Keypad Controlled Dot Matrix Display

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Abstract: - This work is based on the design and implementation of a led matrix display whose display at any point in time is controlled by a keypad. The display is built around ATMEL's 89C52 microcontroller from 8051 families. The desired messages to be displayed at intervals of time is programmed and attached to different buttons on the display system, so that at any point in time, the message desired to be displayed is selected with the corresponding button.

Key Words: —*Dot matrix, Decoders, Microcontroller, Button.*

I. Introduction

Dot matrix display amongst other display technologies have applications in various areas including digital notice board, machine displays, public places such as restaurant, airport, hotels, churches and so on, the common means to change the message displayed by the system varies between using a pc for a PC based type, through text message for the design that employed the use of GSM modem [1] or the crudest and cumbersome way of reprogramming the microcontroller. The use of pc to change the existing message could be more time consuming and cumbersome compared to the use of text message but it's relatively cheaper to design and implement due to the high cost of GSM modems and network charges for each sent text message.

Suppose that a particular message displayed at one time should be redisplayed after some other series of message has been displayed which will also be redisplayed later, then the use of GSM modem or pc to change the message would not be the best option in terms of flexibility of control and cost effectiveness. The use of button to change the message or graphics displayed thus becomes paramount. In this design, several messages, which are likely to be displayed at one point, are programmed and attached to several buttons so that at a button press, the desired message is displayed and can also be easily switched to another message by a button press whenever the need arises.

This project can be applied in a restaurant where messages displayed to the costumers needs to be varied depending on some certain conditions such as the time of the day or seasons of the year, also in religious premises where the message displayed is dependent on seasons or occasion at hand. This project can be improved on to obtain what can be called "an intelligent moving message display" by interfacing some sensors so that the public or user is alerted using the display whenever a certain condition occurs in the monitored process, while the normal message continues to display after the detected condition is resolved.

II. The LED Matrix System Design

The block diagram for the entire system is as shown in the diagram below, which includes the 5V power supply rectified from an ac source 230V/50Hz supply, the controller circuit, driver circuit, keypad, led matrix board and the buffer.

A. Block Diagram

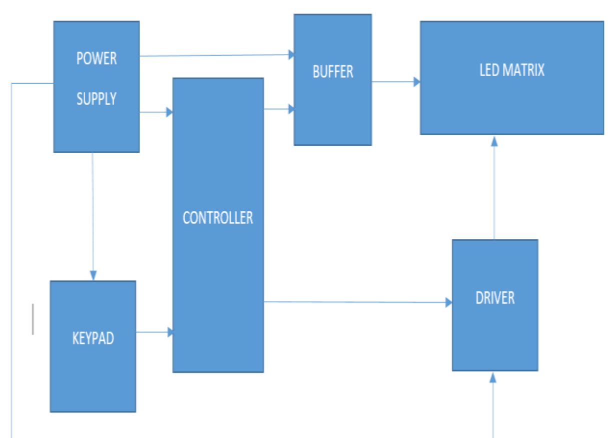

Fig.1. Block diagram of the system

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B. The Power Supply

The power supply circuit consist of 12v, 500mA transformer, bridge rectifier, 2200uf capacitor, lm7805 as the voltage regulator.

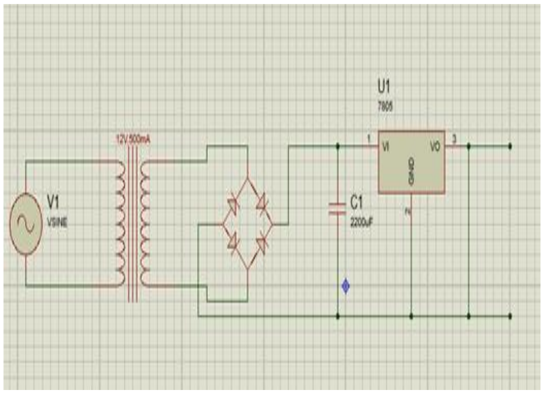


Fig.2. Power Supply Design

The charge Q stored in a capacitor is determined by the capacitance of the capacitor and the voltage across the capacitor

