MICROCONTROLLER TRAINING SYSTEM

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For my beloved family, especially for my mother and father

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ABSTRACT

A microcontroller is sometimes described as a "computer on a chip" because it contains all the features of a full computer including central processor, in-built clock circuitry, ROM, RAM, input and output ports with special features such as serial communication, analogue-to-digital conversion and, more recently, signal processing. The smallest microcontroller has only eight pins but some having 68 pins are also being marketed. A microcontroller training systems is one of the products that use microcontrollers. Microcontroller training system is an important product as means of education and developing skills in the electronic discipline. In constructing the microcontroller training system a microcontroller is chosen that is the ATmega128. It has many features that can contribute to the function of the other components. So in this project a Microcontroller Training System is developed with some functions included. The functions include motor driver, line sensor, liquid crystal display (LCD) and 7 segment display. Four important parts are considered in constructing the Microcontroller Training System which is designing, simulation, development and integration.

ABSTRAK

Mikropengawal boleh digambarkan sebagai satu "komputer di dalam chip" kerana ia mengandungi semua cirri-ciri sebuah komputer penuh termasuk pemproses pusat, linkungan jam terbina dalam, ROM, RAM, input dan pangkalan keluar dengan ciri istimewa seperti komunikasi bersiri, penukaran analog ke digital dan yang lebih baru ialah pemprosesan isyarat. Mikropengawal paling kecil hanya mempunyai lapan batang pin dan terdapat juga yang mempunyai 68 batang pin di pasaran. Sistem latihan mikropengawal adalah satu sistem yang penting dan digunakan dalam sistem pendidikan dan membangunkan kebolehan dalam disiplin elektronik. Dalam membina sistem latihan mikropengawal ATmega128 dipilih. Ia mempunyai banyak ciri yang boleh menyumbang untuk fungsi komponen-komponen lain. Jadi dalam projek ini *Microcontroller Training System* dibangunkan dengan beberapa fungsi tertentu. Fungsi-fungsi projek ini termasuk motor, *line sensor, liquid crystal display* (LCD) dan *7 segment display*. Empat bahagian penting yang perlu dipertimbangkan dalam membina *Microcontroller Training System* ialah mereka, membuat simulasi, pembangunan projek dan integrasi produk.

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PROJECT OVERVIEW

This chapter will explain briefly about the project background, objectives to be achieved, problem statement and scope of work.

1.1 Introduction

A microcontroller is a small computer on a single integrated circuit consisting of a relatively simple CPU combined with support functions such as a crystal oscillator, timers, serial and analog I/O etc. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, remote controls, office machines, appliances, power tools, and toys. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes.

In the electronic market there are many types of microcontroller that are offered out there. Each microcontroller has its own design, size, functions, features and etc. These microcontrollers have their own advantages among them but sometimes also have

their limitations. Therefore selecting the best microcontroller that fulfills the needs of the user as well as to operate the project that the user is doing is very crucial.

The microcontroller training system project is a combination of some support functions that compose of line sensor, motor driver, liquid crystal display (LCD), 7 segment display and others. The main circuit that controls each of the functions will also be constructed that is the Atmel microcontroller circuit. In constructing this trainer we will be able to see the function of each circuit. Development of software and hardware process is also involved.

1.2 Project Objectives

In order for the project to success and to be implemented, the following objectives need to be achieved:

a) Designing a microcontroller training system.
   To start the project a specific plan or drawing of the circuit needs to be done. In this first part the components and functions of the desired circuit board needs to be identified. Thus the schematic circuit must be drawn.

b) Simulation of the system using the appropriate software.
   After designing and obtaining the design (schematic circuit) of the microcontroller training system, simulation is used to test its functionality.

c) Development of the printed circuit board (PCB)
   The microcontroller is then constructed using software that can develop the schematic circuit to printed circuit board design.

d) Integration of the system with the ATMEL microcontroller.
   Lastly the product is integrated; the preferred microcontroller is then tested with the proper instructions. Thus integration between software and hardware is incorporated

1.3 Problem Statement

As technology expands, a lot of methods or products are used to make learning more interesting, understandable or exciting in different fields. In the electronic field there are many products that offer the users wide variety of functions and purposes. One important product in the education system is the microcontroller training kit or board which is widely used in institution of higher learning. There are many versions of microcontroller training system available in the electronic market. Problems associated with these are that microcontrollers have too many functions and are too complicated to be used.

