IMPLEMENTATION OF USER INTERFACE FOR MICROPROCESSOR TRAINER

Tin Mar Kyi

Computer University (Mandalay)

tinmarkyi@gmail.com

ABSTRACT

This paper aims to design and construct the microcontroller-based user interface system and to study input, computation, and output for microprocessor trainer. The other two activities beyond computation: input and output or I/O. This paper also aims to do high quality research in the area of file systems, as well as develop a good implementation on at least one computer system. A computer system's I/O performance must be commensurate (equal) with its CPU performance if the I/O system is not to limit the system's total throughput. When hundreds to thousands of such high performance micro-processors are closely connected in scalable array architecture, the enormous CPU performance of the multi-computer requires an I/O system with correspondingly high performance. A well balanced computer requires I/O performance commensurate with its CPU performance. High performance computers, access large numbers of disks in parallel to achieve the very appreciable I/O performance .

KEYWORDS

I/O unit, Microprocessor Trainer, PIC16F877A microcontrolle , 7-segments , 74ALS573BS , 74LS244, two ULN 2004A .

1. INTRODUCTION

A microcontroller is a complete computer system, including a CPU, memory, a clock oscillator, and I/O on a single integrated circuit chip. The parts of any computer are:

- A central processor unit (CPU)
- Memory for instructions and data
- Inputs to get information into the computer system
- Outputs to get information out of the computer system
- A program to make the computer do something useful

I/O is one of the basic principles in computer science – data is given to a processing unit, which processes the data end gives out the results. Usually memory chips are used to buffer that data, so in most cases the data is copied from the sensors into a buffer, than processed and then copied back into another buffer. Furthermore, data is exchanged between the components of an embedded system via buses.

Inputs can only process digital input signals at the same voltage levels as the main logic power source. The 0-volt ground level is called V_{SS} and the positive power source (V_{DD}) is typically 5 Vdc (direct current). A level of approximately 0 volts indicates a logic 0 signal and a voltage approximately equal to the positive power source indicates a logic 1 signal. Output devices are used to communicate information or actions from the trainer system to the outside world. In trainer system outputs are logic level digital signals that are used to drive display LED (Light-Emitting diodes). [15]

DOI : 10.5121/ijitcs.2011.1405

Most Microcontrollers are general purpose Microprocessors which have additional parts that allow them to control external devices. We often use the terms Microcontroller and Microprocessor interchangeably.[3]

The key difference between a microprocessor and a microcontroller is that a microprocessor contains only a central processing unit (CPU) while a microcontroller has memory and I/O on the chip in addition to a CPU. Microcontrollers are generally used for dedicated tasks. Microcomputer is a general term that applies to complete computer systems implemented with either a microprocessor or microcontroller.[8]

2. RELATED WORK

PICs are popular with developers due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (and re-programming with flash memory) capability [2]. Developing a PIC microcontroller-based project simply takes no more than five or six steps.

- Type the program into a PC
- Assemble (or compile) the program
- Optionally simulate the program on a PC
- Load the program into PIC's program memory
- Design and construct the hardware
- Test the project. [2]

The purpose of this trainer is to provide students with experience in the following techniques: - writing of assembly language programs
- assembling, downloading and running of programs
- programming to output characters to 7-segment displays
- programming to read key-pad characters
- generation of waveforms for display on an oscilloscope
- uses of interrupt facilities
- implementation of timing routines using the on-chip hardware timer

The machine is a free-standing piece of training equipment, incorporating its own power supply, input key-pad and output digital display. [20, 21] The design of computers,covers the overall design,or architecture and internal details or organization[22].The communication between a computer and its human users,a means of translating information between human and binary formats is necessary.The inputoutput equipment can perform this task[23].

