DESIGN AND DEVELOPMENT OF EMBEDDED CONTROLLER FOR CONTROL APPLICATION

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MAY 2008

"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)"

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This Report Is Submitted In Partial Fulfillment of Requirements for the Degree of Bachelor in Electrical Engineering (Control, Instrumentation and Automation)

Fakulti Kejuruteraan Electrik
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ABSTRACT

Embedded controller is a controller (or computer) that is embedded into some device for some specific function other than just provide general purpose computing. Since nowadays there are many controllers have been developed till an advanced state, but these controllers developed might be costly and difficult to be re-programmed, moreover the size of the controller is still can be modified and reduced in a more appropriate form. Hereby, there is necessity to develop a low-cost, programmable and high efficiency speed controller.In this project ,PICs is used as the microcontroller due to their low cost, wide availability, large user base, extensive collection of application notes, and serial programming (and re-programming with flash memory) capability. Other than that, this project will use MikroC as its program language. MikroC is a multi-usage development tool for PIC micros that uses C language as its program language. For the obstacle avoidance mobile robot, different type of sensors will be used for the measurement purpose and information transfer which will work together with the microcontroller to control the movement of the mobile robot so that the mobile robot can move automatically.

ABSTRAK

Pengawal benam merupakan sejenis pengawal (atau komputer) yang terbenam dalam sebuah sistem untuk melakukan sesuatu kerja yang kursus dan bukan hanya melakukan kerja komputer yang biasa sahaja. Dalam report ini, sebuah pengawal benam akan direkakan dan di kembangkan untuk aplikasi kawalan. Pada masa kini, terdapat banyak pengawal yang telah dikembangkan dengan maju, tetapi pengawal tersebut adalah berharga tinggi dan juga susah untuk diprogramkan, selain itu, saiz pengawal yang sedia ada boleh diubah dan dikecilkan kepada bentuk yang lebih sesuai digunakan. Oleh itu , adalah amat perlu untuk mereka dan mengembang sesuatu pengawal yang berharga rendah , boleh diprogramkan lagi dan juga menpunyai kecekapan yang tinggi dan laju. Dalam projek ini, PIC adalah digunakan sebagai pengawal mikro kerana ia berharga murah, senang didapat, diguna dengan ramai, dan juga boleh diprogramkan lagi. Selain itu projek ini akan menggunakan MikroC sebagai bahasa programnya. MicroC adalah sejenis alat program yang mengubahkan bahasa C sebagai bahasa program untuk PIC. Kepada robot yang boleh mengelakan halangan, pelbagai jenis sensor digunakan untuk tujuan mengukur dan menghantarkan informasi pada masa yang sama. Selain itu , sensor tersebut akan melakukan kerja bersama dengan pengawal mikro untuk mengawalkan pegerakan robot supaya robot tersebut akan bergerak sendiri.

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LIST OF ABBREVIATON

PIC	-	Programmable Integrated Circuit
AC	-	Alternative Current
PWM	-	Pulse-width modulation
DC	-	Direct Current
IR	-	Infrared
LED	-	Light Emitting Diode
Hz	-	Hertz
RAM	-	Random Access Memory
EEPROM	-	Electrically Erasable Programmable Read Only Memory
A/D	-	Analog to Digital
ICSP	-	In-Circuit Serial Programming
PCB	-	Printed circuit board

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CHAPTER 1

INTRODUCTION

1.0 Introduction

This project is titled as "**Design and development of embedded controller for control application**". The main purpose of this project is to design and develop an embedded controller for the control application. Since nowadays there are many controllers have been developed till an advanced state, but these controllers developed might be costly and difficult to be re-programmed, moreover the size of the controller is still can be modified and reduced in a more appropriate form. Hereby, there is necessity to develop a low-cost, programmable and high efficiency speed controller.

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For the obstacle avoidance mobile robot, different type of sensors will be used for the measurement purpose and information transfer which will work together with the microcontroller to control the movement of the mobile robot so that the mobile robot can move automatically.

1.1 Problem Statement

In present work , there r a lot of different control circuit is available in the market but its design just for some main purpose and the existing size of the controller is quite big , so the size of the existing control circuit can still be modified and reduce in size. Besides, the controller is design for some particular purpose only, which means that if we need to apply the device on others application, we will find difficulties. Yet, these controllers developed might be costly and difficult to be re-programmed.

For the mobile robot nowadays is not intelligent enough. The mobile robot which available mostly cannot detect the distance between them with the object and some of it cannot avoid obstacle as well, moreover there is necessary for the robot which can reverse so that it can move more flexibility and intelligent.

1.2 Objective

The objectives of this project are to:

i. Design and development of an embedded controller for control application.

1.3 Scope of work

The scope of work in this project is stated as given:

i. Select a suitable PIC microcontroller according to its functionality by determining the amount of I/O ports needed.
ii. The controller circuit is designed as small as possible.
iii. The controller circuit is designed intergraded with its programmer (burner).
iv. The controller circuit is designed multifunctional.