Nevertheless, having a training system that integrate line sensor, dc motor, liquid crystal display (LCD) and 7 segment display in one model is much to be desired. The proposed microcontroller training system is simpler and it can be used by high school or university students. Many microcontrollers sold in the market have many features on the board which would be confusing to the high school students including institution of higher learning students; therefore the proposed project is expected to be able to overcome this problem.

The common brands of microcontrollers used worldwide are PIC, Motorola and Intel 8051. The potential of microcontroller training system that use the Atmel microcontroller to be explored and studied. By studying on a few main functions, the students can focus more and relate the study in accumulating their knowledge. Learning and exploring the parts could be done sequentially

In choosing the microcontroller the cost, speed, peripherals are considered in developing the microcontroller training system.

1.4 Scope of Work

The scope of this project is to develop a microcontroller training system. First of all information about microcontroller training systems will be gathered and reviewed. Information about their function, components and the microcontrollers that the training system use is further studied. After obtaining the schematic circuit of the training system it is then analyzed and reviewed.

Functions and the connection of the circuit are studied. The main components and its functions are highlighted:

a) The main part for all the parts or device to work is the microcontroller kit. The microcontroller circuit will operate the whole training system due to the input of power and also the input of the specific instructions to the microcontroller.

b) Power is important for the system to operate. The power circuit provides the power supply to the whole of the training system outside supply.

c) Line sensor and motor driver are in sync with each other. Line sensor is used to detect the lines and it will affect the motor driver which will move faster, slower, right or left.

d) Liquid Crystal Display (LCD) indicates the instruction or operation that the user will display. Certain messages based on the input instruction will be shown.

e) Seven (7) segment display, shows the numbers from 1 until 7. It will display the value whether it decreases or increases.

As the training system is developed and completed, simulation technique is employed to test the circuit. Construction of the circuit design is done using Proteus 7 Professional software. Using this software, the simulation can be carried out by running the instruction or source code to the finished design of the circuit. The software is also used to create the PCB layout.

At the end, the construction of the printed circuit board is done. The board will be connected with the electronic components and testing will be done.

