A NEW DEVELOPMENT OF MODULAR-APPROACH MULTI-MICROCONTROLLER BASED EDUCATIONAL TRAINING SYSTEM

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ABSTRACT

In traditional Embedded Control Technology courses, students learn to develop assembly language programs to control peripherals, handle interrupts, and perform I/O operations is often difficult because students find the subject rather abstract when presented in a lecture format. In fact this Embedded Controller Technology (ECT) course is a compulsory course in any electrical or electronic field of engineering. This paper aims to describe development of a flexible multi-microcontroller training system based on 8-bit microcontroller in Microchip, Motorola and Intel family. 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. 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*:**, Educational, MCS51 microcontroller, HC11 microcontroller, PIC microcontroller

1. INTRODUCTION

Embedded technology is designed for dedicated applications running in control systems. The unique feature of such systems is the capability to perform timely and predictable operations in response to concurrent requests arriving from the external environment. To design an effective embedded system, one must properly employ the appropriate system architecture, hardware/software interfaces, peripheral devices, and software components. Currently, embedded systems companies are facing with a shortage of engineers having the appropriate skills to respond to market opportunities [1].Therefore, embedded control and technology course has emerged as a key element for curriculums in Computer Science, Computer Engineering, and Electrical Engineering at universities throughout the world.

For this reason, the ECT course has become a core subject in many electronic and electrical fields [2]. 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 [3]. Hands-on laboratory or project-based design is the key element to student knowledge retention and ability to apply the knowledge in practical endeavours. Ironically, many students envisage difficulty in learning this subject because of its complicated programming and structure [4]. 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. This educational training 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 [5].

In this paper, we will explore the challenges and successes that we will encountered in implementing this multi-microcontroller educational training system in ECT class. This paper presents the design of microcontroller training system that is based on 8-bit microcontroller Intel® MCS51, Microchip® PIC 16F877 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 discussion. The paper concludes with conclusion and future development.

2. HARDWARE IMPLEMENTATION

This multi-microcontroller educational development system board hardware component consists of a system board and an application board. System board includes with these three microcontrollers, external RAM and ROM for expandability, and three RS232 interfacing circuit. The application board, on the other hand, consists of LEDs, Bar Graph, 7-Segment Displays, 8x8 Tri-Color Dot Matrix, Liquid Crystal Display (LCD), Stepper Motor, Direct Current (DC) Motor, Wireless Devices and Traffic Light system, while the input devices are an 8-ways Dual-In-Line Package (DIP) switches, and a 4x4 Keypad [6].

System Board

The system board uses the generic three typical microcontrollers, MCS51, HC11, and PIC 16FX as the heart of the system. Additional 64k each of code and data memory space is made available via external ROM and RAM devices connected to data bus of the microcontroller using de-multiplexing latches. Availability of de-multiplexing latches also allow for further I/O ports expansion. In addition to ports expandability, the system board also include a serial communication interface (SCI) that allows the microcontroller to communicate with or to transmit/receive data between other devices. DS275 from Dallas Semiconductor provides the necessary drive for serial RS232 transmission, which will be used with BlueSnap devices. Simplified block diagram of system board in shown in Figure 1.

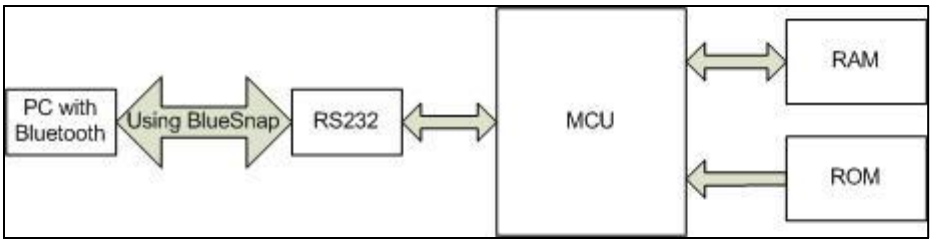

Figure 1: Block diagram of system board

Figure 2 shows the system board with three microcontrollers with serial RS232 transmission.

