DESIGN AND DEVELOP AN EMBEDDED CONTROLLER FOR MULTI-PURPOSE APPLICATIONS

YEE YIT TONG

MAY 2008

"I hereby declared that I have read through this report and found that it has comply the partial fulfilment for awarding the degree of Bachelor of Electrical Engineering (Power Electronic and Drives)

Signature : .....

Name : ..... PROF. MADYA DR. ZULKIFLIE BIN IBRAHIM

Date : 5/5/2008 .....

DEPUTY DEAN
(RESEARCH & POST GRADUATE)
Faculty of Electrical Engineering
Universiti Teknikal Malaysia Melaka

"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 : .....

Name : YEE YIT TONG

Date : 5/5/08

To beloved father and mother

ACKNOWLEDGEMENT

In submitting this report, I would like to convey my sincere and appreciation to Professor Dr. Zulkifilie bin Ibrahim,who is my supervisor of Projek Sarjana Muda (PSM). Along the process of the PSM, professor gives me advices and guidance. Whenever I face problem for my project, he will guide me to solve the problem. Besides, I also would like to thanks my coursemates who shared the ideas, advices and comments in order to help me to accomplish my project so that the project flow according to the planning. The courcemates that I would like to thank are Ngo Chee Guan, Hew Wai Onn, Ng Poo Heng, Leong Chee Meng and Lim Seng Keat. Last but not least, I would like to thanks my panels that are for providing their comments during Seminar PSM 2 to improve my final project.

ABSTRACT

The project title is "Design and Develops an Embedded Controller for Multi-purpose Applications". The type of this project is the combination on both hardware and software. The hardware parts are involved Rabbit Core Module, RCM 2000 and the software part is based on rabbit microprocessor by using Dynamic C programming language to develop the algorithm. The Rabbit2000 is chose because of its high performance 8-bits microprocessor that designed expressly to power embedded system.

The objective of the project is to design and develop a generic controller to drive the external devices such as pneumatic valve, pneumatic cylinder, AC/DC motor and others applications using Rabbit RCM 2000. Besides, the embedded controller can interface with the RCM 2000. Then, the parameter of the external devices also can be keyed in using HID (Human Interface Devices) and display the output through the LCD screen.

The major hardware implementation in this project is Rabbit microprocessor. Rabbit microprocessor is chosen due to its specification features of high speed, suitable for designing embedded controller and low power consumption. Besides, HID (Human Interface Device) also needed to add on in this embedded controller so that the parameters of the external devices can be keyed in and display through the LCD screen.

ABSTRAK

Projek ini bertajuk "Merekacipta dan membangunkan pengawal padat dan kompleks untuk pelbagai aplikasi." Jenis projek ini adalah terdiri daripada kombinasi antara perkakasan dan perisian. Bahagian perkakasan melibatkan penggunaan Rabbit Core Module, RCM 2000, manakala bahagian perisian adalah berdasarkan mikropemproses Rabbit dan penggunnaan bahasa pengaturcaraaan Dynamic C untuk membangunkan algoritma yang diperlukan. RCM 2000 dipilih atas kerana prestasi mikropemproses 8-bit yang unggul dan direka khas untuk sistem pengawal padat yang berkuasa tinggi.

Objektif projek ini aadalah untuk merekacipta dan membangunkan satu pengawal untuk memacukan perkakasan luaran, silinder pneumatic, motor AC/DC dan aplikasi lain-lain dengan menggunkan RCM 2000. selian itu, pengawal yang direkacipta mestilah berupaya menngantaramuka dengan RCM 2000. Pada masa yang sama, parameter perkakasan luaran dapat dimasukkan ke dalam pengawal melalui Perkakasan Pengantaramukaan Manusia (PPM) dan juga dapat dipaparkan melalui skrin LCD.

Implementasi yang utama dalam projek ini adalah mikropemproses Rabbit. Mikropemproses Rabbit dipilih disebabkkan cirri-cirinya yang berkelajuan tinggi, kesesuain untuk perekaciptaan pengawal padat dan penggunaan kuasa yang rendah. Selain itu, Perkakasan Pengantaramukaan Manusia amat diperlukan untuk ditambah dalam struktur pengawal padat yang akan dibangunkan supaya parameter perkakasan luaran dapat dimasukkan ke dalam mikropemproses untuk proses-proses tertentu dan juga dipaparkan melalui skrin LCD.