3. CONTRIBUTION

The main contribution of this thesis is to design and construct the general purpose of instrumentation and user interface module. The executed programs of this thesis are the technical features, the hardware design and the control software of user interface (I/O) system.
A useful step forward from the simple switch is given by the keypad, as seen in the photocopier interface and the Derbot hand controllers. The keypad allows numeric or alphanumeric information to be entered. It is widely used in photocopiers, burglar alarms, and central heating controllers and so on.
A keypad is based on switches, yet it would be extremely resource-intensive if each of these switches were allocated to a port bit. Instead, to make good use of resource, each switch is connected in a matrix. The electrical connections for the keypad have 24 keys. It can be seen that these are arranged in a 4 × 6 matrix, with four rows and six columns. Whenever a key is pressed, it connects its row with its column. A 24 key keypad is arranged in a 4 × 6 format

requiring 10 connections. Consider the 24-key keypad, this is arranged in 6 columns and 4 rows as shown in. Table 1. There are 10 connections to the keypad – C1, C2, C3, C4, C5, C6, R1, R2, R3 and R4. [13].

	Column C1	Column C2	Column C3	Column C4	Column C5	Column C6
Row, R1	INC	MEMRD	0	1 / RUN	2	3 / RESET
Row, R2	DEC	MEMWR	4	5	6	7
Row, R3	FUNCTION	I/ORD	8	9	A	B
Row, R4	ENTER	I/OWR	C	D	E	F

Table 1. (26) Key Keypad

4. HARDWARE AND DESIGN OF THE MICROCONTROLLER-BASED USER INTERFACE (I/O) SYSTEM

The main part which involved in the User Interface (I/O) module are the microcontroller PIC 16F877A, three octal transparent latch 74ALS573BS, the octal buffer line driver 74LS244, two ULN 2004A, eight 7-segments and 24 key pad switch.

PIC 16F877A is used as the user interface controller, 74ALS573BS are used to latch the address output from either the main CPU or from the DMA controller, 74LS 244 is used to drive the control bus signals.

The hardware configuration of the experimental setup and the software organization will be summarized. In the Microprocessor Trainer system, the program debugger, a kind of DMA (Direct Memory Access) controller, is contained in one of the hardware module. There are totally six modules (Processor module, Memory module, User Interface module, DMA (Direct Memory Access) module, PIO (Parallel Input/Output) module and Power Supply module) in the Trainer system and all modules are provided as separate chip, linked together via bus connections on a printed circuit board and supplied 5V DC power. The block diagram of the system is shown in figure (5.1). The Microprocessor Trainer used the 16-bit wide address bus (A [0…15]) and data bus (D [0…15]) and four control signals such as MEMWR, MEMRD, IOWR and IORD. The system buses are used by the main processor and the DMA controller alternatively.

The main part which involved in the User Interface (I/O) module are the microcontroller PIC 16F877A, three octal transparent latch 74ALS573BS, the octal buffer line driver 74LS244, two ULN 2004A, eight 7-segments and 24 key pad switch.

PIC 16F877A is used as the user interface controller, 74ALS573BS are used to latch the address output from either the main CPU or from the DMA controller, 74LS 244 is used to drive the control bus signals.

All parts of the module are controlled by ALE (address Latch Enable) pin from the main CPU. By passing the DMK ACK pin is going to low level, the main CPU gives the bus service to the DMA goes low.The PIC16F877A is connected to LEDs in a similar fashion to the user interface system PORT B is used as the LSB and is connected to LEDs. PORT D is used as the MSB and is connected to LEDs.

The interrupt pin from the user interface system is tied to the capture input pin of the PIC16F877A (RC1/CCP2) and is pulled high using a 1kΩ resistor (R98). The I/O address pins

are connected to switch S2. This is done for testing purposes to allow change of addresses using the switch. These pins can be tied permanently high or low. The I^2C pins (SDA and SCL) from all devices (U1 and U2) are connected together to form the I^2C bus. Both SDA and SCL are pulled high using 4.7 kΩ resistors.

