DEVELOPMENT OF FUZZY LOGIC SPEED CONTROLLER FOR DC MOTOR APPLICATIONS USING RABBIT MICROPROCESSOR

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DEVELOPMENT OF FUZZY LOGIC SPEED CONTROLLER FOR DC MOTOR APPLICATIONS BY USING RABBIT MICROPROCESSOR

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This report is submitted in partial fulfillment of requirements for the Degree of Bachelor In Electrical Engineering (Power Electronics and Drives)

Faculty of Electrical Engineering
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“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 LEectrical Engineering (Power Electronics and Drives).”

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"I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the references."

Signature:_____

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DATE : 23 April 2008

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ABSTRACT

The project is titled as “Development of Fuzzy Logic Speed Controller for DC Motor Applications by Using Rabbit Microprocessor.” In this project, the embedded controller developed is based on Rabbit microprocessor and its core module model *RCM 3100*. The control method implemented in this is fuzzy logic control method. A fuzzy logic algorithm needs to be developed and be compiled in Rabbit microprocessor in order to provide precise control signal for DC motor variable speed drive. Instead of using assembly language to compile the fuzzy algorithm, this controller will use Dynamic C programming language to develop the algorithm.

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The goal of the project is to design and develop a laboratory scale functioning prototype in order to demonstrate the interfacing between the fuzzy logic control algorithm in Rabbit microprocessor and the DC motor speed drive. The Rabbit microprocessor based fuzzy controller is able to generate Pulse Width Modulation (PWM) signal. The PWM signal generated is an input signal for H-bridge DC power converter in order to control the speed of DC motor.

The major hardware implementation in this project is Rabbit microprocessor. Rabbit microprocessor is chosen due to its specification features of high speed (maximum of 112500bps baud rate), easy design hardware system and low power consumption. Besides, H-bridge DC driver also need to be developed, the DC drive has a simple design and allow forward and reverse direction control of the DC motor.

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ABSTRAK

Projek ini bertajuk “Pembangunan pengawal kelajuan digital fuzzy logic untuk aplikasi motor DC dengan menggunakan mikropemproses Rabbit,” dalam projek ini, satu pengawal padat yang dibangunkan adalah berteraskan mikropemproses Rabbit dan modul tersnya *RCM 3100*. Cara pengawal atur yang digunakan dalam projek ini adalah cara kawalaturan fuzzy logic. Satu algoritma fuzzy logic perlu dibangunkan dan dikompil ke dalam mikropemproses Rabbit agar dapat memberikan isyarat kawalan yang tepat kepada pemacu kelajuan motor DC. Daripada menggunkan bahasa himpunan, pengawal yang direkacipta ini menggunakan bahasa pengaturcaraan Dynamic C yang dikhaskan untuk mikropempemproses Rabbit.

Matlamat projek in adalah untuk merekacipta dan membangunkan satu prototaip yang berfungi dalam skala makmal. Prototaip ini diharapkan dapat mendemonstrasikan pengantaraan yang baik antara algoritma fuzzy logic yang dibangunkan dlam mikropemproses Rabbit, dengan pemacu kelajuan motor DC. Pengawal fuzzy asas mikropemproses Rabbit mampu menjanakan isyarat PWM. Isyarat PWM yang terjana akan dijadikan isyarat masukan untuk pemacu dan seterusnya pemacu kelajuan dapat mengawal kelajuan motor DC.

Mikropemproses Rabbit dipilih sebagai perkakasan yang utama adalah disebabkan cirri-ciri kelajuan pemprosesan isyarat yang ditampilkannya. Kelajuanini boleh mencapai tahap maksimanya 112500bps. Rekacipta pengaturcaraab yang mudah dan penggunaan kuasa yang rendah juga merupakan kelebihan mikropemproses ini. Selain itu, perkakasan yang diperlukan dalam projek ini ialah

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H-bridge. Topologi H-bridge digunakan atas keupayaannya yang membenarkan kawalan putaran motor DC dalam dua arah dan mudah untuk direkacipta.

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LIST OF CONTENTS

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LIST OF TABLES

© Universiti Teknikal Malaysia Melaka

LIST OF FIGURES

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LIST OF ABBREVIAITIONDS

AC	Alternating current
ADC	Analogue-to-digital converter
CPI	Common Programming Interface
DAC	Digital-to-analogue converter
DC	Direct current
DSP	Digital Signal Processor
EMF	Electromotive Force
EPROM	Electrical Programmable Read-Only Memory
FL	Fuzzy logic
FLC	Fuzzy logic controller
IDE	Integrated development environment
ISA	Industry standard architecture
LQFP	Low Quad Flat Profile
LSB	Least significant bit
MOSFET	Metal oxide silicon field effect transistor
OEM	Original equipment manufacturer
PC	Personal computer
PCI	Peripheral Component Interconnect
PICMG	PCI Industrial Manufacturer Group
PWM	Pulse width modulation
RFI	Radio frequency interference

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LIST OF APPENDIX

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CHAPTER 1

INTRODUCTION

This project is titled as “Development of a fuzzy logic speed controller for DC motor applications using Rabbit microprocessor”. The purpose of this project is to provide a modular of fuzzy logic control algorithm in the aspect of DC motor speed controlling by using Rabbit Core Module 3100 prototyping board. The project development consisted of two major parts; hardware implementation and software development.

In the hardware part, H-bridge DC motor driver will be designed and developed. The designed H-bridge DC power converter will be used as the hardware interface between DC motor and the microprocessor-based fuzzy controller. While, a frequency-to-voltage converter (FVC) and analogue-to-digital converter (ADC) will be used to convert and provide the actual speed signal from speed rotary encoder, and to be used as fuzzy controller input.