1.4 Methodology

The project methodology is an important chapter as the methodologies; design flow and construction of the project are discussed. Brief description is given about each procedure in the completion of the project.

According to the methodology that is already planed, this project will start with the literature review base on the title which is "**Design and development of embedded controller for control application**". The whole project will be separated to two phases which is phase one for PSM 1 and phase two foe PSM 2.beside that it also will separated to four main parts. Part one and two will be done at phase one and part three and four will be done at phase two. For part one, the literature review and research on the title will be done at this section. After that, the second part of the project is to design a suitable controller for the control purpose. In this section, the most suitable microcontroller will be chosen and circuit design also will be done at this part. After acquiring the suitable component, the whole circuit will be constructing on the bread board for testing and modifying purpose. After testing and troubleshooting, the whole circuit will construct on the PCB board and the mobile robot construction and

programming will be done at section three. Finally, after testing and troubleshooting, the project will follow by part four which is report writing and presentation. For more information on the methodology of this project, it is easier to explain in the way using floe chart which all of the progress of the project is included. Here is the methodology flow chart:

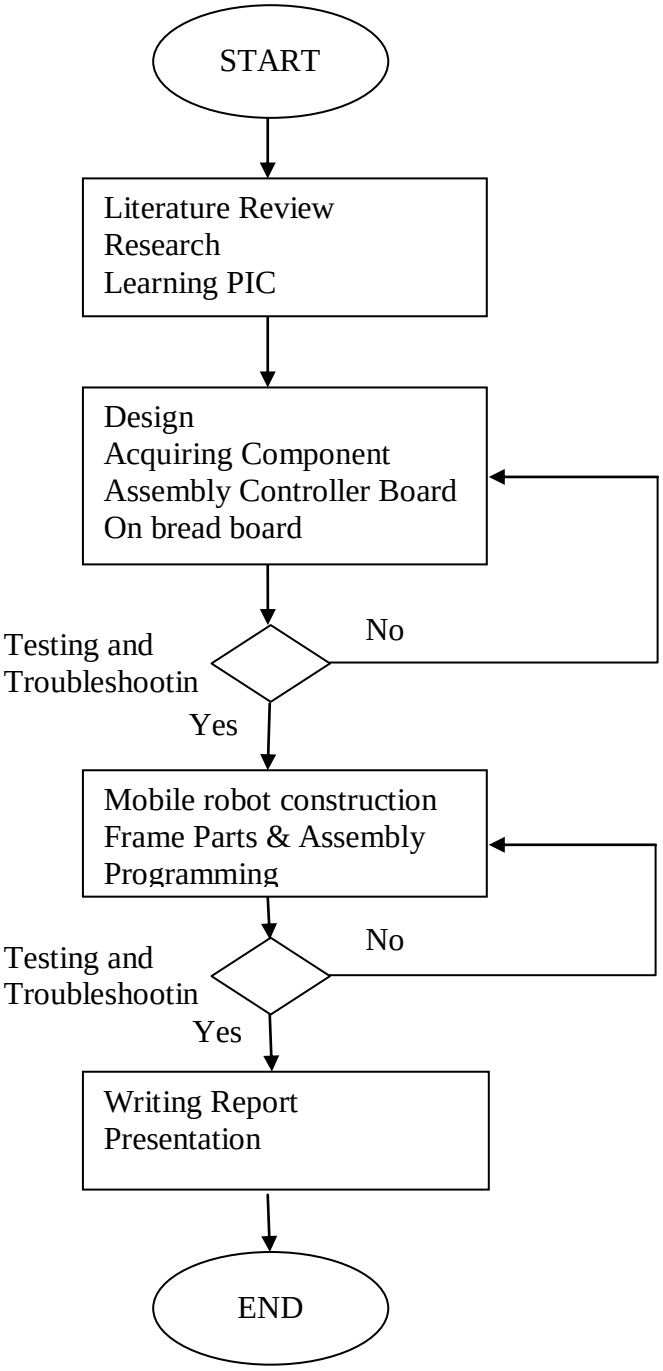

Figure 1.1: Flow Chart of Project

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

With various amount of embedded controller, microcontrollers, circuit design in the market, it is rather complicated to find the suitable components and not to mention the vast number of specification which varies according to their manufacturers. Hence, a literature review is performed in this chapter to make a review on the various types of embedded controller and microcontrollers that are available on the market. This is imperative step as a guide to choose the most suitable components which are going to be used for this project.

2.2 Embedded Controller

2.2.1 History of embedded system and embedded controller

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.

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.

2.2.2 Definition of Embedded Controller

An Embedded Controller is simply a device that performs embedded control. The embedded market is a part of the overall DAQ market. The main differentiating feature of an embedded controller is that all system operation is not controlled by external PC. In fact the CPU running the system is actually built into the I/O system itself. While a typical, slaved data acquisition system is hosted by some type of general purpose Personal Computer complete with mouse, monitor and other human interface devices (HID), an Embedded Controller's processor is usually dedicated to controlling the I/O system and often does not provide any direct human interface.

