MICROCONTROLLER BASED MOVING MESSAGE DISPLAY USING LED DOT MATRIX

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ABSTRACT

Microcontroller based LED matrix Moving message display has become an important and prominent symbol of the city lighting, modernization, information society to carry information and beautify the people's life with decoration. The microcontroller based moving message displays are widely used in the towns and cities to display information to general public. The hardware and software design of moving message can be implemented with single PIC16f877A microcontroller. The system mainly involves the PIC microcontroller, LED matrix display and the data shifting using register. The LED display system consists of numbers of section of 5-pixel by 7-pixel dot matrix which is controlled by the Microcontroller I/O ports.

Keywords: *Microcontroller, LED dot matrix module, Shift register, MPLAB IDE and microcontroller Programmer.*

1. INTRODUCTION

Information can be exchanged in a variety of ways. In the past information were displayed and exchanged in different ways like letters, banner and sculpture. Information is now more accessible and appealing through televisions, computers, and video displays. This display technology includes CRT (Cathode Ray Tube), LCD (Liquid Crystal Display), LED (Light Emitting Diode) and most recently the E-paper (Electronic Paper). Ever since its invention, LED are being used extensively in industries, laboratory and home for lighting system, television, display, multi-touch sensor, sign board, etc... LED-based moving-message displays are becoming popular for transmitting information to large groups of people quickly.

Many organizations, Institutes and College has its name written on the concrete cement block or wooden block beside the every entrance gate, where the

visitors are unable to read the messages displayed on the board during the night. This issue can be solved by having moving LED display, where the intended message to be displayed prominently to the people during day and as well at night time. There by communication process of informing the people about existence of organization and firm can be improved and advertised.

The System will use one of the recommended micro-controller as the heart of the circuit along with the other IC like shift register, transistor, voltage regulator, and LED display and power supply unit in the circuit. The system where have four module (units) of dot matrix display and PIC16F877A is use to control all the four dot matrix to generate the output in character. The PIC C program are developed using the CCS C compiler and MPLAB IDE environment. The message coded as the source code is downloaded to the EEPROM of PIC16F877A through the programmer to interface each column and rows of the dot matrix, there by having the effect of moving message over the LED display.

2. SCOPE OF THE PAPER

- Design the microcontroller based circuit with other peripheral device for the moving message.
- Develop the LED dot matrix and multiplexing technique for moving message with dot matrix.
- Program the micro-controller using MPLAB IDE editor.
- Understanding the method to simulate the design circuit with proteus professional VSM professional.

3. 5X7 LED MATRIX CONSTRUCTION

In this LED Module, Five vertical columns and seven horizontal rows are present at regular pattern of spacing. 5x7 Module contains 35 LED in one segment. The numbers of segments are combined to form large panel of LED Module to display the characters. There are two types of LED Dot Matrix Module which as follows:

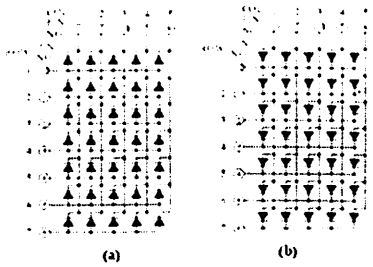

Figure 15x7 LED Matrix Module

a) *Common Cathode:* This type of construction contains seven horizontal rows having common cathode connection. It means that $+V_{cc}$ applied to the columns and ground applied to the rows.

b) *Common Anode:* This type of construction contains five vertical columns having common anode connection. It means that ground applied to the columns and +Vcc applied to the rows.

These type of the LED matrix module are extensively used in Moving message display in town and cities area. The LED module are fabricated by planting the LED on the wooden or fiber block keeping a regular spacing. The readymade LED matrix module of multi-colour are available in the market(Petal, 2012, 06).The figure 2 shows the 4 units of 5x7 LED dot matrix display.

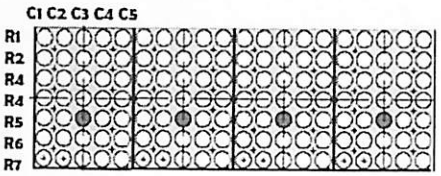

Figure 2 The 40 columns of LEDs (Hanwei, 2011)

4. POWER SUPPLY

Volt regulated DC is obtained from 9V, 500mA transformer, diode, capacitor and regulator IC 7805 as shown in the main circuit diagram of the power supply. In this system since we need to light up numbers of LEDs through microcontroller the external supply is necessary and to powered up other devices and microcontroller.

