DESIGNING A MODULAR-APPROACH OF MULTI-MICROCONTROLLER BASED EDUCATIONAL TRAINING SYSTEM WITH IDE

R.S.K. Selvakumar*, K.H. Ghazali, N.M.K. Nik Yusoff

Faculty of Electrical & Electronics Engineering, Universiti Malaysia Pahang,
26300 UMP, Kuantan, Pahang, Malaysia; Phone: +6012-9631397
E-mail: inderjit_1791@yahoo.com, kamarul@ump.edu.my, nik@ump.edu.my

Corresponding Author: inderjit_1791@yahoo.com

ABSTRACT

The advancement of microcontroller technology demands the need of everyone have grasp of this technology. In fact this technology is a compulsory course in any electrical or electronic field of engineering. This paper aims to describe development of a flexible microcontroller training system based on 8-bit microcontroller in Microchip, Motorola and Intel family. According to the latest survey, more than half of the total student in Faculty of Electrical & Electronics Engineering are having problem in understanding program structure and developing hardware. For this reason, the multi-microcontroller based development project will be designed to be as a learning tool for those who intend to learn microcontroller. With an extensive a development board, it could let the user to get start with their microcontroller application efficiently. The system provides a simple testing bed that offers various current applications such as Liquid Crystal Display (LCD), DC Motor, Keypad, DIP switches, sensors, multi-purpose displays and others that can be used extensively in experiments or projects. In addition, it is further boosted by the introduction of Integrated Development Environment (IDE) features in order to create user-friendly environment. By using this system, users are exposed to practical experience of the microcontroller and provide an easy path to learn this intelligent electronic device in short time. Without wasting too much time in preparing prototype circuit is one of the advantages by using a development board. In this respect, this multi-microcontroller Training System would be applicable for education and expose the electrical engineering students to the understanding fundamental of microcontroller in electronic design field.

Keywords: microcontroller, educational, Intel® MCS51, Motorola® MC68HC11

INTRODUCTION

The need of microcontroller in today's technology is inevitable. In fact, in near the future, it is predicted that almost all electronics equipments will include microcontroller in their hardware design. The utilization of this device in the hardware design augments the design's capabilities while simplifying the design implementations. Undoubtedly, in the near future, the microcontroller will play pivotal role in design of any electronic products. (Seong, 2007). For this reason, the microcontroller has become a core subject in many electronic and electrical fields. However, the success of the educational process of teaching this course is greatly improved by the possibility of students having individual access to the prototyping system for experiment it. Hand-on laboratory or project-based design is the key element to student knowledge retention and ability to apply the knowledge in practical

endeavors. (Stoltz, 2005) Ironically, many students envisage difficulty in learning this subject because of its complicated programming and structure. (Ling, 2008) To make the matter worst, it is difficult to find any prototype systems that can meet the individual demand in the market. Therefore, a flexible and versatile prototype system will be developed. The system can be used extensively in experiment or project for diploma, undergraduate and short courses. The system will also be boosted with a simple application board that is suitable for the students to test their capabilities and to improve their knowledge in this course. In addition, a monitor program will be developed to integrate the basic software such as communication software, text editor, cross assembler and compiler. Needless to say, it will tremendously create user friendly environment. (Selvakumar, 2009)

This paper presents the design of microcontroller training system that is based on 8-bit microcontroller Intel® MCS51 and Motorola®MC68HC11. It begins with the discussion of the hardware design of the system. It proceeds then with software development of the system to be interfaced with the PC creating a user-friendly environment. It is followed by the result and discussion. The paper concludes with conclusion and future development.

HARDWARE DESIGN

Figure 1 shows the hardware consists of two major modules; system module and application module. The system module provides the microcontroller, storage units, interrupt facilities, a RS232 interfacing circuit and interfacing units that can be easily interfaced with various I/O devices. The system will be developed based on modular design where user can configure the system to be interfaced with its own test bed or with any application modules or any industrial system or even with user's own design. In addition, it permits the system board to be expanded for future development. (Selvakumar, 2008). Likewise, the application is designed based on the most current devices. They are output devices that will be inserted such as bar graph, 3-digit 7-segment displays, multipurpose display, Liquid Crystal Display (LCD), Light Emitter Diode (LED), buzzer, stepper motor and direct current (DC) Motor. In contrast, the input devices consist of 8-ways Dual-In-Line Package (DIP) switches, keypad. Some sensors such as light and temperature sensors are provided in the design to test the internal timer and ADC functionality.