$$Q = CV \ldots \quad (1)$$

$$\text{But } Q = IT \ldots \quad (2)$$

$$IT = CV \ldots \quad (3)$$

(Combining 1 and 2)

$$C = \frac{IT}{V} \ldots \quad (4)$$

Considering the entire component that makes up the system, the maximum current to be drawn by the load will not exceed 500mA, and since a 12v transformer is used, the capacitor is expected to charge up to 12v at the peak voltage cycle and then then to discharge exponentially until the next peak voltage value is reached. Using a 5v voltage regulator, the voltage should not discharge to less than 7v. Hence the maximum discharge voltage is

$$V_d = 12v – 7v = 5v$$

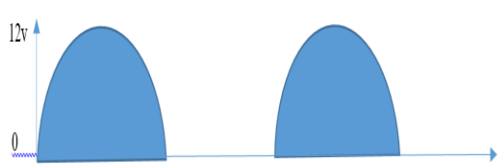


Fig.3. Waveform representation of sinusoidal signal

Fig.3. shows the wave form of a half wave rectified output, the discharge time of the capacitor is from the time t1 to t2 which is equal to the period of the ac source

i.e. discharge time $T_d = 1/f$

Hence for a full wave rectification, $T_d = 1/2f \ldots$ (5)

For a 50Hz supply, $T_d = 1/2*50 = 1/100 = 0.01s$

$$C = \frac{0.5*0.01}{5} = 0.001F$$

Or C = 1000uF.

For this design, 2200uF capacitor was chosen to ensure a very stable power supply amidst fluctuations in the ac source.

C. The Controller

The controller used in this project is 89C52 from the 8051 family of microcontroller. It is an 8-bit machine with four input/output ports (P0, P1, P2 and p3), two timers (Timer0 and Timer1). 11.0952 crystal oscillators with two 30pf capacitor was used to configure the external clocking circuit used in the project, 10k resistor and 10uf capacitor was used at pin 9 to achieve automatic reset whenever the system is powered on.[2]

The pin description of the 89C52 microcontroller is given below in details:

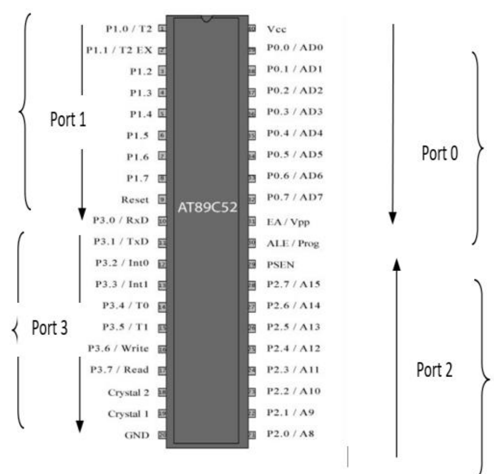


Fig.4. Pin configuration of AT89C51 Microcontroller

D. Led Matrix Display Board

The LED matrix display is made of an array of LEDs (light emitting diodes) arranged in a matrix configuration with a specific number or rows and columns. The arrangement is such that each LED is the array can be individually addressed and manipulated. Below is a schematic diagram of the arrangement of the LEDs in matrix form.

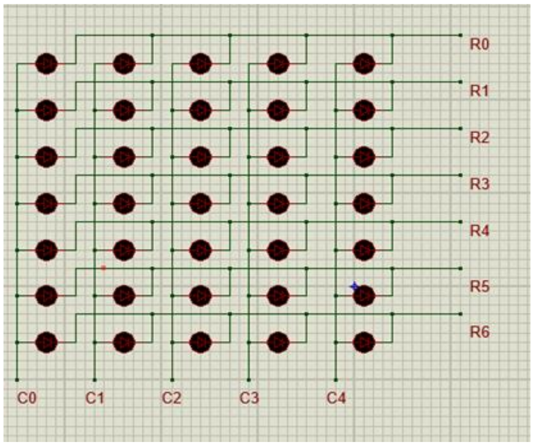


Fig.5. 5x7 LED matrix arrangement

As shown in fig.5. Above, a single character is represented by a 5x7 matrix of LEDs for this project, by changing the value of signal applied at the individual column and rows of the LED array. The methodology used to display characters or graphics is by scanning.