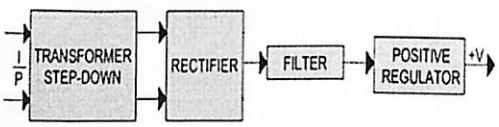

Figure 3 Block Diagram of the Regulated 5V DC Power Supply

The AC source of 230V, 50Hz is supplied to the Transformer which steps down the input voltage to 12volts, 50Hz. This is supplied to the Rectifier circuit which converts it into 12volts dc. The output of the rectifier is pulsating dc in nature which needs to be supplied through the filter circuit to get the constant voltage. The filter circuit used here is the capacitive filter. The constant output voltage of the capacitive filter is given the +5volts dc voltage regulator from where the final output is obtained and supplied to the microcontroller(L.Floyd, 1996).

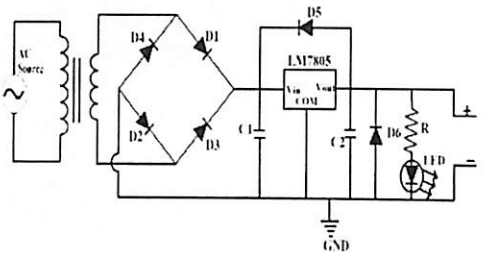

Figure 45V DC power Supply

5. OVERALL STRUCTURE DESIGN

Due to the advantages like flexibility in programming, high performance, low cost and low consumption of power PIC16F877A is more popularly used. For these reasons, PIC16F877A is chosen as the controller of the entire system for the present application. The system is implemented by a circuitry which consists of PIC16F877A chip, XT time clock, column scanning circuit, row scanning circuit and the four 5 x 7 LED dot matrix panels.

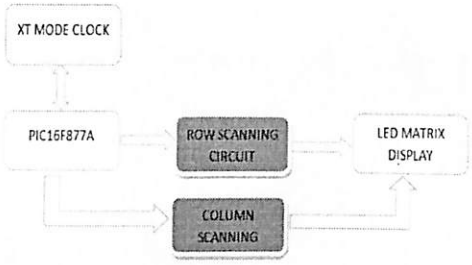

Figure 5 Overall system design

The display unit is composed of the four 5 x 7 LED dot matrix modules, five ULN2803 and five 74HC254. Row data signal is driven by one 74HC254. The column scanning signal of each character was driven by the four 74HC254 and five ULN2803. The input signals are mainly from data port B, C and D.

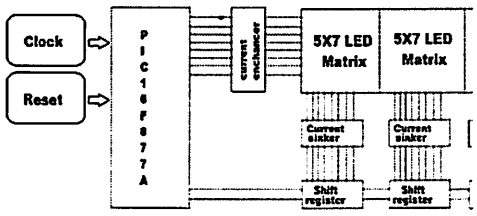

Figure 6 Concept of display design

The more numbers of the desired LED Matrix can be added by adding shift register and other components (Myla, 2010).

6. HARDWARE IMPLEMENTATION

The circuits of the moving message display consist of the microcontroller, Shift register, current source, current sinker and LED dot matrix. Logically, the moving of the character is achieved by the row and column scanning of the LED on the dot matrix.

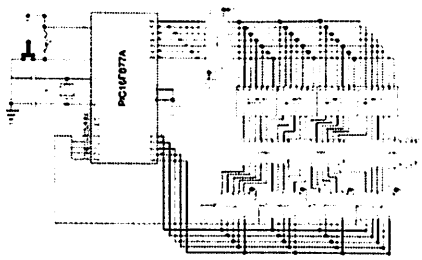

Figure 7 Main circuit Diagram

The programmed microcontroller will give the data output according to the program form the port B and the 74HC245 will help to source the current to make the LED brighter. The device 74HC245 allows data transmission from the A Bus to the B Bus or from the B Bus to the A Bus. The enable input (G) can be used to disable the device so that the buses are effectively isolated.

The control of Moving Message Display System based on PIC16F877A microcontroller, each module of dot matrix display consist of seven rows namely R1 through R7 and five column C1 through C5. Here both the 74HC245 and ULN2803 will acts as the current sinker since the current added up through the rows which will harm microcontroller. Row of dot matrix module is connected to PORT B of microcontroller R1 is connect to LSB of PORT B via driver IC 74HC245. This circuit uses common anode display (Agarwal, 2007).