The application board is one of the key features of the Educational Development board. There will be several application modules incorporated on to the application board. The modular approach used in developing the application modules provides flexibility for instructor to use the development system either as laboratory training tool or as platform for students' design project. (Nik Yusoff, 2009) Due to the limited number of I/O ports, address decoder is used with latches and buffers to select some of the application devices. Likewise, the application is designed based on the most current devices. They are output devices that will be inserted such as bar graph, 3-digit 7-segment displays, multi-purpose display, Liquid Crystal Display (LCD), Light Emitter Diode (LED), buzzer, stepper motor and direct current (DC) Motor. In contrast, the input devices consist of 8-ways Dual-In-Line Package (DIP) switches, keypad. Some sensors such as light and temperature sensors are provided in the design to test the internal timer and ADC functionality. (Eren, 2004)
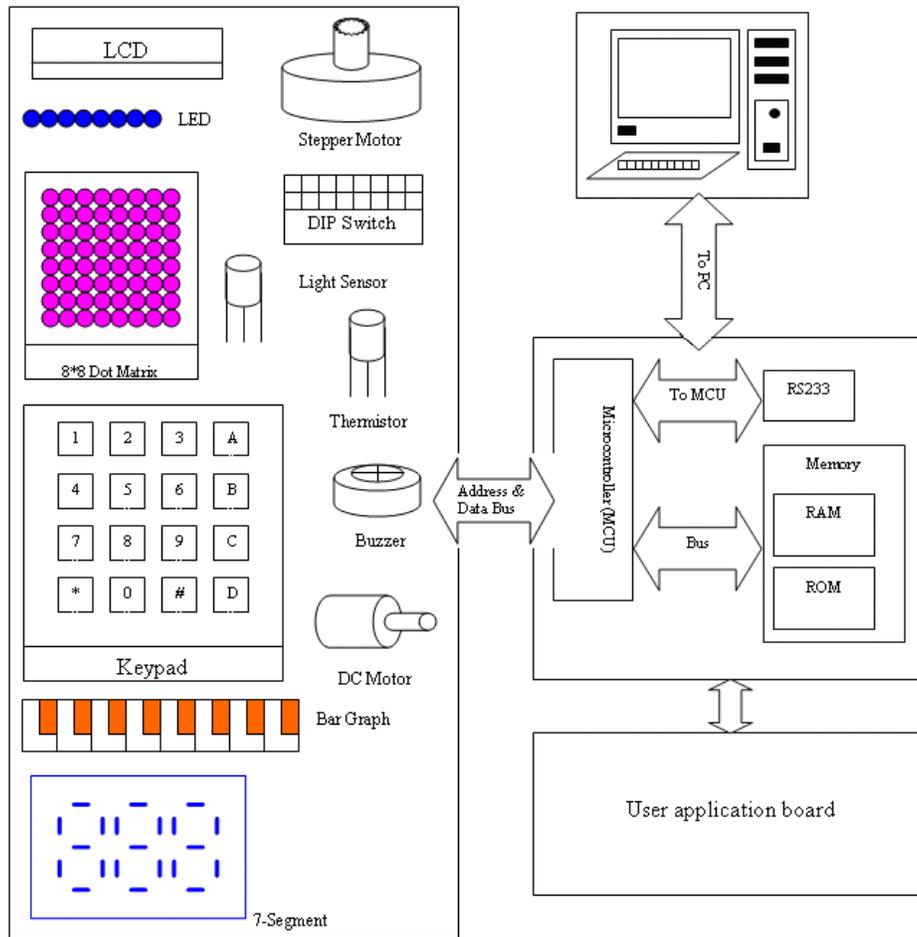
Figure 1: Block diagram of Educational Training System

