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Speed Control Using Fuzzy logic technique

(Application in Automotive)

DIVAN A/L TARMALINGGAM

BEKC

MAY 2009

"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation and Automation)"

Signature : _____

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Date : 13 MAY 2009

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MAY 2009

I declare that this report entitle "Speed control using fuzzy logic technique (application in automotive)" 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 : DIVAN A/L TARMALINGGAM

Date : 13 MAY 2009

To father and mother

To all my lectures and friends

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First of all I express gratitude to my supervisor, Pn Sahazati binti Md Rozali for her guidance and teachings. I also would to thank my previous supervisor En Saifuza bin Alwi@Suhaimi and both of the panels for their guidance.

I would also wish to extend my gratitude to my parents for their support and their understanding. The last but not least, all my friends that help me in this project.

ABSTRAK

Tujuan projek ini adalah untuk membina satu system mengawal kelajuan menggunakan pengawal logic kabur bagi aplikasi dalam kenderaan. Sistem logic kabur adalah satu system pintar yang boleh membuat keputusan menggunakan logic pelbagai nilai. Sistem ini juga tidak mempunyai sempadan yang menampakkan diantara nilai-nilai serta boleh membuat keputusan memberangsangkan. Aplikasi logik kabur yang diprocess mengunakan perkataan menjadikannya lebih rapat dengan pimikiran manusia serta berdaya untuk memberikan pengeluaran tanpa dipengaruhi toleransi. Kawalan logik kabur akan diaplikasi dalam projek itu menggunakan mikropengawal (PIC). Mikropengawal yang akan digunakan adalah PIC 16F877A yang berfungsi untuk menghantar / menerima data dan serta memjadi platform bagi sistem logic kabur. Bagi system in satu input iaitu sensor dan satu output iaitu motor. Selain itu, projek ini akan ditulis dengan perisian C.

ABSTRACT

This project is to develop a speed control method using fuzzy logic for Automotive application. Fuzzy logic technique is an intelligent control that able to make decision on multi-valued logic. In other sense, the technique does not have a significant boundary between the value and able make narrow decision. Further more fuzzy logic is analyzed using word rather than numbers. This makes fuzzy logic closer to human intuition and able to utilize tolerance for imprecision. The fuzzy logic control will be implemented in the project using microcontroller (PIC). The microcontroller that will be used is a 16F877A which able to send/receive data and become platform for fuzzy inference system. As for the input, a sensor will be used to detect the variable while a dc motor will be used as actuator. Instead of using assemble language, C-language will used for programming and develop of the algorithm and interface.

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LIST OF TERMS

A/D (ADC)	Analog to Digital Converter
CPU	Central Processing Unit
CMOS	Complementary Metal–Oxide–Semiconductor
D/A (DAC)	Digital to Analog Converter
EEPROM	Electrically Erasable Programmable read-only memory
FL	Fuzzy Logic
FLC	Fuzzy Logic Controller
FIS	Fuzzy Inference System
IC	Integrated Circuit
I/O	Input and Output
MCU	Microcontroller Unit
MIMO	Multi input-Multi output
MIN	Minimum
MAX	Maximum
PC	Personal Computer
PCB	Printed Circuit Board
PIC	Peripheral Interface Controller
PSP	Parallel Save Port
PWM	Pulse Width Modulation
RAM	Random Access Memory
ROM	Read-only Memory
RISC	Reduced Instruction Set Computer
SISO	Single input-Single output

CHAPTER 1

INTRODUCTION

1.1 Overview

Speed control application is very common; it is used in many industries and machineries. Speed control can be done on both AC and DC motors using software or hardware. My project is based on controlling the speed of DC motor using fuzzy logic which is applicable to automotive. This concept can be applied in real world for various applications such as automatic electrical train (LRT), braking system, autonomous robot and many more. Along with Fuzzy Logic, the system can provide faster and smart decision (control).

The development of this project is divided into two parts which are hardware and software development. In the hardware part, a microcontroller is used as the controller along with a input (sensor) and a output (motor). The motor is controlled through an h-bridge driver which can provide a precise control. As for the software part, c-program is used to program the microcontroller. Fuzzy logic logarithm is implemented in the in the PIC along with interface program for sensor and motor.

As the result, the fuzzy controller developed is able to provide precise PWM signal in order to drive the DC driver based on the input from sensor.