In case of clock applied to microcontroller unit, the XT mode is the one most commonly used. This is because the extra component cost is small compared with the cost of the chip itself and accurate timing is often a necessity. An external crystal and two capacitors are fitted to CLKIN and CLKOUT pins. The crystal frequency in this mode can be from 200 kHz to 4 MHz a convenient value is 4 MHz, as this is the maximum frequency possible with a standard crystal and gives an instruction execution time of 1.000 μ s (1 million instructions per second) (Bates, 2008).

To insure that the device does not get reset unintentionally during normal operation, the voltage on the MCLR pin must be kept higher than the minimum input high voltage specified in the datasheet. This is usually 4 volts for operation at 5 volts.

The will help to execute the program in the microcontroller from the start. If reset button is press in the process of moving message, it will help to return the word to first letter of the message(Technology, 2001).

7. SOFTWARE SYSTEM IMPLEMENTATION

The PIC microcontroller program comprises a list of machine code instructions, decoded and executed in sequence, resulting in data movement between registers, and arithmetic and logic operations. The program could be written in raw binary code, but this would require manual interpretation of the instruction set. Therefore, the machine code is generated from assembly code, where each instruction has a corresponding mnemonic form that is more easily recognizable, such as MOVF05, W (move the data at Port A to the working register). This low-level language is fine for relatively simple programs but becomes time consuming for more complex programs. In addition, assembly language is specific to a particular type of processor and, therefore, not "portable". Therefore *C*has become the universal language for microcontrollers(Bates, 2008).

7.1 PROGRAMMING PIC16F877A

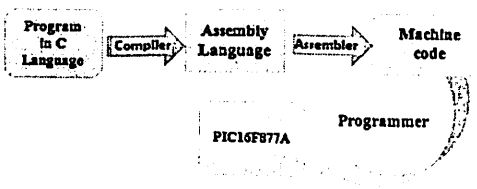

Figure 8 Programing Concept of PIC16F877A

The C program in written in the MPLAB IDE text editor and CCS C compiler is integrated with the MPLAB IDE which understand the dialect of C language. This CCS C compiler will convert the Source code (in C) in to the Assembly language, which are made of certain mnemonic code. The Assembly language is converted in to the machine code by the Assembler. Than this machine code is fused or uploaded to the microcontroller using the microcontroller called the Pickit-3. The Interfacing Circuit called six-way in-circuit serial programming (ICSP) connector.

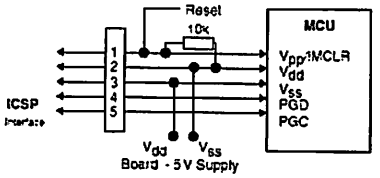

Figure 9ICSP Target Board Connections (Bates, 2008)

An in-line row of pins provides the programmer connection to the target MCU. For Programming the Microcontroller the Port B is employed, where RB6 (PGC) and RB7 (PGD) are for program clock and program data respectively. Pin 1 carries the programming voltage (12–14 V) and is connected to pin Vpp, which doubles as the MCU reset input, MCLR. Pin 4 (PGD) carries the program data and pin 5 (PGC), the program clock. Any other circuits connected to these pins must be designed with care, so that they do not interfere with the programmer (Bates, 2008).

As shown in Figure 9 the program written are edited and compiled to the PIC instruction on the PC using the MPLAB and the CCS C-compiler. The PIC machine instructions are uploaded from PC to PIC system via the PICkit which will loaded in the PICKit. Finally the PIC microcontroller is fused with the required program and it will be used to drive the peripheral device like LED, LCD and other component (both internal and external) as far the instruction of program in machine code (Grimbleby, 2008).

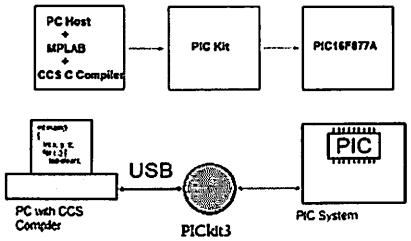

Figure 10 Programming PIC16F877A(Grimbleby, 2008)

The Pickit 3 programmer will work with the MPLAB IDE, where the programing instruction will be given from the PBLAB IDE by selecting the target PICKit type.