The draf memory map for the microcontroller Motorola®MC68HC11 and Intel® MCS51 are simplified in Table 1 and Table 2. In general, microcontroller provides a total 256 bytes internal RAM. This internal RAM can be used to store temporary data or even a program. There are a few locations reserved for special purpose. One of them is used to store vector address for interrupt routine. Another one is reserved for internal register. RAM which is used as external temporary memory to store the user's application. Likewise, ROM which is used as external memory to store the monitor. (Eren, 2005)

Table 1: Memory Map for Motorola®MC68HC11

Memory Range		Component
$00 - $FF		Microcontroller Internal RAM
Application Board Component $8000 - $9FFF	$8000	Bar Graph
	$8002	Dot Matrix for Row
	$8004	Dot Matrix for Column
	$8006	7-segment Displays
	$8008	LCD for Display Setting
	$8009	LCD for Display
	$800E	8-ways DIP Switches
$C000 - $DFFF		System Board RAM
$E000 - $FFFF		System Board ROM

Table 2: Memory Map for Intel® MCS51

Memory Range	Devices Mapping Allocation
0000 H – 1FFF H	External ROM (Monitor Program)
2000 H – 21FF H	Yellow LED – Active High
2200 H – 23FF H	Bar Graph
2400 H – 25FF H	7 Segment Display
2600 H – 27FF H	*
2800 H – 29FF H	Traffic Light
2A00 H – 2BFF H	*
2C00 H – 2DFF H	*
2E00 H	LCD for Command
2E01 H	LCD for Character
2E02H – 3FFF H	*
4000 H – 41FF H	DIP Switch
4200 H – 43FF H	Keypad
4400 H – 45FF H	Dot Matrix for Row
4600 H – 47FF H	Dot Matrix for Green Column
4800 H – 49FF H	Dot Matrix for Red Column
4A00H – 4BFF H	*
4C00 H – 4DFF H	*
4E00 H – 4FFF H	*
5000 H – 7FFF H	*
8000 H – 9FFF H	External RAM (For System Use)
A000 H – BFFF H	*
C000 H – DFFF H	*
E000 H – FFFF H	*
Selector on Port 1	Red LED – Active Low
Selector on Port 1	DC Motor
Selector on Port 1	Stepper Motor

SOFTWARE DEVELOPMENT

The software development of the system will be divided into two categories; the monitor program and the IDE parts. The monitor program will be developed by using the assembly language to allow communication between the PC and the system module. From the PC, the user can communicate with the system board to issue commands to upload or download, execute and read or write to memory location. The concept diagram for the monitor program is shown in the Figure 2. This concept diagram is the main structure of the monitor program. It consists of several subroutines which each performs different tasks. The basic function of the monitor software is to read the input based on user's selection. Based on the selection, it will determine which procedure will be executed. In this section, several subroutines are developed, such as read keyboard, read string, display character, display string and many more. (Pardo, 2009)
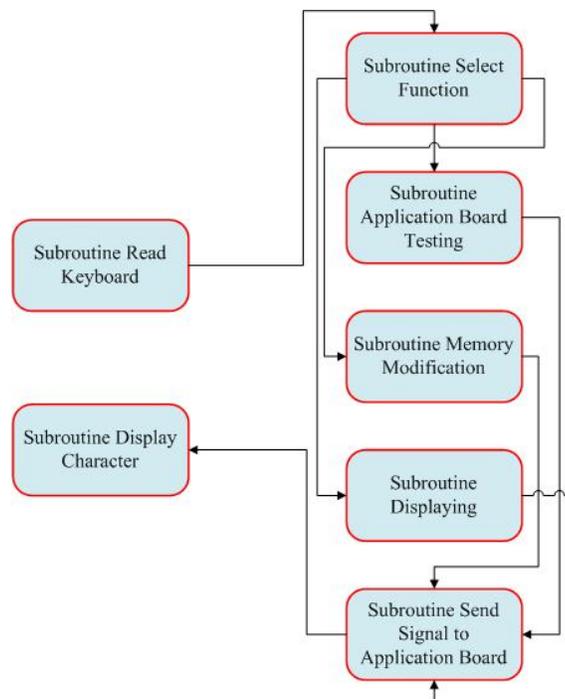