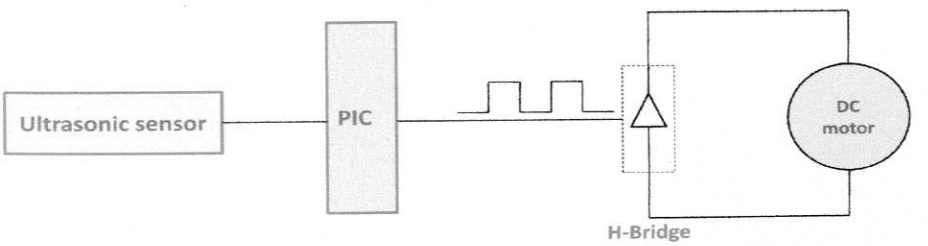

Figure 1.1: Project overview

1.2 Problem Statement

1. Non-fuzzy is very complicated to derive, program and interpret if involve system with high highly precision, compared with fuzzy logic that uses common sense statement.

2. Non-fuzzy controller also required long set point recovery and has high overshot which makes it less appropriate for high speed application.

3. In industry, the whole configuration of the system using non-fuzzy have to changed if any modification is done on the system. Compared with fuzzy, that only needs the average to be changed without rewriting the rules.

1.3 Project Objective

1. To study and obtain the knowledge about fuzzy logic, microcontroller and its application.

2. To identify the problem, testing and do improvement to enhance the knowledge in troubleshooting and problem solving.

3. To design, develop and apply the fuzzy logic to control the speed using a PIC for automotive application.

1.4 Project Scope

1. Program fuzzy logic concept in a PIC 16F877A.

2. Design and construct circuit by using PIC 16F877A, input and output.

3. Interface both hardware and software.

1.5 Methodology

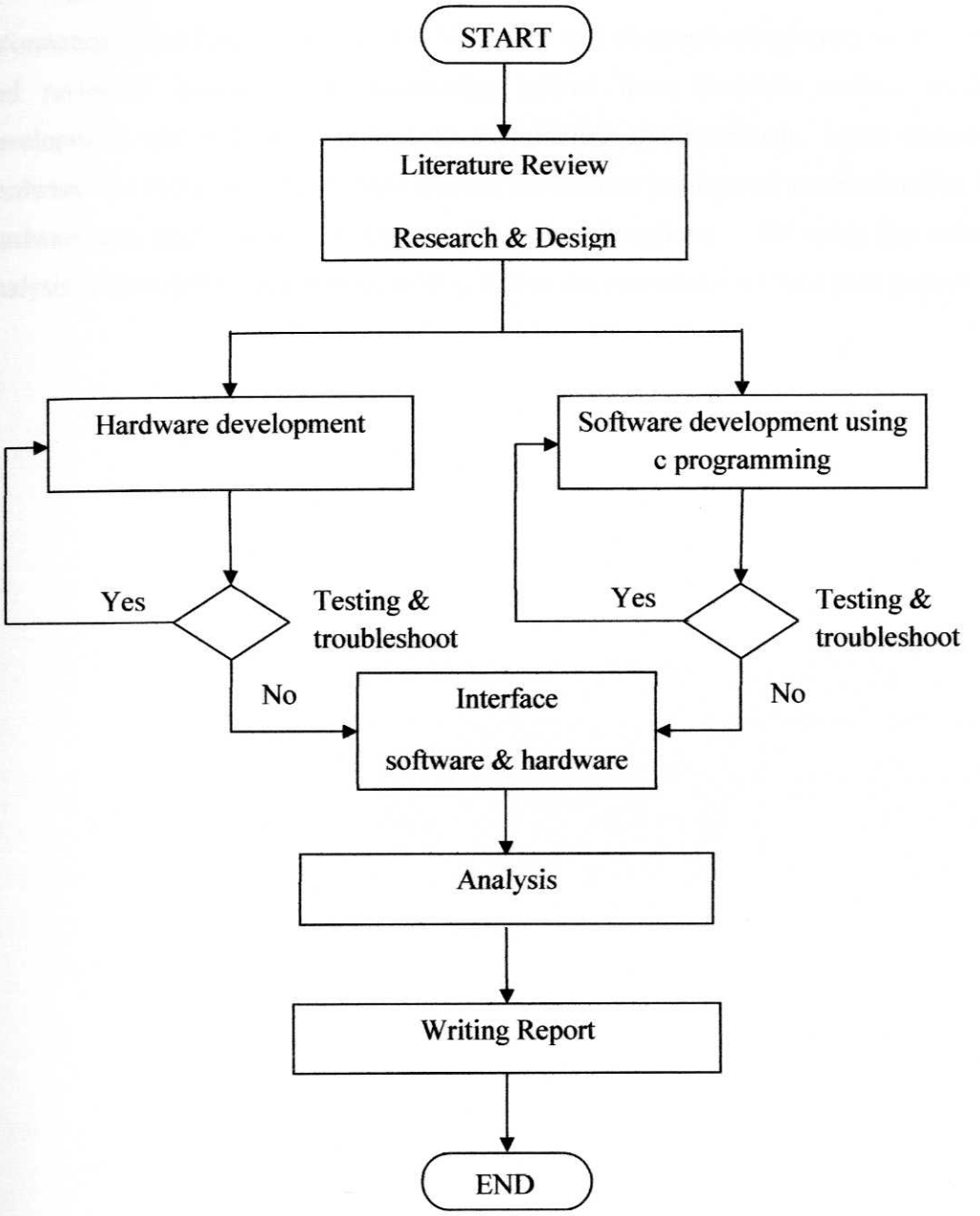

Figure 1.2: Methodology flow chart

1.5.1 Flow chart description

Initially the final year project is started with literature review, thus all the required information about Fuzzy Logic, Mikro C, Sensor and electronic component were gathered and reviewed. Based on the knowledge gained from literature review, hardware development and software development is initialize simultaneously. Upon succeed of hardware and software development through continuous testing and troubleshooting, both hardware and software will be integrated together (interface). By using the outcome, analysis is done followed by report writing before the completion of final year project.

CHAPTER 2

LITERATURE REVIEW