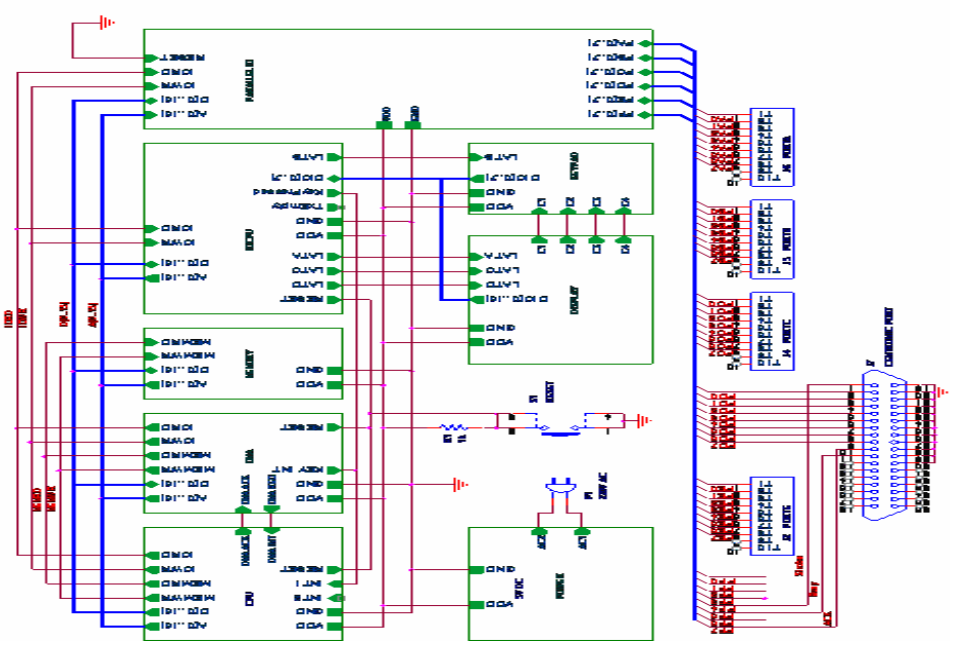


Figure 1. Complete Block Diagram of Microprocessor Trainer

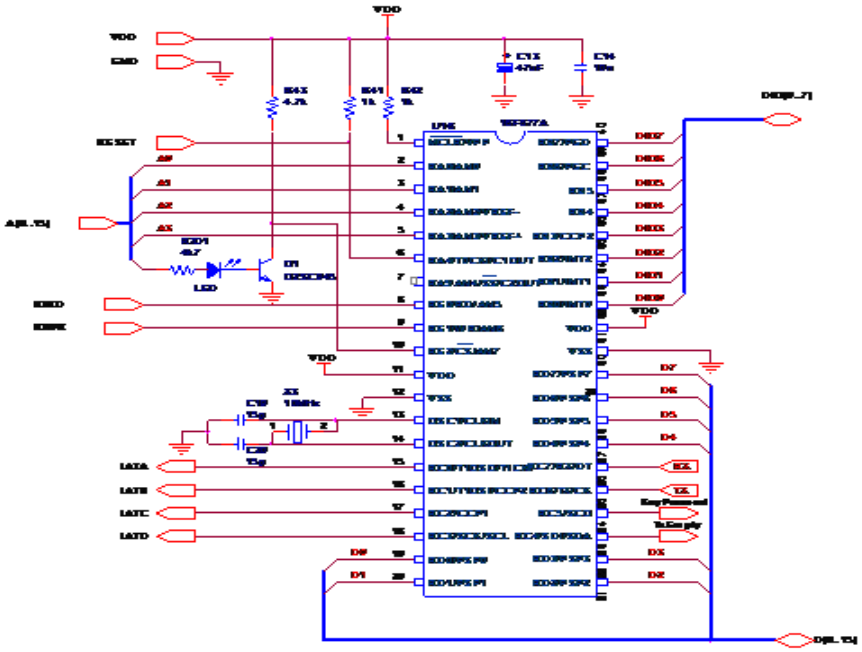


Figure 2. Circuit Diagram of I/O Module

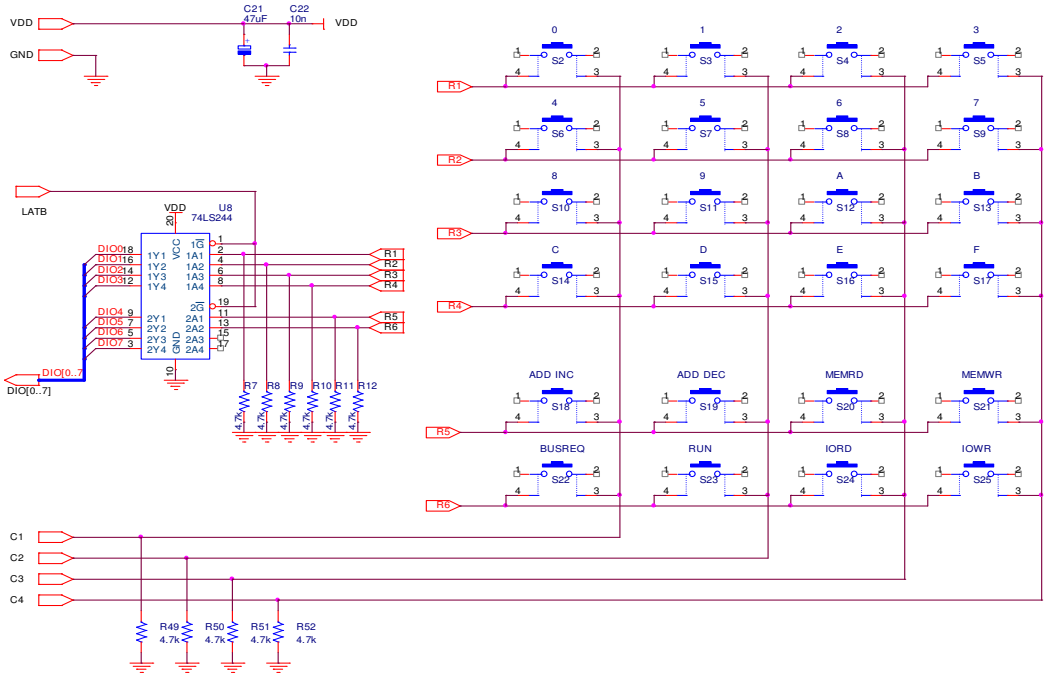


Figure 3. Circuit Diagram of Keypad Module

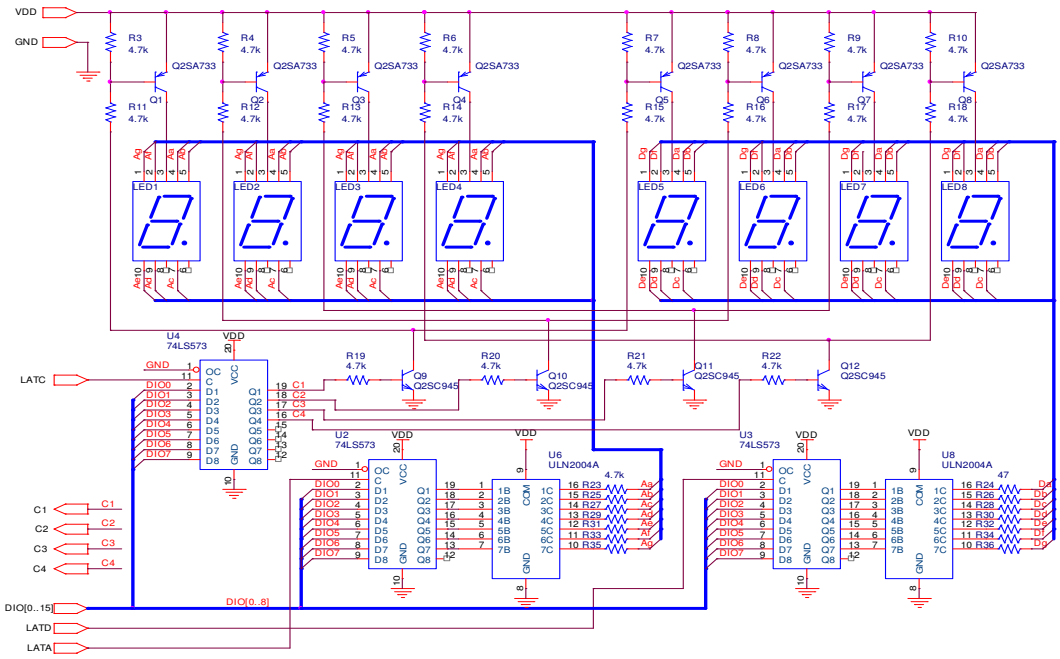


Figure 4. Circuit Diagram of LED Display Module

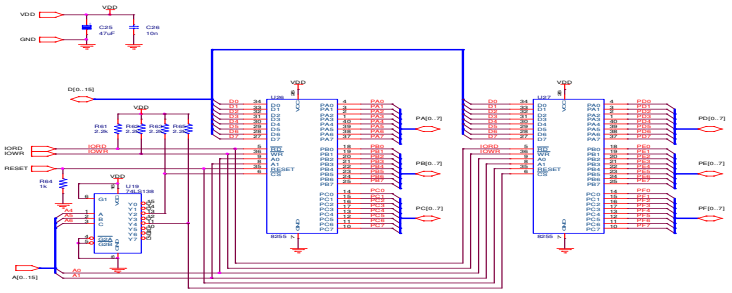


Figure 5. Circuit diagram of I/O port

