MINI 11 – Microcontroller Laboratory Hardware Platform with IDE Approach

N.M.K.Nik Yusoff[1], H.AbdulAziz[2], M.Z.B.M.Sapein[3], R.S.K Selvakumar[4] & K.H.B.Ghazali[5]
Faculty of Electrical & Electronics Engineering
Universiti Malaysia Pahang
26600 Pekan Pahang
Telephone: 609-4242031
Facsimile: 609-42424032
Email: [1]nik@ump.edu.my, [2]hazizulden@ump.edu.my, [3]mohdzulhilmi_5253@yahoo.com,
[4]inderjit_1791@yahoo.com, [5]kamarul@ump.edu.my

***Abstract*—**Microcontroller technology has become a core subject in many electrical and electronic fields. Ironically, students envisage difficulty of understanding the material in this course. Hand-on laboratory or project-based design is the key element to student knowledge retention and ability to apply the knowledge in practical endeavors. However, it is difficult to find a portable and low cost prototype system that can meet the individual demand in the market. This paper aims to describe development of a flexible microcontroller training system based on 8-bit Motorola family (MINI11) with a simple testing-bed. In addition, it is further boosted by the introduction of Integrated Development Environment (IDE) features in order to create user-friendly environment thus offering a simple approach to learn this embedded device in short time

***Keywords*:** IDE, microcontroller

I. INTRODUCTION

Microcontrollers have become an integral part of our everyday lives. The number of home appliances and gadgets without micro controllers are rapidly decreasing while the microcontrollers themselves are getting more complex and powerful [1].

Due to its usage in any electronic products has increased tremendously, the microcontroller has become a core subject in electronic and electrical courses. Thus, a hand-on trainer is required to provide simple platform to learn microcontroller effectively. However, most the available models are bulky and high in cost which restricts the laboratory space and budget [2].

Therefore, a flexible and versatile prototype system will be developed. The system can be used extensively in experiment or project for diploma, undergraduate or short courses. The system will also be boosted with simple application board that is suitable for the student 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 [3].

This paper presents the design of microcontroller training system board on 8-bit MC68HC11 from Freescale Semiconductor Inc. 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.

II. HARDWARE OVERVIEW

As shown in Figure 1, the hardware design of MINI11 features two modules; the system board and the application board. The system board is designed by using Printed Circuit Board (PCB) that can operate in bootstrap mode and expanded mode. A simple 2-way DIP switch is used to select the mode. The system module provides the microcontroller with internal storage unit, interrupt facilities, a serial asynchronous communication interfacing circuit, RESET module and clock circuit and interfacing units that can be easily interfaced with various I/O devices. Since the application board is designed for bootstrap mode, all ports are available to be explored.

(ISBN: 978-983-2948-77-3)

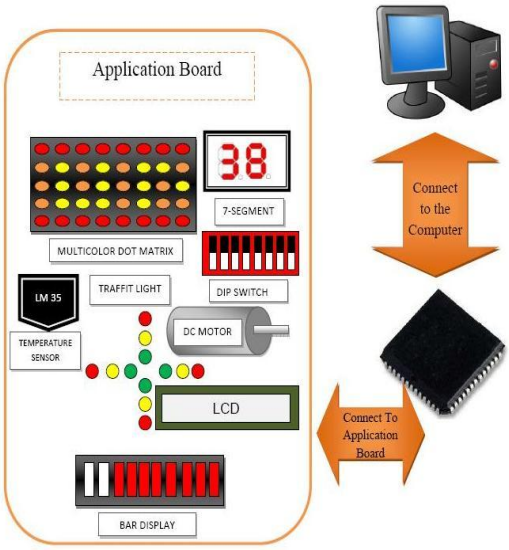

Figure 1: Mini 11 Platform System

System Board Module

As shown in Figure 2, the system board consists of 4 basic circuits to support the basic operation of microcontroller. They are clock circuit, power module, RESET circuit and EIA232 module. The latter provides the EIA232 conversion and in this case, DS275 is preferred in the design due to circuit simplicity and cost.

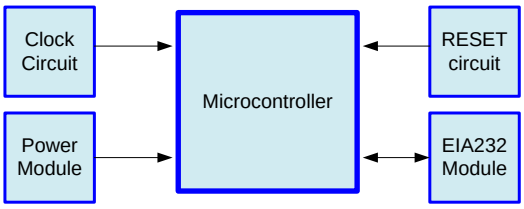

Figure 2: System Block Diagram

The memory map for the MINI11 is simplified in Table 1. In general, microcontroller provides a total 512 bytes internal RAM begins at address $00 to $1FF. This internal RAM can be used to store temporary data or program code. There are a few locations reserved for special purposes such as to store pseudo vector address interrupt routine and internal register. The 512 byte internal EEPROM are used for monitor and the run-time libraries and is located at the address $B600 - $B7FF [1].