Figure 2: Concept Diagram of Monitor Software

The IDE, on the other hand, integrates various basic software such as cross assembler, communication software and text editor to create user-friendly environment. This new software tool is developed to allow the user to perform all development activities without needing to exit any programs. (Pardo, 2009) This environment tool is developed by using an object-oriented programming Microsoft Visual Studio. The software will offers standard windows button such as command buttons, check boxes, option buttons, text boxes, and etc and produces a user friendly environment system. Figure 3 is simple procedure to develop an IDE tools.
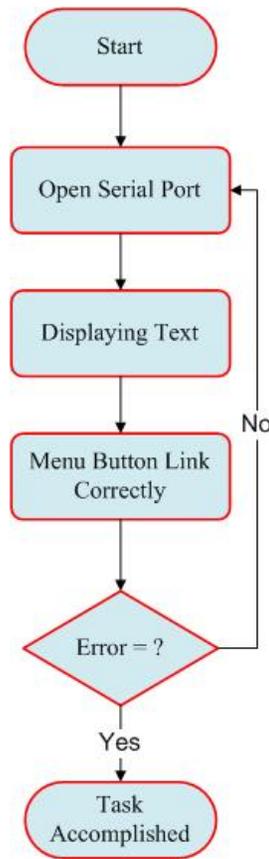
Figure 3: Window Environment