Reference and general understanding is gained from various sources. Books, internet articles, journals and previous projects are main sources for this entire project. IN this section I had done some journal review along with detail description about fuzzy logic and its application.

2.1 Journal review

From all the journal that I have reviewed, these 2 journals provides vast information about fuzzy logic and its implementation on microcontroller. That journal provides me an opening and excellent information for the development of my project. The journal are "fuzzy logic microcontroller implementation for dc motor speed control" by Yodyium Tipsuwan [1], Mo-Yuen Chow[2] and "real time fuzzy logic speed control using conventional, assembly and simulation method for industrial dc motors" by Navin Govind [1], Abul R. Hasan [2].

2.1.1 Fuzzy logic microcontroller implementation for dc motor speed control by Yodyium Tipsuwan [1], Mo-Yuen Chow[2].

This paper described an alternative method to implement a fizzy logic speed controller for a DC motor using a fuzzy logic microcontroller. The design, implementation, and experimental results on load and no load conditions are presented. The controller can be implemented by using only a small amount of components and easily improved to be an adaptive fizzy controller. The controller also provides high performance with compact size and low cost.

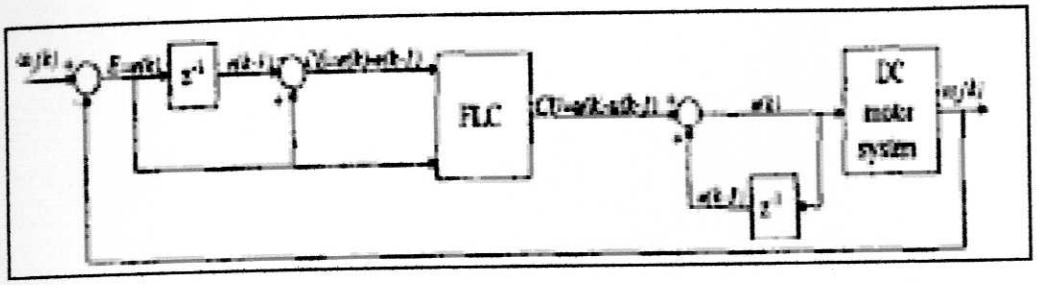

Figure 2.1: Block diagram FLC

$$E = e(k) = \omega_r(k) - \omega_a(k) \quad (2.1)$$

$$CE = e(k) - e(k-1) \quad (2.2)$$

$$CU = u(k) - u(k-1) \quad (2.3)$$

Where,

k = time index

E= error

ω_a=reference speed

ω_r=real speed

CE=change in error

CU= armature voltage

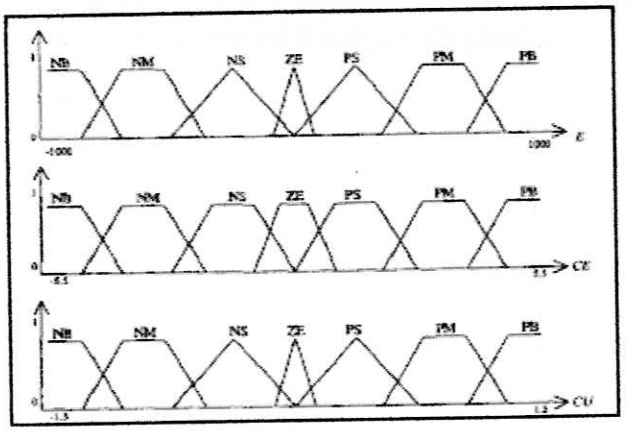

Figure 2.2: Membership function

E / *CE*	NB	NM	NS	ZE	PS	PM	PB
PB	NM	NS	NS	NB	PB	PB	PB
PM	NM	NM	NS	NB	PB	PB	PB
PS	NB	NM	NM	ZE	PB	PB	PB
ZE	NB	NB	NM	ZE	PM	PB	PB
NS	NB	NB	NB	ZE	PM	PM	PB
NM	NB	NB	NB	NB	PS	PM	PM
NB	NB	NB	NB	NB	PS	PS	PM