LIST OF CONTENTS

CHAPTER 3 PROJECT METHODOLOGY

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

AC	Alternating current
ADC	Analog to digital converter
AMD	Advanced Micro Devices
AVR	Audio Video Receiver
CPU	Central Processing Unit
DAC	Digital to analog converter
DC	Direct Current
DOS	Disk operating system
EPROM	Erasable Programmable Read Only Memory
GPIO	General purpose input/output
HID	Human Interface Device
LED	Light emitting diode
LCD	Liquid crystal display
PC	Personal Computer
PLC	Programmable Logic Control
RAM	Random Access Memory
RCM	Rabbit Core Module
SRAM	Static Random Access Memory
USB	Universal serial bus

LIST OF APPENDICES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

Nowadays, the development of the electric and electronic (E&E) field is more and more compatible. The electronic components are getting smaller and smaller. To reduce the size and weight of the integrated circuit, a new embedded system is introduced by Charles Stark Draper. [1]

An embedded system is a special-purpose computer system designed to perform one or a few dedicated functions. Some also have real-time performance constraints that must be met, for reason such as safety and usability; others may have low or no performance requirements, allowing the system hardware to be simplified to reduce costs. Normally, an embedded system contains an embedded controller. An embedded controller may only be a discrete subsystem in a larger electronic control project.

The multi-purpose generic controller in PSM project is the combination of different type of controllers. This controllers can be use to drive the pneumatic cylinder valve, AC/DC motor and others applications. So, we can control different type of applications by using the generic controller. System integration can be reduce development time, and in small volume production, it can save money.

1.1 Objective of the project

There are a few main objectives in this project, which are:

- To design and develop a generic controller for multi-purpose applications using Rabbit RCM 2000.
- To control various type of external devices such as multi-channel pneumatic valve, AC/DC motor using the generic controller.
- To key in the parameter by using the user interface input device such as keypad, push button and output through LCD.

1.2 Scope of the project

- Develop an algorithm to drive the multi-channel pneumatic cylinder valve, and AC/DC motor.
- Write a program to interface the RCM 2000 with the applications using Dynamic C.
- Develop the generic controller for multipurpose applications.
- Add on I/O device such as keypad, push button and LCD.

