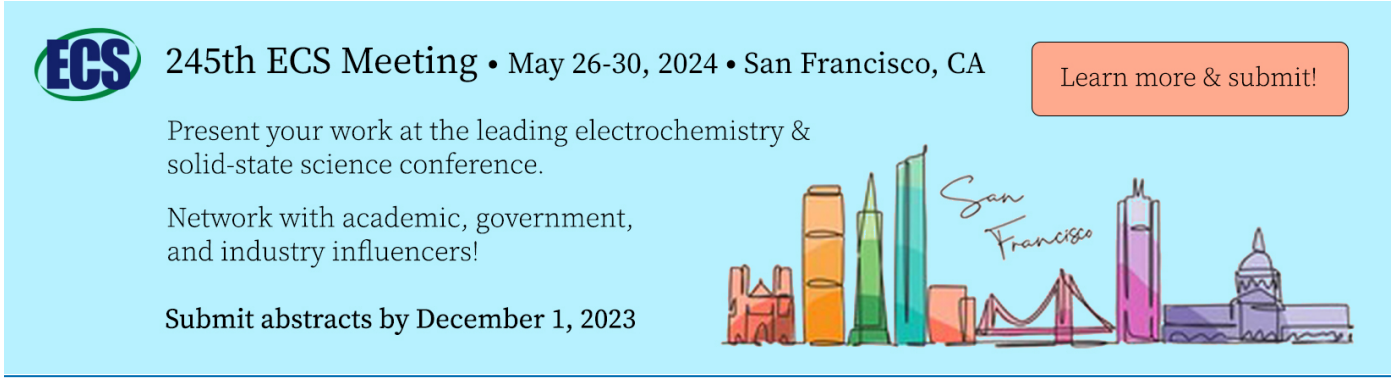
Design and Construction of LED Matrix Display



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Design and Construction of LED Matrix Display

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Abstract. This paper presents a compilation of the design and construction of a programmable scrolling matrix display that scrolls the following characters "WELCOME TO PHYSICS DEPARTMENT". Dot Matrix Display based on the logic output signals of a digital signal processor (DSP) and microcontroller or other logic device. The Perspex board measuring 0.3x1.5 meters was acquired and holes of 4mm were drilled for the Perspex in order to allow the LED measuring 5mm in diameter fit tightly into the drilled holes. The circuit diagram was gotten after careful design and calculation had been done. The complete work was designed, simulated and routed with proteus and after the design, construction and testing, the device (programmable scrolling matrix display) was ascertained to be working satisfactorily.

Keywords: LED's; Microcontroller; Scrolling Matrix Display; Digital signal processor

1. Introduction

Analog display of information has long been in use in various forms some of which include sign posts for showing direction or caution signs, bill board for displaying prices and exchange rates, score boards for displaying scores in a game or even large boards for advertisement purposes. This involved arranging some form of lighting in a particular style to depict what is to be displayed. This style has one major challenge; no flexibility which possess numerous problems for the display. Due to this major setback in the analog format of display for signposts andWrite-up, it is important to solve this challenge digits and automatic electronic display system [1]. This is to enable the viewers to get enough information displayed in attractive colours [2]. The extent at which dissemination of information has reached in Nigeria and the world at large will be maintained if the information to be displayed is burnt into the microcontroller especially the ones that have to do with bigger firms. This will bring about mutual relationship between firms and its consumers. Matrix display of information is based on the logic input signals processor (DSP) and or other logic device.

LED matrix display operates on what is known as persistence of vision (POV). One LED only is displayed at every point in time and your eye combine the lit LEDs to get the image. This is known as the persistence or permanency of vision (POV) and this happens when the eyes sees images that changes at a very fast rate of 10 scans per second. A flickering effects is observe when the scan increases to 20 scans per second but when it is increase to 30 scans per second the effect is observe to be smooth.

In this work, the display works at a rate greater than 100 scans per second and the eye observe the display to be steady. If we reduce the scan rate, each of the LEDs can be seen as the efficiency of the

microcontroller clock is reduced. In this work, we will designed and construct the electronic circuit for driving the LED matrix and also program the microcontroller and demonstrate its operation on the matrix display board.