5. Controlling with PIC 16F877 Assembly Software

5.1 Flow of the Main Routine

Before entering the Main Loop the software initializes peripheral modules. In the main loop, the program checks for three flags. New key Flag, DMA message Flag and Error Flag. If new key flag is found; it performs decoding operation. If DMA message is set it will displays message code ON the LED display and if error flag is set it will display error code.

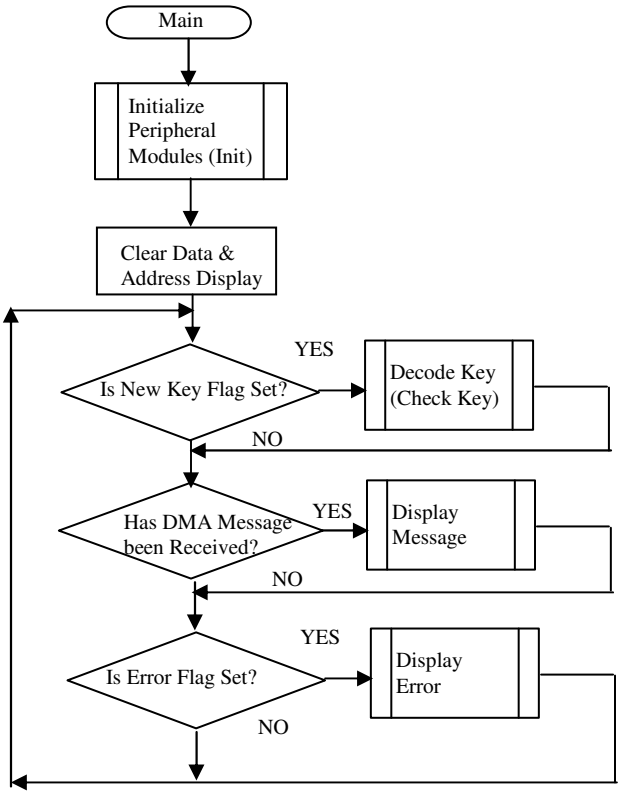


Figure 6. The Flow Chart of the Main Routine

5.2 Flow of Initialization Routine

Firstly, initialize LAT A, LAT C and LAT D are cleared and LAT D is set. Digital input and output are configuring at Port A and parallel slave module is enabling. Then

CCP1 module is interrupted setup at every 5ms and timer 1 module is turned on.The Figure 7 is shows flow chart of the initialization sub routine.