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In the software part, the fuzzy logic control algorithm will be developed and implemented by using Dynamic C, a high level programming language developed by Rabbit Semiconductors especially for its microprocessor. In the means of high level programming language, the assembly language will not directly being applied in the development of fuzzy logic algorithm. The fuzzy logic algorithm programmed in C structure will be compiled into the memory system of Rabbit Microprocessor. As the result, the fuzzy controller developed is able to provide precise PWM signal in order to drive the DC driver. Lastly, the Rabbit microprocessor will be interfaced to the H-bridge DC power converter and DC motor to run in real time and debug.

1.1 Objectives

- To design and develop a digital fuzzy logic speed controller for DC motor applications using Rabbit microprocessor.
- To design and develop functional laboratory scale prototype fuzzy logic speed controller (FLC).

1.2 Scope of project

- To develop a DC motor speed controller by implementing fuzzy logic control method using Rabbit microprocessor.
- To interface between the fuzzy logic algorithm in Rabbit microprocessor and the H-bridge DC power converter.

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1.3 Problem statement

In present world, the conventional controller of DC motor speed mostly based on Digital Signal Processor (DSP), Programmable Logic Controller (PLC) or PC-based controller. Yet, these controllers might be costly and difficult to be re-programmed. Hereby, there is necessity to develop a cost effective and programmable speed controller. In the terms of cost effective, a controller with minimize number of components need to be developed by using 8-bits Rabbit microprocessor.

Besides, the fuzzy logic algorithm that applied in this project having its difficulties to be realized in digital microprocessor. This is because the central of a fuzzy logic controller (FLC) is linguistic variables. A linguistic variable is a non-precise variable. For that reason as well, the fuzzy logic controller in present days mostly are PC-based. Thus, there is a challenge to find out a way for describing a linguistic variable in a crisp term that the Rabbit microprocessor can deal with.

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1.4 Project Gantt Chart

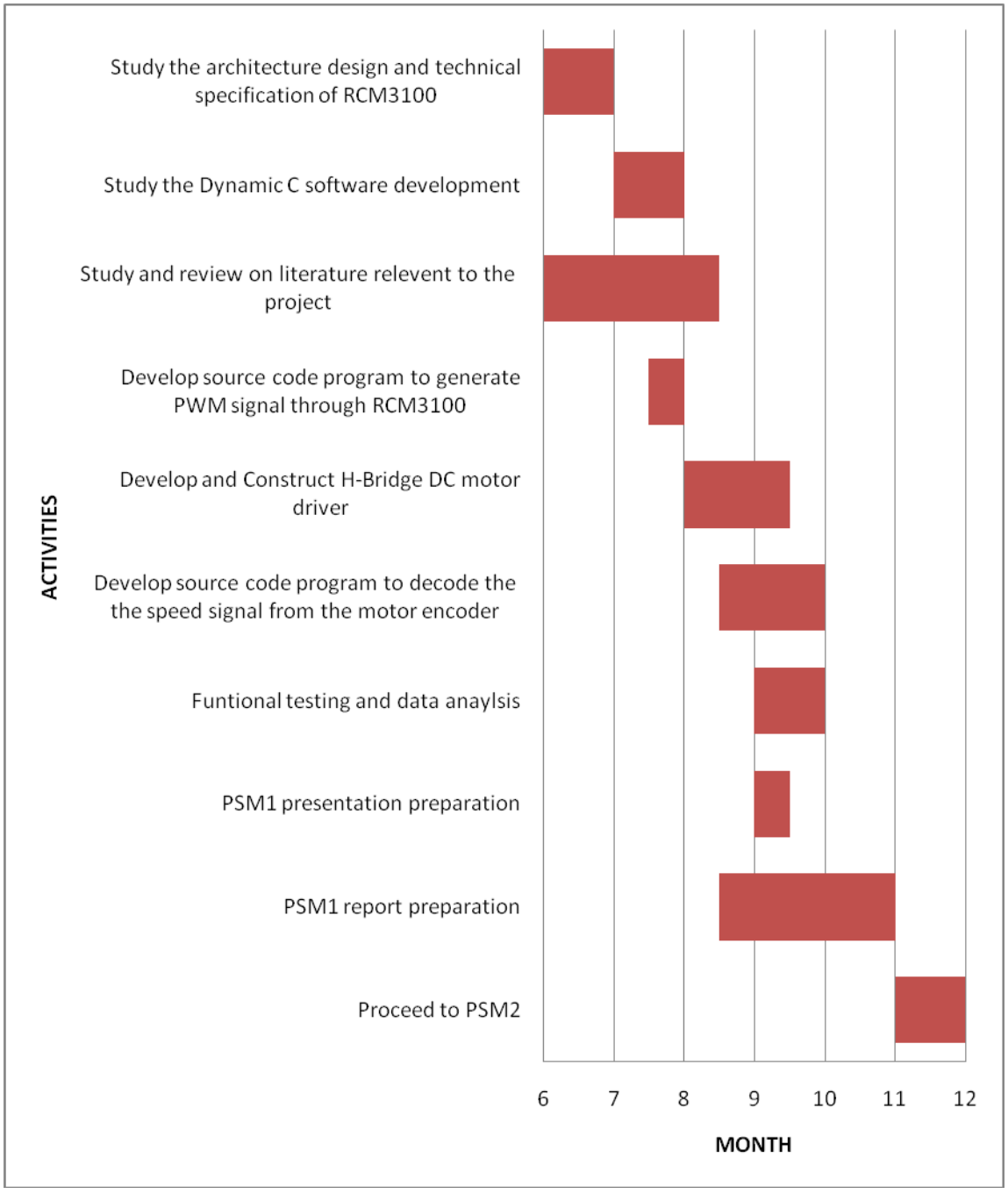

Figure 1.1: Gant chart for PSM I.

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