7.2 HEX CODE GENERATION FOR CHARACTERS

In the present design, the characters code is obtained by column scanning method. Each character is composed of 5 x 7 pixels. The intension is to display the moving string of character "***Welcome***" on the dot matrix LED character. The Hex codes for the characters are generated as following, where the code will be display through the port B of the pic16f877a microcontroller. The following example shows the HEX code generation of the Word "w" by column scanning method.

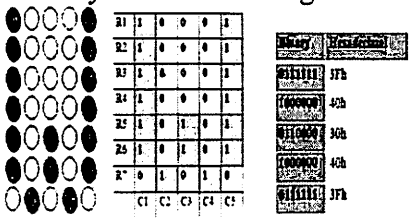

Figure 11 Hex code Generation for Word "W"

In the first column for character "w", R1~R6 are asserted while the R7 is de-asserted. That is, in binary 0111111, and converts to hexadecimal as 3Fh. With the codes for each column, the program turns on the respective LEDs column by column with a refresh rate faster than 25Hz. For displaying the "W", following HEX code is required to from port B to lit respective LED (Hanwei, 2011).

In the PIC programming construct, the HEX code of the character should be define in the array and for the part of above message "WELCOME" the Code will define in the following way. These Hex codes are flush from the port B of the PIC16F877A to obtain the output character on the character

```
Addr [40] = {
0xEF, 0x40, 0x38, 0x40, 0x3F,
//W
0x7F, 0x49, 0x49, 0x41, 0x00,
//E
0x7f, 0x40, 0x40, 0x40, 0x00,   //L
0x3E, 0x41, 0x41, 0x41, 0x22,   //C
0x3E, 0x41, 0x41, 0x41, 0x3E,   //O
0x7F, 0x02, 0x0C, 0x02, 0x3E,   //M
0x7F, 0x49, 0x49, 0x41, 0x00,   //E
                }
```

The hex code is generated for "WELCOME" is shown above. This single dimensional array content will be fetch form another part of the program and to display it in endless loop on the LED module.

Figure 12 Hex code for word "WELCOME"

7.3 SOFTWARE & INTERNAL CONFIGURATION

All C programs have a common organization scheme, this organization scheme are followed in order to construct the application smoothly. In the first part, headers file are included in the source code. These headers contain functions that are shared across different programs (Hanwei, 2011). This are the header file

defined in the pic18f877A microcontroller.

```
#include<16f877a.h>
#include <defs_877.h>
#use delay (clock=4000000)
#fuses hs, nowdt, nocpd, nolvp,
noprotect
```

Note, in the source code, a statement #include 16F877A.h. This defines the specific chip for which the program is created and refers to a header file supplied with the compiler. This file must be included because it holds information about the chip register addresses, labeling, and so on (Bates, 2008).

The header file (defs_877.h) which defines each special function register (SFR) byte and each bit within these and then use the "data sheet" to develop own utilities. This approach is close to assembly language programming without the aggravation of keeping track of which SFR contains each bit and keeping track of the register banks. The defs_877.h file was prepared from the register file map and special function register (Anderson, 2002).

Watchdog Timer (wdt): When enabled, the watchdog timer automatically resets the processor after a given period. This allows an application to escape from an endless loop caused by a program bug or run-time condition not anticipated by the software designer. To maintain normal operation, the WDT must be disabled (nowdt). Otherwise, the program is liable to misbehave, due to random resetting of the MCU.

Low-Voltage Programming Mode (lvp): This mode can be selected during programming so that the customary high (12V) programming voltage is not needed, and the chip can be programmed at V_{dd} (5 V). The downside is that the programming pin cannot then be used for digital I/O and since the project used the Port B pins for I/O the function is disabled (nolvp).

*Code Protection (cp):*The chip can be configured during programming to prevent the machine code being readback from the chip to protect commercially valuable or secure code. In the present source code we disabled it.The preprocessor directive #fuses is used to set the configuration fuses in C programs for PICs as shown in the above code. The options defined in the standard CCS C 16F877 header file are;

Clock Type Select: LP, XT, HS, RC
Power up Timer Enable: PUT, NOPUT
Program Code Protect: PROTECT, NOPROTECT
In Circuit Debugging Enable: DEBUG, NODEBUG
EEPROM Write Protect: CPD, NOCPD

These are PIC-Microcontroller configuration to be configured for the programming of the microcontroller (Bates, 2008).