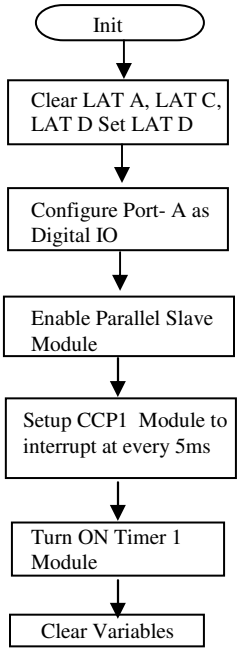


Figure 7. The Flow Chart of the Initialization Sub Routine

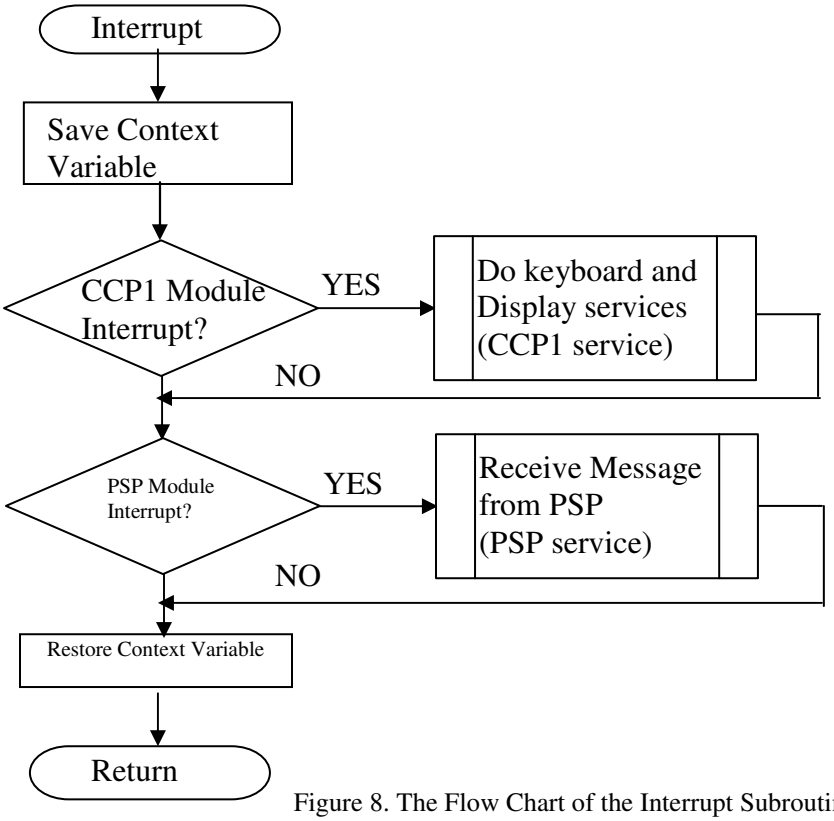
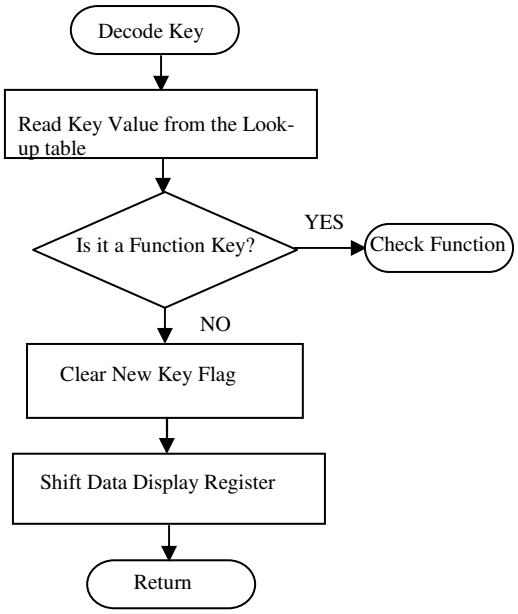


Figure 8. The Flow Chart of the Interrupt Subroutine

5.3 Flow of the Key decoding subroutine

Before the key decoding, key value is read from the look-up table. If it is a function key, the function will check. Then new key flag is cleared, shift data to display register and return to main loop. This process is shown as a flow chart in Figure 9.