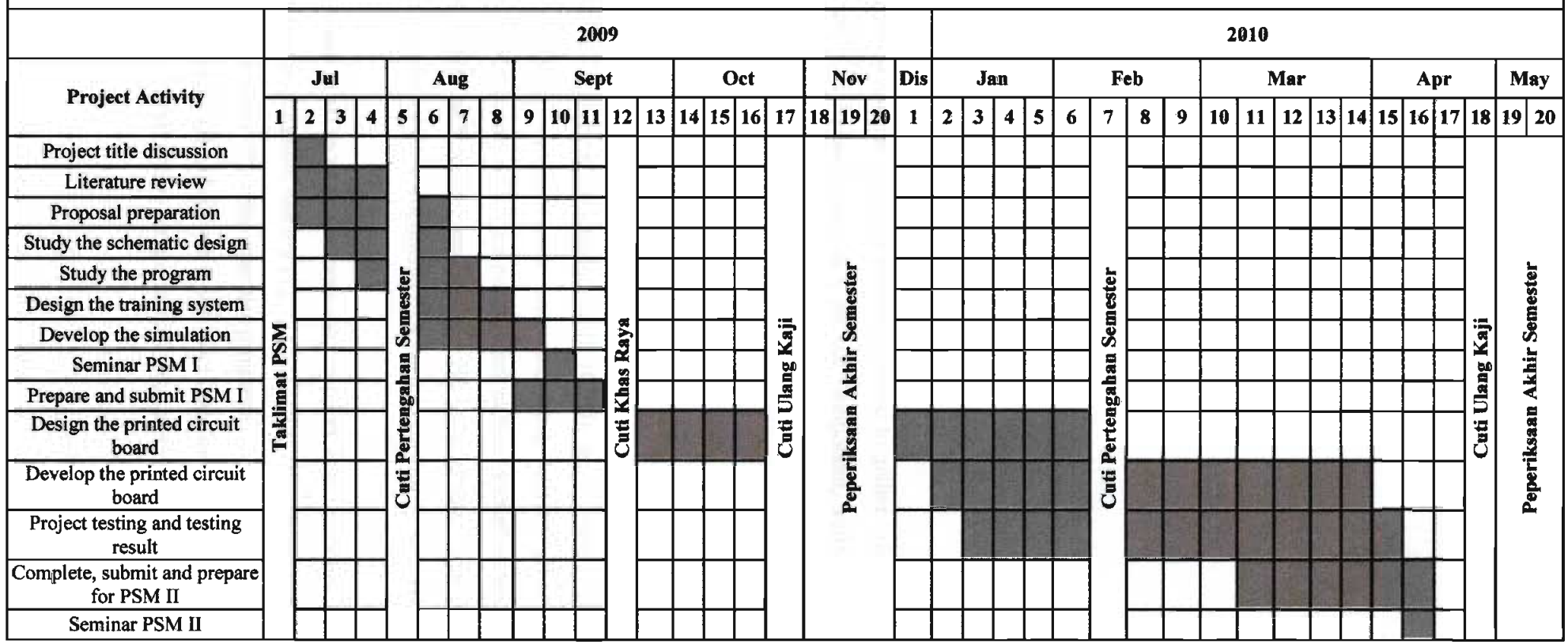
1.5 Thesis Outline

In this thesis there are six chapters that will cover the development of the microcontroller training kit project. The first chapter will cover the project overview. It consists of the project background, objectives to be achieved, problem statement and scope of work. Second chapter includes the literature review of the project. The contents focus on the component, software and application related to the project. Next is the third chapter that consists of the project methodology. This chapter covers the implementation of the project. Subsequently is the design and experiment chapter. The designing and testing of the product is conveyed. Then there is chapter five which will discuss the result and discussion. The outcome of the experiment is compared between obtained and expected result. Consequently it is discussed. Last chapter is the conclusion of the overall project. It will discuss of what has been achieved at the end of the project.

1.6 Project Planning

PROJECT PLANNING

List all the main activities for the proposed project.State the time limit needed for each activity.



CHAPTER II

LITERATURE REVIEW

This chapter describes about the literature review involved to gather information about the project. This study is focused especially on the component, software and application related to the project.

2.1 Overview

A microprocessor is a central processing unit (CPU) on a single chip. Microcomputer is defined as a microprocessor and associated support circuitry, peripheral I/O components and memory which are put together to form a small computer specifically for data acquisition and control applications [1]. A microcontroller is a device which integrates a number of the components of a microprocessor system onto a single microchip.

Microcontroller is a computer with most of the necessary support chips onboard. All computers have several things in common, namely [2]:

a) A central processing unit (CPU) that executes programs.
b) Random-access memory (RAM) where it can store data that is variable.
c) Read only memory (ROM) where programs to be executed can be stored.

d) Input and output (I/O) devices that enable communication to be established with the outside world i.e. connection to devices such as keyboard, mouse, monitors and other peripherals.

There are a number of other common characteristics that define microcontrollers. If a computer matches a majority of these characteristics, then it can be classified as a 'microcontroller'. Microcontrollers may be [2]:

a) 'Embedded' inside some other device (often a consumer product) so that they can control the features or actions of the product. Another name for a microcontroller is therefore an 'embedded controller'.

b) Dedicated to one task and run one specific program. The program is stored in ROM and generally does not change.

c) A low-power device. A battery-operated microcontroller might consume as little as 50 milliwatts.

Difference between microprocessor and a microcontroller is that the microcontroller has built in peripherals like timers USART and interrupt controller whilst microprocessor these have to be interfaced as separate integrated circuit (IC).