Figure 2.3: Rule table

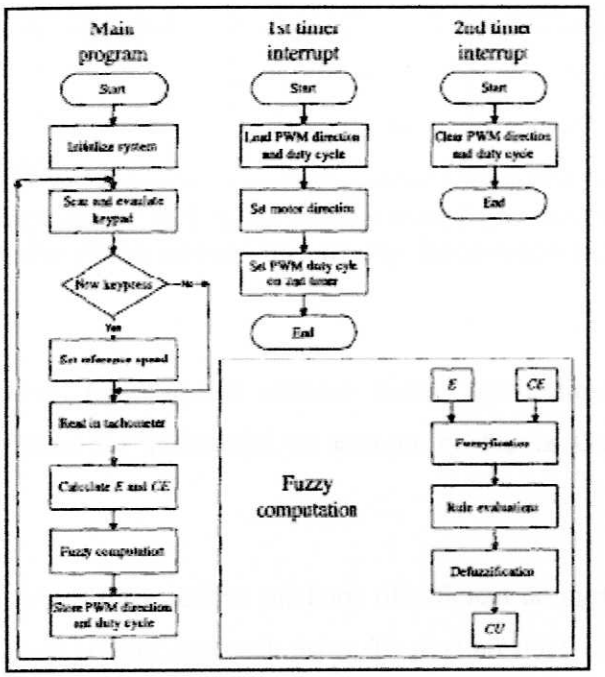

Figure 2.4: Flowchart of the algorithm running on the FLC

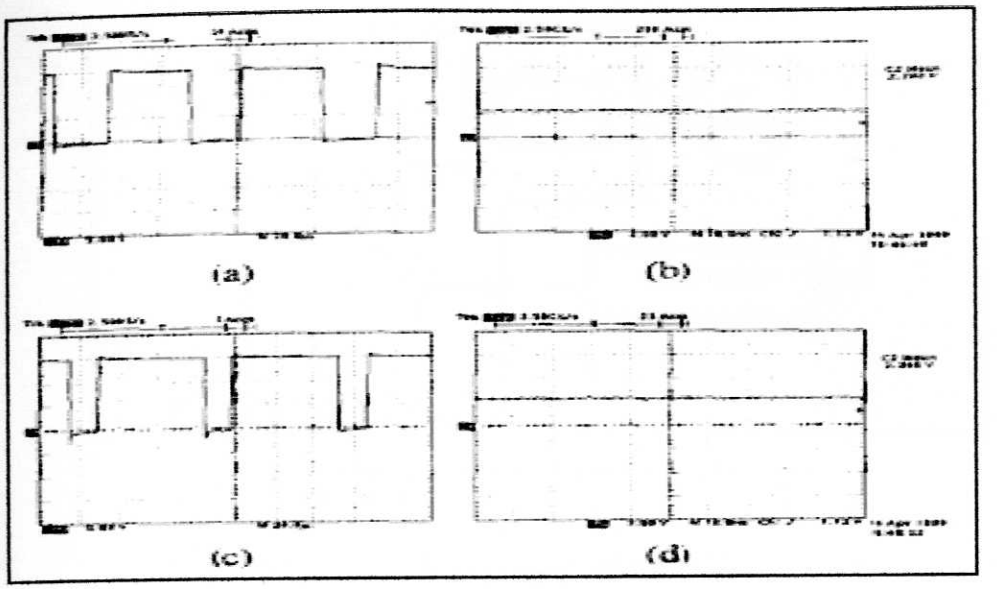

Figure 2.5: (a) Shifted-positive PWM output without load, (b) Tachometer output from (a), (c) Shifted-positive PWM output with load, (d) Tachometer output from (b).

2.1.2 Real time fuzzy logic speed control using conventional, assembly and simulation method for industrial dc motors by Navin Govind [1], Abul R. Hasan [2].

This paper describes three unique methods of efficient dc motor speed control. A simplified real time speed control approach using *'C,* next an Intel 16-bit microcontroller based *fuzzy* controller using assembly language and finally, using Inform *fuzzy* tools which allows *fuzzy* system design with graphical development tools including simulation and code optimization. The *fuzzy* controller controls the speed of the dc motor by maintaining it at a constant level after an external load is applied and removed. Binary Input Output Fuzzy Associative Memory (BIOFAM) is used for control. Fuzzy Associative Memories (FAM) are transformations which map *fuzzy* sets to fuzzy sets. Inputs are error and the rate of change of speed. Fuzzy logic speed control in the field of power electronics and stability of fuzzy controllers are discussed.