Table 1: Memory Map for the MINI11

Memory Range	Component
$00 - $1FF	**Internal RAM for program code or scratchpad**
$1000 - $103F	**Internal Register**
$B600 - $B7FF	**Mini Operating System & Run-Time Libraries**

Application Board Module

The module consists of two inputs and six outputs device. The former include input modules such as 8-ways DIP switches and Temperature sensor. The latter consists of output modules such as Bar Graph, 2 Digit 7-Segment Display, Multicolor Dot Matrix , LED, LCD and DC motor. All of the modules are directly connected to the I/O port of microcontroller. With limited numbers of ports, the module operations are controlled by 8-way output switch. Table 2 shows the output device which controlled by the switch.

Table 2: Switch control output device

Switch 1	LCD
Switch 2	LCD
Switch 3	BAR Display
Switch 4	Direct Current Motor
Switch 5	7- Segment
Switch 6	Traffic Light
Switch 7	Traffic Light
Switch 8	Traffic Light

A simple DC motor circuit connection is shown in Figure 3. Two inputs from port C are connected to input pins of motor driver (L293) while another two output pins from motor driver are connected to DC motor. The motor driver offers high current driver to provide bidirectional drive for motor, solenoid, relay and any high voltage loads with internal protection.

The LCD circuit connection is depicted in Figure 4. In this case, Register Select (RS) is directly connected to PC0 to determine if the operation is intended as a command or data. Likewise, D0-D7 pins at the LCD are directly connected to port B.

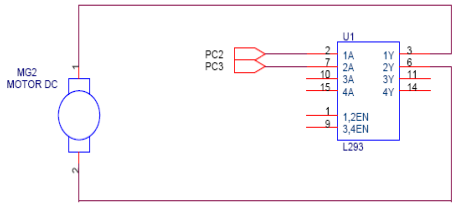

Figure 3: DC motor circuits

(ISBN: 978-983-2948-77-3)

A multi-purpose dot matrix is also feature in the application module. In this case, a 5 x 7 tricolor display is deployed to generate characters, symbols and image. Figure 5 shows the circuit for this 2-dimensional array of dot-matrix where Port B and Port C are allocated for its usage.

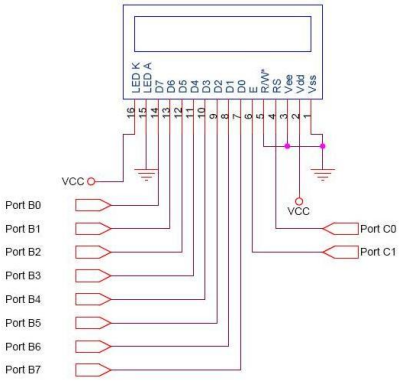

Figure 4: LCD circuit

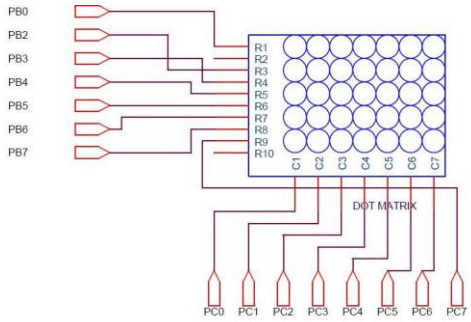

Figure 5: Multicolor dot-matrix

III. SOFTWARE OVERVIEW

The software developments of the MINI11 are divided into two categories; the monitor program and the IDE parts. The monitor program is developed by using the assembly language to allow communication between the PC and Training System Board. This program will be stored into internal EEPROM. From the PC, the user can communicate with the system board to issue command for upload an object code and executing User's program [4].

The concept for the monitor program is shown in the Figure 6. 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 selection, several subroutines are developed, such as read keyboard, read string, display character, display string and many more.

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 [5]. This environment tools is developed by using an object-oriented programming Microsoft Visual Basic 2008. It offers standard windows button such as command buttons, check boxes, option button, text box and etc and produced a user friendly environment system.

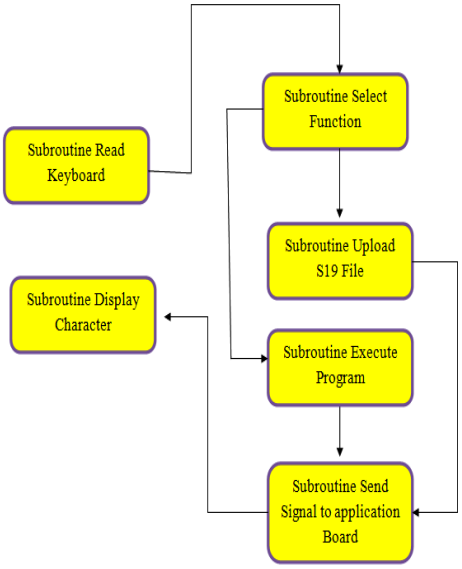

Figure 6: Concept Diagram of Monitor Software

IV. RESULT AND DISCUSSION

Various tests are conducted in this project. The results of the testing reveal the system have achieved of substantial goal. Since the system consists of MINI11 system board and application board module, each part is tested independently to test its functionality.