8. SIMULATION

The Microcontroller controlled peripheral devices can be simulated using the proteus VSM simulation software. The program that coded in the MPLAB IDE can be loaded to the Proteus VSM for the simulation. Proteus Virtual System Modeling (VSM) combines mixed mode SPICE circuit simulation, animated components and microprocessor models to facilitate co-simulation of complete microcontroller based designs. It is possible to develop and test such designs before a physical prototype is constructed. The any kind of simulation which involve the microcontroller with the programming is simulated in the proteus VSM

professional along with the MPLAB and other plugin software.

The circuit diagram is drawn in ISIS (Intelligent Schematic input system) professional environment and microcontroller can be loaded with source code form the MPLAB using the plug in software or the program is written inside using different language. The programs are debugged and circuit is simulated and the external peripheral will act according to the program in it. This software also supports animation where we will see the flickering of the LED or moving message display (Electronics, 2003).

From the present system prospective, the PIC16F877A microcontroller, dot matrix, shift register and other miscellaneous component can be drawn and connected in the ISIS environment. Than the PIC C program is loaded to the microcontroller as source code form the MPLAB IDE. According to the programming instruction and loop formation of the programming code, the animation like moving message can be seen in flushing and scanning through the dot matrix and again repeating.

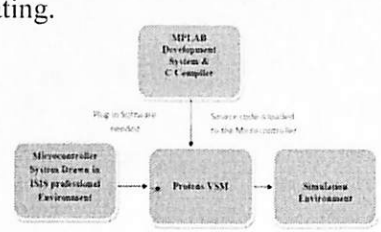

Figure 13 Simulation Concept of system

9. SYSTEM IMPLEMENTATION & PROTOTYPE

The power supply circuit is fabricated on the PCB and housed in the plastic box to prevent the external and physical damage. The Expected output was +5V but the actual hardware output obtained +4.05V. This power supply can be employed for the system as microcontrollers can operate from 3V to 5V of external supply.

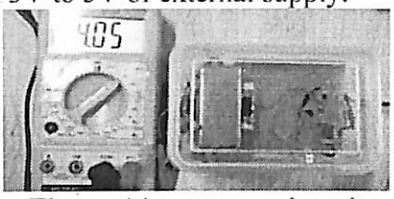

Figure 14power supply unit

The Dot matrix module is constructed by panting the LED on the wooden block at regular spacing. The seven row are kept fixed and the column are expanded to have longer display screen to accumulate more words.

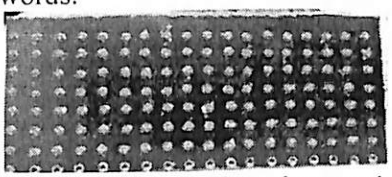

Figure 15LED planted on the wooden board

The system testing is done on the bread board and the message "WELCOME" scroll through the LED matrix module. The speed of the moving message can be controlled form the program using different delay function.

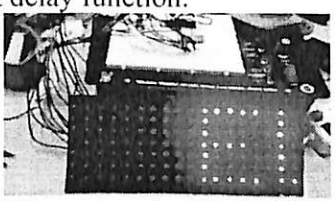

Figure 16LED showing Moving message

10. CONCLUSION

The set goals within this paper have been achieved, by moving the message "WELCOME" through the LED dot matrix. The hardware and software system are implemented to obtain the moving message over LEDs using PIC16F877A microcontroller.

11. FUTURE SCOPE

Today the moving message display can be used convey message to the public which are commonly seen in enterprise, airports, and other public buildings. Right now there is limitation on maximum data that can be sent. If some modification is done at software and hardware more data can be displayed and can bring lots of improvement. Some of the future scope of this paper are:

- GSM based SMS moving message can be developed in future. The wireless short messages can be transferred from mobile to the display module devices displaying the messages. The display system will have the receiver to receive the message send by the mobile to be displayed.
- Dzongkha language moving message can be implemented. This will help to inform message to the Dzongkha reader and lay man. Moreover it will also act as the tools for promoting the national language
- Using the same system and concept, the picture and logo can be displayed using the multi-colour LED.
- It will help for mass communication and the public advertisement in the town and cities area. As a result this may create the business adventure in Bhutan where people will buy the product of LED for advertisement, public announcement and entertainment purposes as like in other countries.

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