By scanning, the first column of the LED array (C0) is activated by sending a high to it and then the corresponding data values to represent the character is fed along the rows (R0 through R6), the character is allowed to be displayed for a small amount time then the column C0 is deactivated and column C1 is activated while the corresponding data to be displayed is also fed through the rows and so on until the last column (C4) is addressed, then this sequence is repeated for a number of times so that by the persistence of vision principle, the human eye will see the character as being steady. Say the character to be displayed is "M".

O				O
O	O		O	O
O		O		O
O		O		O
O				O
O				O
O				O

Fig.6. A LED matrix showing how to display the letter "M"

Fig.6. Represents the entire activations of the individual LEDs of the columns and rows to display the character "M", it is seen that entire row of the first column are lit, only the second row R1 of the second column, R2 and R3 of the third column, only R1 of the fourth column and the entire rows of the last column C4.

This helps to generate the entire row characters for the letter "M" to be 0000000 for C0, 1111101 for C1, 1111001 for C2, 1111101 for C3 and 0000000 for C4.

E. The Driver Circuit

As the number of columns to be addressed increases, the need to employ other digital ICs arises, for this project, the number of columns addressed is 60 making it a 60 by 7 dot matrix display. With the help of 74LS154, a 4 to 16 decoders, we are able to give out 4 pins from the microcontroller to gain 16 pin control at the output.

The DM74LS154 is a 24 pin dual in line integrated circuit, a 4-line-to-16-line decoders which utilizes TTL circuitry to decode four binary-coded inputs into one of sixteen mutually exclusive outputs when both the strobe inputs, G1and G2, are low. The features of this decoder is summarized below

- Decodes 4 binary-coded inputs into one of 16 mutually exclusive outputs
- Performs the demultiplexing function by distributing data from one input line to any one of 16 outputs
- Input clamping diodes simplify system design
- High fan-out, low-impedance, totem-pole outputs
- Typical power dissipation 45 mW[1]

The pin configuration and the truth table is shown in fig.7. below

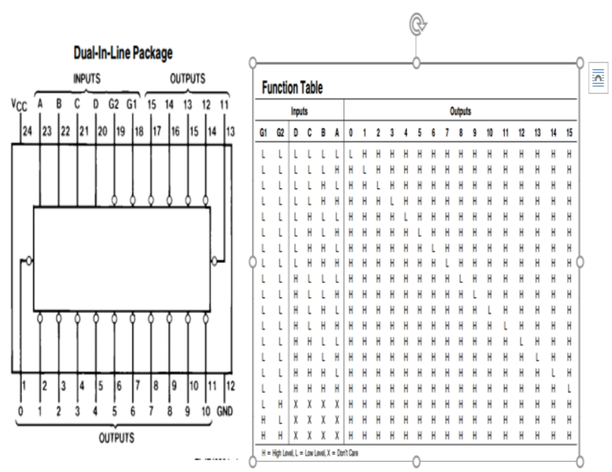


Fig.7. Output diagram of the driver IC: 74LS154 [3]

With the help of this IC, scanning of the individual columns of the dot matrix display can be achieved by counting in binary, the input pins A, B, C and D are connected to pins 3.0, 3.1, 3.2

and 3.3 of the AT89C52 microcontroller so that by counting up from 0 to 15 in binary, the activated output of the decoder will be varying serially from the first output to the last output hereby scanning through the first 16 columns of the dot matrix display. For the 60 columns, a total of four 4-to-16 decoders is needed, the corresponding inputs (A, B, C and D) of the 4 decoders are connected together so that they are scanned by the same binary counting.