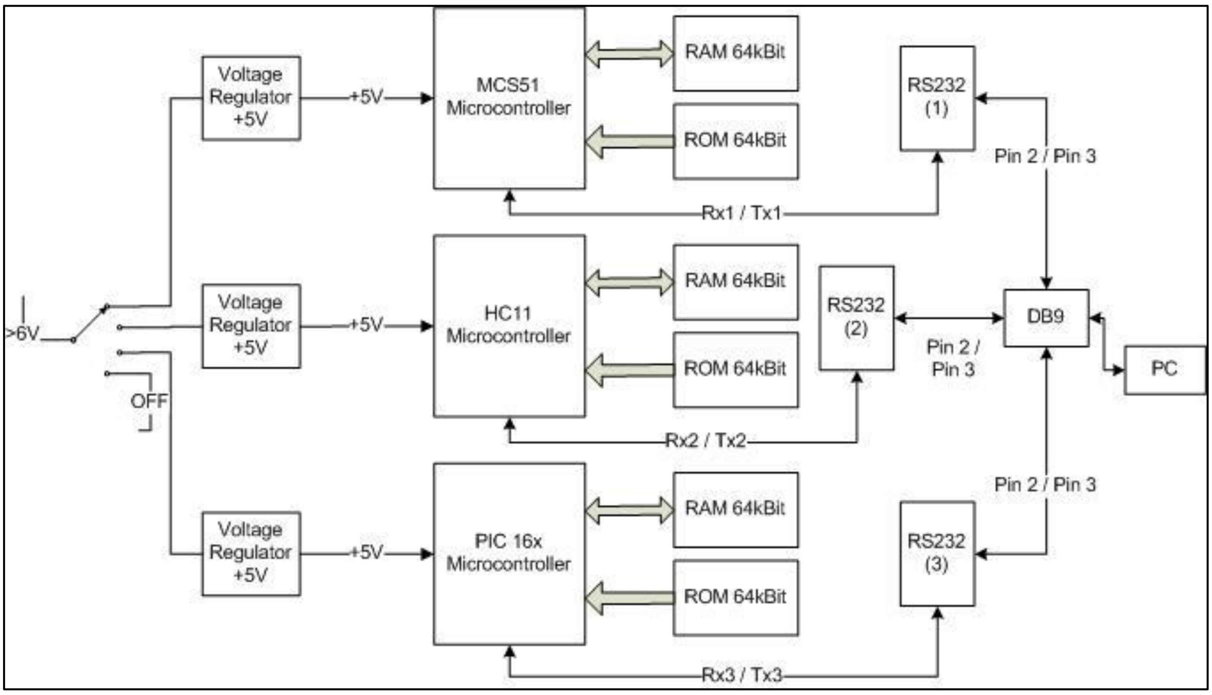

Figure 2: Block diagram of the multi-microcontroller

Figure 3 shows the BlueSnap devices. Placed on DB9 in system board with Pin 9 connect to +5V. Same concept with prolific USB-Serial, instead using USB, BlueSnap will convert data from RS232 to Bluetooth. It can be used for distance up to 10 meters.

Figure 3: BlueSnap device

3. SOFTWARE IMPLEMENTATION

The software development of the system will be divided into two categories; the monitor program and the Integrated Development Environment (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 4. 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 [7].

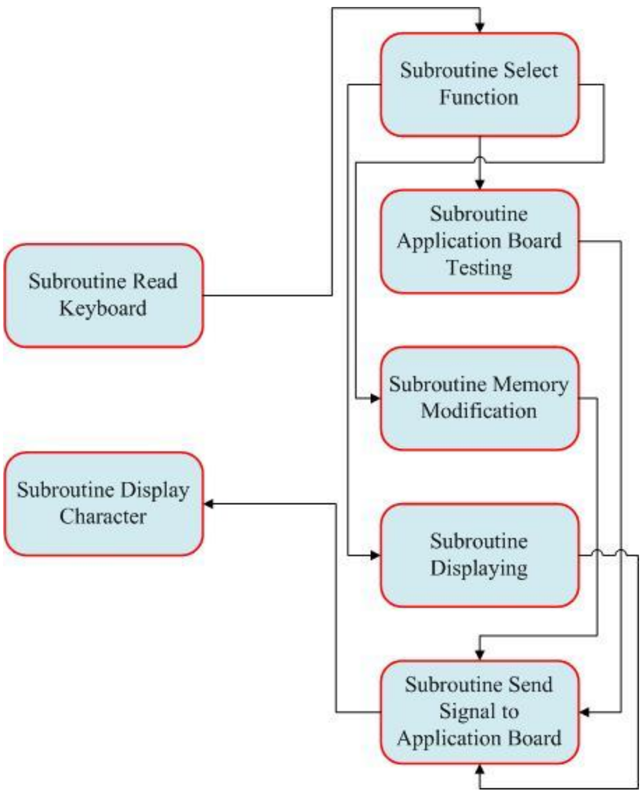

Figure 4: Concept Diagram of Monitor Software

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 [7]. 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 5 is simple procedure to develop an IDE tools.