DISCUSSION

Various tests will be conducted in this project. The results of the testing will reveal the system have achieved of substantial goals. Since the system consists of development board and application module, each part is tested independently. This is shown in Figure 4. A thorough free run test on the system will be performed to ensure system reliability. Likewise, a monitor program will be developed, assembled, and downloaded into the EEPROM. Several tests of mini operating system will be tested several times and prove that the system is reliable and sufficiently stable. It will show that the monitor program is able to communicate with the computer and capable of performing several commands issued from the host. There are two types of display mechanism will be provided in the project. They are text-oriented example (Figure 5) and graphical-oriented example (Figure 6). (Selvakumar, 2008) The graphical-oriented will be developed by using Microsoft Visual Studio to provide a standard windows object and graphic user interface that will make the program become user friendly.
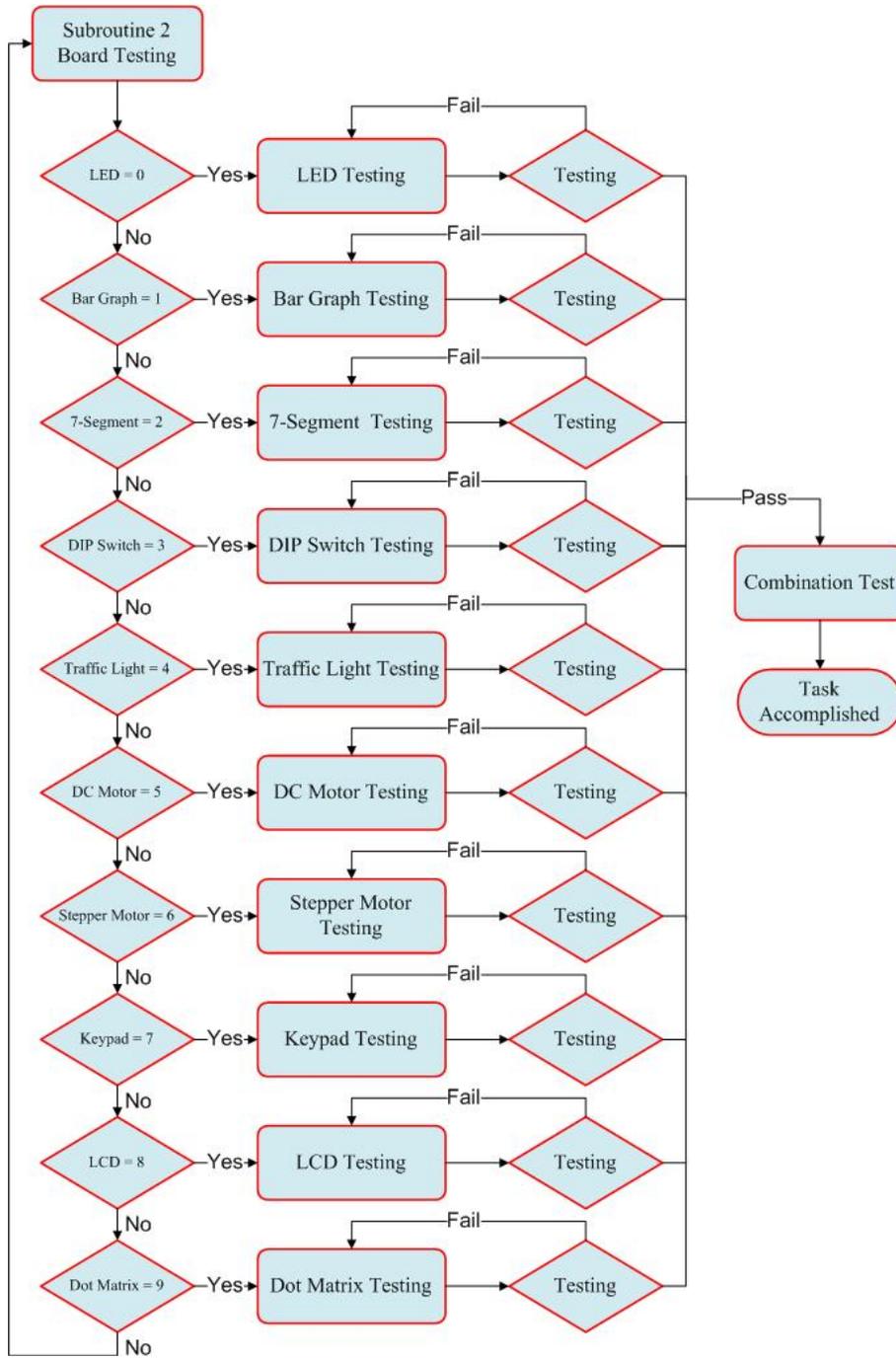
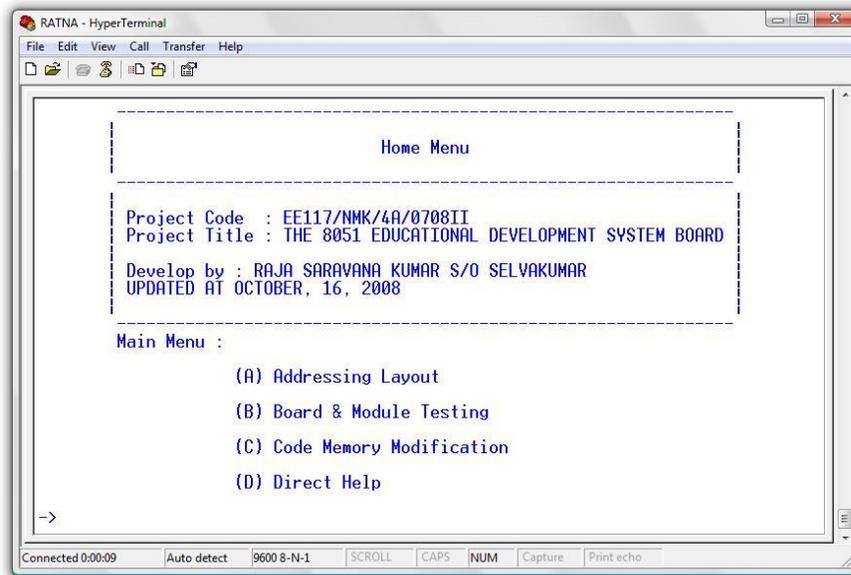Figure 4: Application Module Testing Flow