2. Materials & Methods

2.1. Design process and implementation

In the design of the matrix display circuit, very little calculation is required due to the fact that most of the integrated circuits (ICs) used in this circuit operate with digital signals and require little or no transformation[5, 6]. Nevertheless, the calculations made in the cause of design are outlined as follows

2.2. Calculation for Voltage Regulator Parameters

Vout = LED regulated voltage
Vin(max) = LED maximum input voltage
Iload(max) = LED maximum load current for this work
Vout = 5V
Vin(max) = 5V
Iload(max) = 3A.
The inductor L, output capacitor (C_{out}) and input capacitor (C_{in}) are 680µH, 1000µf and 100µf respectively. [7]

2.3. The Current Limiting Resistors to the LEDs

Practically, a voltage (V_{DD}) = 2volts can considerably bias an LED to be driven in the forward direction. Diodes require 20mA from a source for full brightness. [7]

To limit the current flowing through the LED, it must have a resistor connected in series in other to prevent the LED from damaging. In this project a block of LED is used which consists of four LEDs (two parallel connected and two series connected). The resulting block is terminated to act as a single unit

For the series EDs,

V_{DD} = 2 x 2v = 4Volts (1)

For paralleled LEDs

I_{DD} = 20mA X 2 = 40mA (2)

In the circuit, driving voltage V_S = 12volts is applied to the line driving the LEDs. This is too high for the LEDs and hence, the current limiting resistors are needed whose value is calculated below

$$\frac{\mathbf{12v-4v}}{\mathbf{40mA}} \quad (3)$$

$$= \frac{\mathbf{12-4}}{\mathbf{0.04}} = 200\Omega \quad (4)$$

Considering safety, it is advisable to use resistor with higher value for each LED block to reduce the current driving them. 270Ω resistor is chosen as current limiting resistor for each block of the LEDs.

Hence the current that will drive the LED block from this current limiting resistor will be;

$$\frac{12v-4v}{270\Omega} = 30\text{mA} \quad (5)$$

30mA is a reasonable current value to drive a block of four (4) super bright LEDs requiring a maximum current of 40mA current.

2.4. *Construction Procedure*

2.4.1. The LED Matrix Board. The Perspex board measuring 0.3x1.5 meters was procured. The points for the placement of LEDs were carefully identified and evenly marked. Holes of 4mm were drilled in the marked points in the Perspex in order to allow the LED measuring 5mm in diameter fit tightly into the drilled holes. 980 holes were drilled for 980 LEDs on the Perspex.

The LEDs were tested and the faulty (including those with poor brightness) LEDs were promptly replaced. The LEDs were grouped in four and interconnected to form a single lighting. LEDs were wired such that all the cathodes along a row share a common terminal and all the anodes along a column shared a common terminal.

The arrangement of the dot matrix are the LED matrix which have a common anode for LEDs in a row and in each of the , the anode is common and the LED with a common cathode each row are also common.

*2.4.2. The Circuit.*The circuit diagram was gotten after careful design and calculation had been done. Most of the components were gotten from the local electronics store. The workability of all the discreet components and integrated circuits were verified before they were all used in the project.[8, 9]The complete project was designed, simulated and routed with Proteus and found to be working satisfactorily, before the actual components were then assembled on a printed circuit board. All the IC sockets were first soldered on the PCB before all other component were soldered after being tested.

2.4.3. Software Design. The software required for displaying characters “WELCOME TO PHYSICS DEPARTMENT” on the LED matrix. The hex code is downloaded on to the PIC18F4620 microcontroller and is verified by interfacing the microcontroller pins to the pins of the board. For any given character, a corresponding pattern of LED is generated and is used to display the character at run time. The equivalent data bytes required for the Display of “WELCOME TO PHYSICS DEPARTMENT” character were computed and stored at internal ram address and were transmitted sequentially by monitoring the TI flag of the register.

3. Results and Discussion

In displaying the world “WELCOME TO PHYSICS DEPARTMENT”, we start by displaying the word ‘WE’. The D-1 is selected, meaning D_1 is drag low and other columns are unselected columns by obstructing their paths by dragging D_2 through D_5 pins to logic high. By so doing, the first column is made active while the LED’s in this rows R-1 through R-7 of this are turn on, which is done by the application of forward bias to row (1, 5, 7) until we get to the information to be displayed which is ‘WELCOME TO PHYSICS DEPARTMENT’, where D- means column and D- means row.. Consequently, a quick scan across the column greater than 100 times per second and the LEDs are turn on in each of the row of that column, the is graphics is seen to be still by stability of vision or observation.

The written program was examined and the result was used to test its functionality by executing the program with some chosen inputs before it was burnt into the microcontroller..
We then burnt the code which we have written in C compiler into the PIC18F4620, and later we assemble the control circuit and fix connectors and also the serial port to pc. Now we setup the software into computer and when we type the messages in the computer we get the display.
The tables below show the codes for the display 'WELCOME TO PHYSICS DEPARTMENT'.