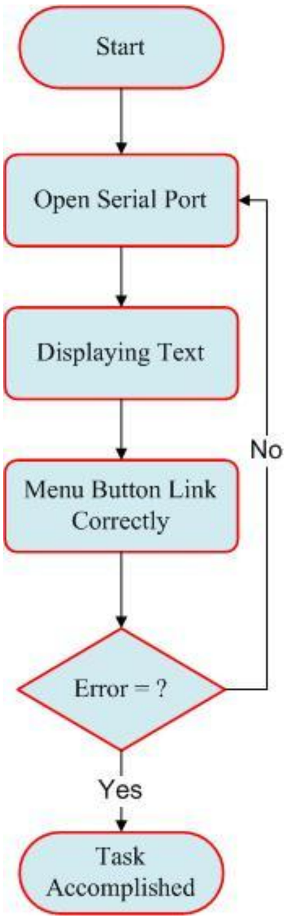

Figure 5: Window Environment

4. 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 will be tested independently. This is shown in Figure 6.

A through 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 or NVRAM. 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 and graphical-oriented. 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.

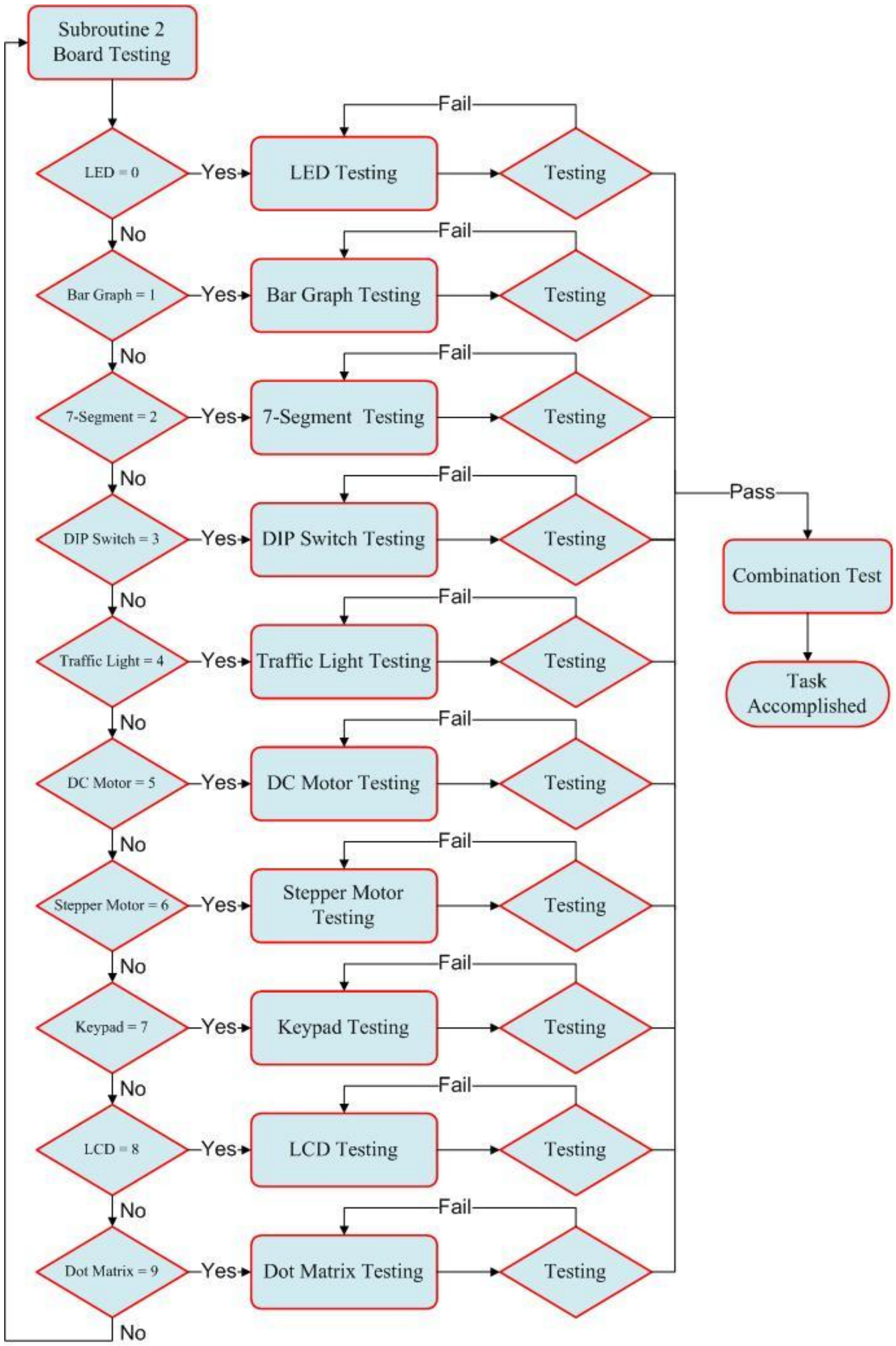

Figure 6: Application Module Testing Flow

5. 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.

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