Fgure 9. The Flow Chart of the Key Decoding Subroutine

6. Controlling with PIC16F877A Assembly Software

6.1 Software Implementation

The firmware program for the microcontroller is complied with the Assembly Language. The source code is written in the MPLAB IDE version 8 from Microchip Corporation. To implement the actual algorithm in the PIC 16F877A, the assembler is used with debugger. There are two main parts in the software implementation. They are the software implementation of master controller module and the software implementation of eight channels digital I/O STIM.

The complete block diagram of Microprocessor Trainer is shown in Figure 10.

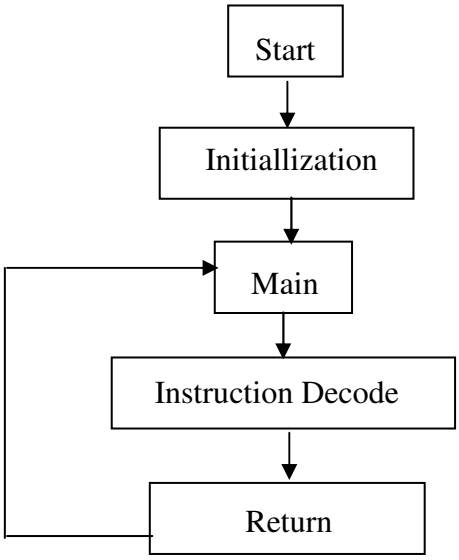


Figure 10. Block diagram of Microprocessor Trainer

7. Conclusions

A microcontroller-based user interface system is designed and constructed using LED display unit. At first, PIC 16F877A controlled input and output has been tested. It can display any characters on the 7-segment LED. There are eight 7-segments display is implement. Four 7-segments are display address and other four 7-segments display data and controlled with PIC 16F877A.

This system has covered the design and implementation of moving message user interface systems, which are contrast to the types commonly seen in shop windows, airports, and other public buildings. In this research PIC microcontroller is used MPASM Assembler language and programmed with a PIC start plus PIC programmer. The source code is written in the MPLAB IDE version 8 from Microchip Corporation. This microcontroller based system has various advantages; the electronic circuit used are less and cheaper than that of a commercial one, portable hardware components, low power consumption rate and operation. This system is intended to use in marketing, advertising and communication purpose.

This design can be improved by allowing the system to be programmed from a computer via the serial port through RS 232 since PIC 16F877A contains I2C as a built in module. This paper will support the introductory level beginners to understand the characteristics of computer architectures and their operations. All modules are working perfectly according to their characteristics. Once they are ready, it will be a good tool for beginners to learn basics of microprocessor Architecture programming skill. Therefore it will be very helpful to beginners who are familiar with PIC to appreciate the internal operations of a processor. However the interfacing units keypad and a display have to be designed and connected to the board. This processor can be improved further by 32-bit instruction execution. 7-segment display is convenient but the slow of the amount of data is less. It is better to put LCD (Liquid Crystal Display) instead of the 7-segment display.

Acknowledgements

First of all, I would like to thank to His Excellency Minister U Thauung, Ministry of Science and Technology for the opening of Doctor of Philosophy Degree courses.

I am very much indebted to Dr. Ni Lar Thein, Rector of University of Computer Studies Yangon, for her enthusiastic support and permission to carry out this thesis.

I would like to profoundly grateful to U Kyaw Swa Soe, Pro-rector, University of Computer Studies, Yangon for his invaluable advice, guidance and encouragement on this thesis.

Thanks are also extended to Professor Daw New Ni, Head of Computer Hardware Technology Department, University of Computer Studies, Yangon. I would like to express my gratitude and deep appreciation to Dr. Mie Mie Thet Thwin, Pro-rector, University of Computer Studies, Mandalay for her valuable supporting to complete the whole thesis.

