base was implemented into MATLAB FIS editor to simulate the result. Figure 2.6 show the output result for the temperature control in the reactor by using fuzzy logic controller.