Table 1: Shows the digital code for the alphabet 'WELCOME TO PHYSICS DEPARTMENT'

R/D	D_6	D_5	D_4	D_3	D_2	D_1
R-1	1	1	0	1	0	1
R-2	0	1	0	1	0	1
R-3	0	1	0	1	0	1
R-4	1	1	0	1	0	1
R-5	0	1	0	1	0	1
R-6	0	1	0	1	0	1
R-7	1	1	0	1	1	1
R-1	1	1	0	0	1	0
R-2	0	1	0	0	1	0
R-3	0	1	0	0	1	0
R-4	0	1	0	0	1	0
R-5	0	1	0	0	1	0
R-6	0	1	0	0	1	0
R-7	1	1	0	1	1	0
R-1	1	1	0	1	1	0
R-2	1	1	0	1	1	0
R-3	0	1	0	1	1	0
R-4	0	1	0	1	1	0
R-5	0	1	0	1	1	0
R-6	0	1	0	1	1	0
R-7	0	1	0	1	1	0
R-1	1	0	1	1	0	1
R-2	0	0	0	1	0	1
R-3	0	0	0	1	0	1
R-4	0	0	1	1	0	1
R-5	0	0	0	1	0	1
R-6	0	0	0	1	0	1
R-7	0	0	1	1	0	1
R-1	0	1	1	0	1	1
R-2	0	1	1	0	0	1
R-3	0	1	1	0	0	1
R-4	0	0	1	0	0	1
R-5	0	0	1	0	0	1
R-6	0	0	1	0	0	1
R-7	0	0	1	0	0	1
R-1	1	1	0	1	0	1
R-2	0	1	0	1	0	1

R-3	1	0	0	0	1	0
R-4	1	0	0	0	1	0
R-5	1	0	0	0	1	0
R-6	0	0	0	0	1	0
R-7	1	1	0	0	1	0
R-1	0	1	1	0	1	0
R-2	0	0	1	0	1	0
R-3	0	0	1	0	1	0
R-4	0	0	1	0	1	0
R-5	0	0	1	0	1	0
R-6	0	0	1	0	1	0
R-7	0	1	1	0	1	0
R-1	0	1	1	0	1	1
R-2	0	1	1	0	0	1
R-3	0	1	0	0	1	0
R-4	0	1	0	0	1	0
R-5	0	1	0	0	1	0
R-6	0	1	1	0	1	0
R-7	0	1	1	0	1	1
R-1	0	1	1	0	1	1
R-2	0	1	1	0	0	1
R-3	0	1	1	0	0	1
R-4	0	0	1	0	1	1
R-5	0	0	1	0	0	1
R-6	0	0	1	0	0	1
R-7	0	0	1	0	1	1
R-1	0	1	1	0	1	1
R-2	0	1	1	0	1	1
R-3	0	1	1	0	1	1
R-4	0	1	1	0	1	1
R-5	0	1	1	0	1	1
R-6	0	1	1	0	1	1
R-7	0	1	1	0	1	1
R-1	1	1	0	1	1	1
R-2	0	1	0	0	1	0
R-3	0	1	0	0	1	0
R-4	0	1	0	0	1	0
R-5	0	1	0	0	1	0
R-6	0	1	0	0	1	0
R-7	0	1	0	0	1	0
R-1	1	0	1	1	0	1
R-2	1	0	0	1	0	1
R-3	1	0	0	1	0	1
R-4	1	0	1	1	0	1
R-5	1	0	0	1	0	1
R-6	1	0	0	1	0	1
R-7	1	0	1	1	0	1

R-1	0	1	1	1	1	1
R-2	0	0	1	0	1	1
R-3	0	0	1	0	1	1
R-4	0	0	1	0	1	0
R-5	0	0	1	0	1	0
R-6	0	0	1	0	1	0
R-7	0	0	1	0	1	0

[10, 11, 12]

In table 1 above, one pin source for the current for only one LED across each row at a time while the column pin will sink the current from more than one LED. For instance, to display the word "WE", C1 column will sink the currents six (6) LEDs. An external transistor arrangement is required since the microcontroller I/O pin cannot sink much electric current. In digital electronics, 1 means ON while 0 means OFF. When powered on the LED, it displays "WELCOME TO PHYSICS DEPARTMENT. Only the areas that have 1 are light up while the areas that are 0 are OFF as shown in the table above.

4. Conclusion

The matrix display of light is made up of LEDs arranged in a rectangular array in such a way that by turning on or off, picture or image or characters can be displayed. With the help of the dot matrix controller, information can be turn into signals thereby turning on and off lights in the matrix in other to turn on the required display. Hence the need to expand research and development in the LED matrix display technology. All thanks the advent of microcontroller which has made it possible for information to be displayed in any format.

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