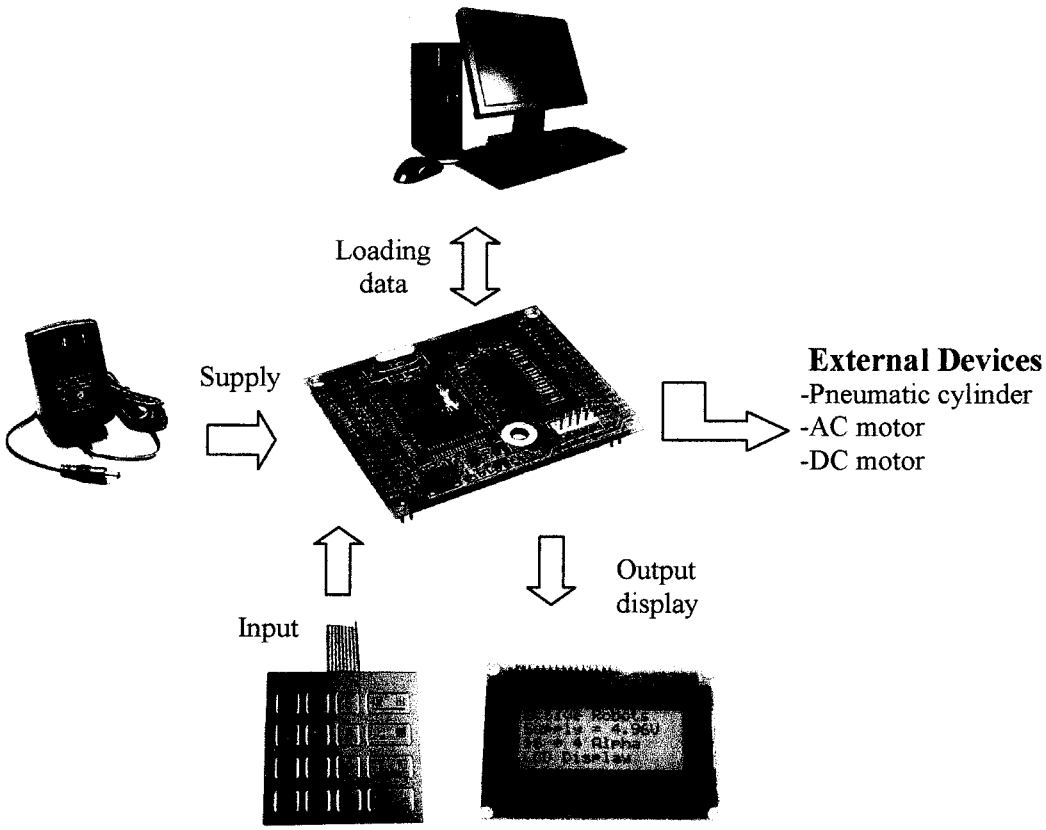

Figure 1.1: The overall idea to realize the multi-purpose application embedded controller.

1.3 Problem Statement

- Presently, the general controller that exists is mostly big size, expensive, and hard to do integration.
- So, it is needed to develop a generic controller that compact in size, cost effectively and can be apply to different applications.

1.4 Project planning schedule (Grant Chart)

	2007						2008			
Project Activities	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**
Report PSM I & II	√	√	√	√	√	√	√	√	√	
Study the architecture design and technical specification of RCM 2000	√	√								
Study about the embedded controller in the market			√							
Study the Dynamic C programming language		√	√	√	√					
Study about the operation and application of relay and optocoupler			√							
Design and develop basic controller				√						
Presentation PSM I				√						
Design the multipurpose controller						√	√			
Troubleshoot, debug, and testing						√	√	√	√	√
Hardware and software integration								√	√	
Study on the human interface device keypad and LCD									√	
Develop the driver and controller									√	
Presentation PSM II										√

Table 1.1: Gantt chart of Project PSM 1 & PSM 2

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

The design and development of generic multi-purpose embedded controller can be divided into 2 major parts which are hardware and software parts. In the hardware part, relays and optocoupler and others components are use to develop the embedded controller which can be apply to different type of applications such as pneumatic cylinder valve, AC/DC motor, push button, buzzer, and others. For the software part, the Dynamic C will be used to interface between the controllers with the Rabbit Core Module (RCM2000).

2.1 Embedded system

In the earliest years of computers in the 1940s, computers were sometimes dedicated to a single task, but were too large to be considered "embedded". Over time however, the concept of programmable controllers developed from a mix of computer technology, solid state devices, and traditional electromechanical sequences. [2]

The first recognizably modern embedded system was the Apollo Guidance Computer, developed by Charles Stark Draper at the MIT Instrumentation Laboratory. At the project's inception, the Apollo guidance computer was considered the riskiest

item in the Apollo project. The use of the then new monolithic integrated circuits, to reduce the size and weight, increased this risk.

The first mass-produced embedded system was the Autonetics D-17 guidance computer for the Minuteman missile, released in 1961. It was built from transistor logic and had a hard disk for main memory. When the Minuteman II went into production in 1966, the D-17 was replaced with a new computer that was the first high-volume use of integrated circuits. This program alone reduced prices on quad nand gate ICs from $1000/each to $3/each, permitting their use in commercial products.

Since these early applications in the 1960s, embedded systems have come down in price. There has also been an enormous rise in processing power and functionality. For example the first microprocessor was the Intel 4004, which found its way into calculators and other small systems, but required external memory and support chips.

In 1978 National Engineering Manufacturers Association released the standard for a programmable microcontroller. The definition was an almost any computer-based controller. They included single board computers, numerical controllers, and sequential controllers in order to perform event-based instructions.

By the mid-1980s, many of the previously external system components had been integrated into the same chip as the processor, resulting in integrated circuits called microcontrollers, and widespread use of embedded systems became feasible. As the cost of a microcontroller fell below $1, it became feasible to replace expensive knob-based analog components such as potentiometers and variable capacitors with digital electronics controlled by a small microcontroller with up/down buttons or knobs. By the end of the 80s, embedded systems were the norm rather than the exception for almost all electronics devices, a trend which has continued since.