Atmel (Advanced Technology for Memory and Logic) Corporation designs, develops, and manufactures programmable logic devices, application-specific integrated circuits, and memory and microcontroller devices. During the 1980s, and 1990s the company built its reputation and its business on the design of nonvolatile memory chips, which do not lose their programmed instructions while system power is turned off (Source: http://www.answers.com/topic/atmel-corporation). Products such as home appliances, automobiles, portable telephones and microwaves integrated the nonvolatile memory chips.

Atmel focused its design work on a specific type of memory chip called Eeprom [3], short for electrically erasable programmable read only memory.

Now Atmel Corporation has a wide range of products in the market. Some of the products include security, military and aerospace automotive, communication, multimedia and even microcontrollers [4]

Atmel's AVR RISC family of controllers has the following features:

a) RISC architecture with mostly fixed-length instruction, load-store memory access, and 32 general-purpose registers.
b) A two-stage instruction pipeline that speeds up execution.
c) Majority of instructions take one clock cycle.
d) Up to 10-MHz clock operation.
e) Wide variety of on-chip peripherals, including I/O, ADC, EEPROM, Timer, UART, RTC timer, pulse width modulator (PWM), etc.
f) Internal program and data memory.
g) In-system programmable.
h) Available in 8-pin to 64-pin package size to suit wide variety of applications.
i) Up to 12 times performance speedup over conventional CISC controllers.
j) Wide operating voltage from 2.7V to 6.0V.
k) A simple architecture offers a small learning curve to the uninitiated.

Figure 2.1, shows detailed block diagram architecture of the AVR (microcontroller product of Atmel).

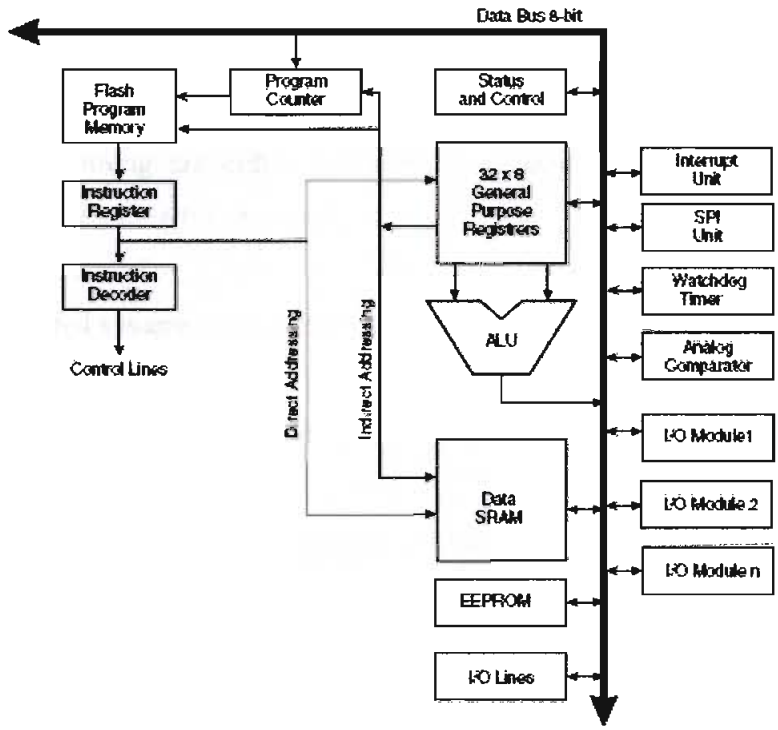


Figure 2.1: Block diagram of the AVR architecture

2.2 Embedded Systems

Embedded system is in almost every electronic device that are designed today. There is software hidden away inside our watches, microwaves, VCRs, cellular telephones, and pagers. The military uses embedded system to guide smart missiles and detect enemy aircraft; communications satellites and space probes. In healthcare, modern medicine would be nearly impossible without it. Of course, someone has to write all that software, and there are thousands of computer scientists, embedded engineers, and other professionals who actually do.

Microprocessors [5] and Microcontrollers are widely used in such embedded system products. Embedded systems are extremely important branch of modern digital technology. Each embedded system is unique and highly customized to the application