Her Sincere thanks go to her Supervisor, Professor Dr. Win Aye, Material Science and Material Engineering Research Centre for her invaluable guidance, advance, and encouragement for this thesis.

I am very thankful to U Win Khaing Moe, Deputy Director General, Myanmar Science and Technological Research Department for his kind advice and guidance to complete this thesis.

I would also like to express my sincere thanks to Lecturer Daw Yee Yee Mon, Head of the Department of English, University of Computer Studies, Mandalay, for giving me advices on usage of English in this thesis.

I also wish to express my deepest gratitude my parents, my sisters and my brother for their encouragement, understanding and support through out the period of this painstaking research.

References

[1] B. Williams “Designer’s Handbook of Integrated Circuits” McGraw-Hill book company.

[2] Ken Arnold, “Embedded Controller Hardware Design”, LLH Technology Publishing, in 2000.

[3] Andrews. Tanenbaum, “Structured Computer Organization”, Prentice-Hall of India, in 1999.

[4] David A. Patterson & John L.Hennessy, “Computer Organization and Design”, First Printed in India, in 2005.

[5] Julio Scanchez & Maria.P, Canton, “Microcontroller Programming”, Tailor and Franci Group LLC, in 2007.

[6] “PIC Microcontroller Mid-Range MCU Family Reference Manual”, Microchip Technology Incorporated, USA, in 1997.

[7] Randall Hyde, “The Art of Assembly Language Programming”, in 2001.

[8] DOUGLAS V.HALL, “Microprocessors and Interfacing”, Programming & Hardware, 2/E International Edition, 1992.

[9] Dogan Ibrahim”, PIC BASIC Projects 30 Projects Using PIC BASIC and PIC BASIC PRO”, Linacre House, Jordan Hill, Oxford OX2 8DP, UK 30 Corporate Drive, Suite 400, Burlington, MA 01803, USA 2006.

[10] Julio Sanchez and Maria P. Canton," Microcontroller Programming The Microchip PIC", Taylor & Francis Group CRC press, 2007.

[11] "PIC microTM Mid-Range MCU Family Reference Manual", Microchip Technology Incorporated, Printed in the U.S.A, 2002.

[12] Elsevier, "Interfacing PIC Microcontrollers Embedded Design by Interactive Simulation", Martin Bates, in 2006.

[13] Tim Wilmshurst," Designing Embedded Systems with PIC Microcontrollers Principles and applications", Published by Elsevier Ltd, 2007.

[14] Dogan Ibrahim, "PIC BASIC Projects 30 Projects Using PIC BASIC and PIC BASIC PRO" Linacre House, Jordan Hill, Oxford OX2 8DP, UK, in 2006.

[15] James M.Sibigtroth, "M68HC05 Family, Understanding Small Microcontrollers-Rev. 2.0",

[16] M.E.Sloan, "Computer Hardware and Organization An Introduction Second Edition", Intel Corporation, 1975.

[17] Barry B. Brey, "The Intel Microprocessors", Prentice-Hall, in 2000.

[18] E.A.PARR, "The Logic Designer's Guide Book", Printed in the United States of America, in 1984.

[19] Rafiquzzaman, M., Microprocessor Theory and Applications, Intel and Motorola, Englewood: Prentice-Hall International Editions, 1992.

[20] Hall, V., Microprocessor and Interfacing Programming and Hardware, Computer Science series, New York: McGraw-Hill International Edition, 1986.

[21] Collier, M., An Introduction to Microcontrollers and Picocontrollers, NUST Lecture Notes Series No.5, NUST, Bulawayo, 1999.

[22] JohnP.Hays,ComputerArchitectureandOrganization,ISBN0071159975,Third Edition,1997..

[23] Furbur,S.B.VLSIRSCArchitectureandOrganization,NewYork:MarcelDekker,1989 nd

[24] Siewiorek,D.P.and R.S.Swarz.ReliableComputerSystems.2ed.Burlington,MA:Digital Press,1992.