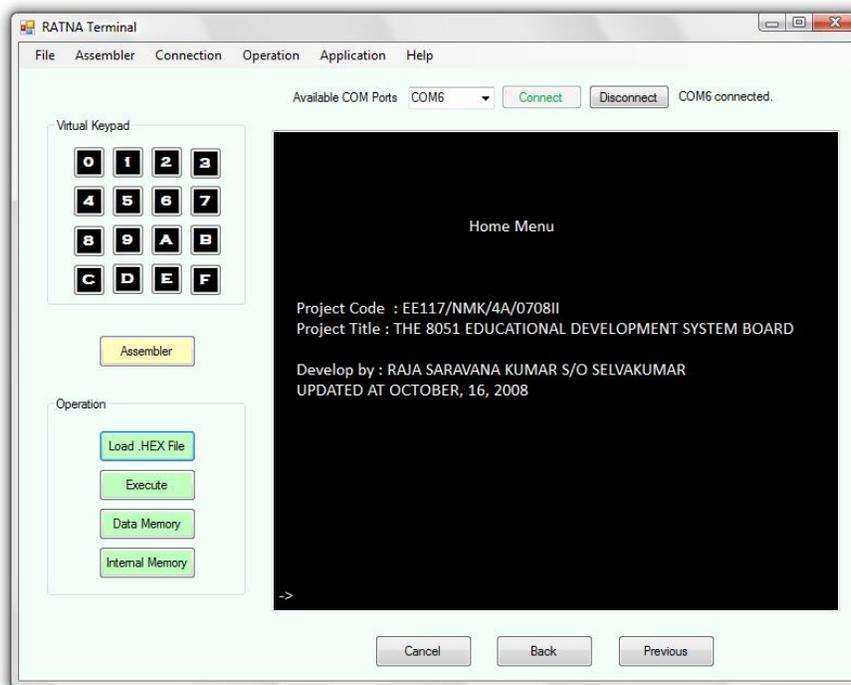Figure 5: Text-Oriented Display Mechanisms

Figure 6: Graphical-Oriented Display Mechanisms

CONCLUSION

A prototype of training system will be designed and developed as teaching and learning tools and the system can be used extensively in experiment or project for diploma, undergraduate and short courses. The system will provide a simple application board that is

suitable for the students to test their capabilities and to improve their knowledge in this course. A mini operating system based on IDE concept will be developed to integrate the basic software such as communication software, text editor, cross assembler and compiler. Although most of the goals discuss will be achieved, but there are still some enhancement should be introduced to improve its quality. This includes the need to upgrade the operating system so that it will provide more user friendly environment. In this case, an establishment of complete IDE environment must be implemented.

REFERENCES

Eren, H. 2004. *Electronic Portable Instruments: Design and Applications.* CRC Press United.

Eren, H. 2005. *Electronic Portable Instruments handbook*. Ed. New York: McGraw Hill.

Ling, L.C. 2008. *The MC68HC11 Development Board with IDE.* Master's Thesis, Universiti Malaysia Pahang, Malaysia.

Nik Yusoff, N.M.K., Muhammad, B. and Mohd Omar, M.S. 2009. Embedded-Based Multi Purpose Electronics Notice Board with Wireless Technology Approach. *International Conference on Advances in Recent Technologies in Communication & Computing 2009 (ARTCom2009)*, 125 – 131.

Pardo, F., Boluda, J.A. and de Ves, E. 2009. *Development Board for the Microcontroller Lab. Tapec*. http://tapec.uv.es/papers_en.html, accessed on 25.08.2009.

Selvakumar, R.S.K. 2008. *The 8051 Educational Development System with Integrated Development Environment*. Master's Thesis, Universiti Malaysia Pahang, Malaysia.

Selvakumar, R.S.K.; Nik Yusoff, N.M.K. and Alla, A.N. 2009. A New Development of Multi-Application of Microcontroller through Educational Training Systems. *Malaysia Technical Universities Conference on Engineering and Technology*, 151 – 155.

Seong, K.C. 2007. *The MC68HC11 Development Board*. Thesis UMP.

Stoltz, T.; Paulik, M.; and Al-Holou, N. 2005. A Microcontroller Laboratory hardware Platform for the Academic Environment. *The UDM-EVB', 35th ASEE/IEEE Frontiers in Education Conference*, 35: 192 – 199.