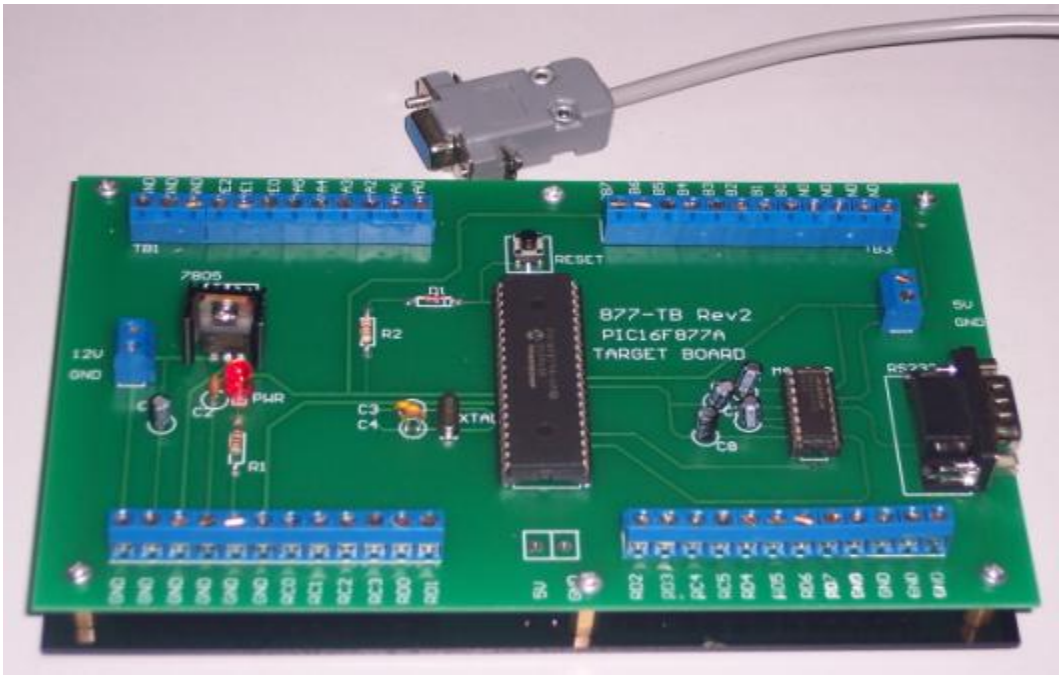

Figure 2.1: An embedded controller using PIC microcontroller

Differences between an embedded controller and a standard PC are easily observed. However, the differences in software are equally noticeable. While most PCs operating systems for your desktop and laptop computer are large (in terms of RAM and hard drive space needed), operating systems developed for embedded systems are likely to be smaller and have been developed without all of the built-in GUIs as well as much of office equipment peripheral support.

Linux and Windows CE and Linux are likely to be the operating system under the hood of an embedded controller. Also, it is much more likely that one of these systems is running a real-time operations system such as QNX, RTX or RTAI Linux as a substantial percentage of these applications have either timing critical or high throughput requirements.

It is not uncommon for an embedded controller to run independent of any supervisory or otherwise outside controller. However, there is usually some link to the outside world. This may be limited to providing a simple status such as "I have no error conditions to report at this time", or it may such a tight connection that it allows an external computer take complete control while the interface between the two computers is alive. Typically, if will be in the middle where an external computer tracks system status, provides some control of key factors (e.g. temperature set point or target RPM), and/or offers the interface between the system and a human controller in charge of overall system operation.

Embedded controllers are often the heart of an industrial control system or a process control application. They may also be at the center of a portable data acquisition system or remote controller that allows an application to keep running even if its umbilical link to the outside world is cut.

2.2.3 Modern Usage of Embedded System and Controller

Embedded systems span all aspects of modern life and examples of their use are numerous.

Telecommunications systems employ numerous embedded systems from telephone switches for the network to mobile phones at the end-user. Computer networking uses dedicated routers and network bridges to route data.

Consumer electronics include personal digital assistants (PDAs), mp3 players, mobile phones, videogame consoles, digital cameras, DVD players, GPS receivers, and printers. More and more household appliances like the microwave ovens and washing machines are including embedded systems to add advanced functionality. Advanced HVAC systems use networked thermostats to more accurately and efficiently control temperature that can change by time of day and season. Home automation uses wired- and wireless-networking that can be used to control lights, climate, security, audio/visual, etc., all of which use embedded devices for sensing and controlling.

Transportation systems from flight to automobiles are also increasingly using embedded systems. New airplanes contain advanced avionics such as inertial guidance systems and GPS receivers that also have considerable safety requirements. Various electric motors — brushless DC motors, induction motors and DC motors — are using electric/electronic motor controllers. Automobiles, electric vehicles. and hybrid vehicles are increasingly using embedded systems to maximize efficiency and reduce pollution. Other automotive safety systems such as anti-lock braking system (ABS), Electronic Stability Control (ESC/ESP), and automatic four-wheel drive.