Likewise, a monitor program is developed, assembled and downloaded into the EEPROM. Several tests of mini operating system have been tested several times and prove that the system is reliable and sufficiently stable. It shows that the monitor program is able to communicate with the computer and capable of performing several commands issued from the host.

Figure 7 is a simple graphical-oriented developed by using Visual Basic to provide a standard windows object and graphic user interface that will make the

(ISBN: 978-983-2948-77-3)

program become user friendly. Figure 8 is a complete prototype of training system with its application module.

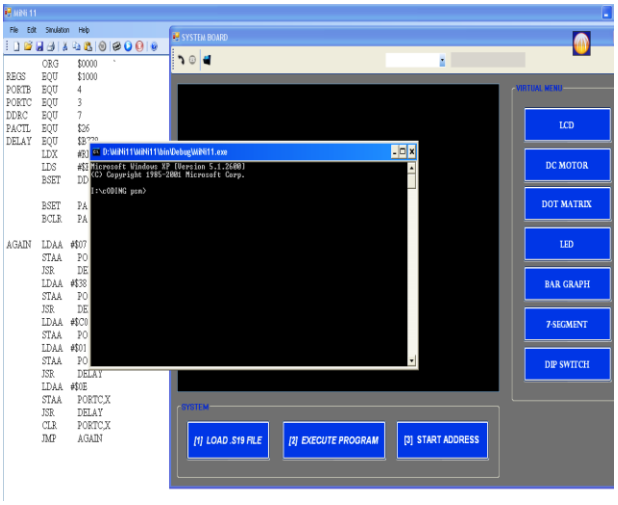

Figure 7: GUI of MINI11

V. CONCLUSION

The prototype of MINI11 has been designed and developed as teaching and learning tools. The system can be used extensively in experiment or project for undergraduate and short courses student. A mini operating system based on IDE concept is developed to integrate the basic software such as communication software, text editor, cross assembler and compiler. In addition, the system provides a simple application board that is suitable for the student to test their capabilities and to improve knowledge in this course. They can be tested individually during the learning lessons or combined some of them to do a simple project.

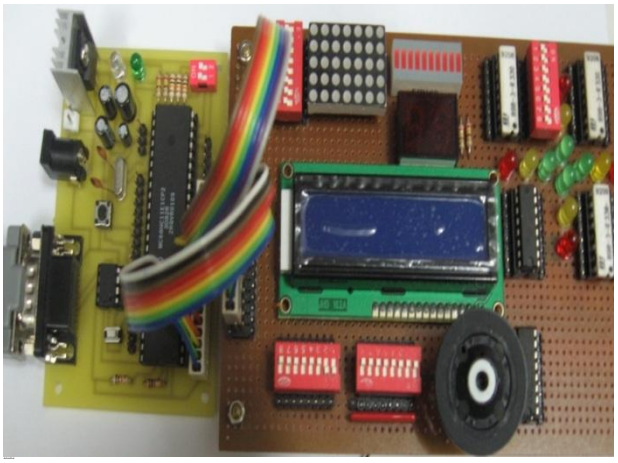

Figure 8: Mini 11 System & Application Module

VI. ACKNOWLEDGEMENT

Financial and management support from the Universiti Malaysia Pahang through short-term funding vote RDU090344 is acknowledged with gratitude.

VII. REFERENCES

[1] M.Z.B.M.Sapein' "MINI 11-Microcontroller Laboratory Hardware Platform With IDE Approach", Thesis University Malaysia Pahang, 2009.

[2] L.C. Ling "The MC68HC11 Development Board With Integrated Development Environment (IDE)", Thesis University Malaysia Pahang 2008.

[3] K.C. Seong "The MC68HC11 Development Board" , Thesis University Malaysia Pahang 2007.

[4] R.S.K Selvakumar, N.M.K Nik Yusoff, A.N. Alla, 'A New Development of Multi-Application of Microcontroller Through Educational Training Systems', Proceeding of MUCEET2009, June 20-22, 2009, Kuantan, Pahang

[5] R.S.K Selvakumar, N.M.K Nik Yusoff, H. Abdul Aziz, 'MCS51 Educational Development System with IDE Approach', International Conference on Software Engineering and Computer Systems 2009 (ICSECS09), 19-21 Oct, 2009, Swiss Garden, Kuantan, Pahang

(ISBN: 978-983-2948-77-3)