The strobe inputs G1 and G2 are utilized here in order to switch between the current decoder that should be scanning, for each 4 to 16 decoder, the enables (G1 and G2) are tied together and connected to the outputs of another 3 to 8 decoder, DM74LS138 [4] starting from the first output to the fourth output. The inputs of the 3 to 8 decoder (A, B and C) is in turn connected to pins 3.4, 3.5 and 3.6 of the microcontroller. Hence, the increments that will occur on the 5th and 6th bit of the binary number after every 16 counts will switch the effectiveness of the counting to the next decoder and so on until the last column of the display is scanned. Fig.8. shows the connections.

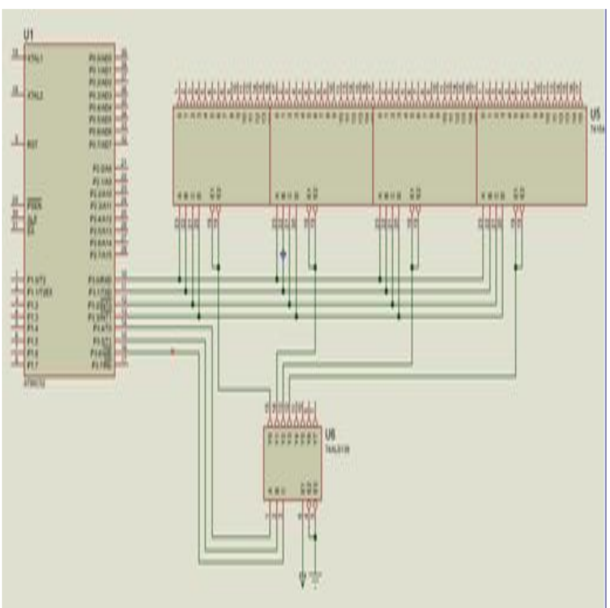
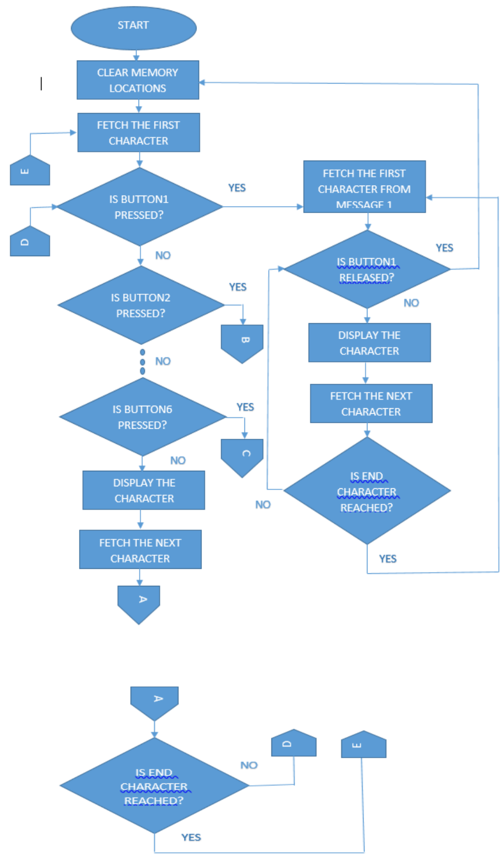


Fig.8. the connection of the drivers

The output of the decoder is a ground since it is an active low device; hence, it is used to bias a PNP transistor alongside a 1k resistor which in turn switches a high to the columns. For the purpose of simulations in proteus as will be shown later, the transistors where replaced with a NOT gate since it mimics the behavior of a PNP transistor as an inverter.

F. The Project Software

The program software was written in assembly language [5] using MIDE programming environment, below is the flow chat of the project.



G. Simulation Test and Result

The work was simulated using the proteus software, the transistor arrays were replaced with a logic NOT gate for easy and efficient simulation.

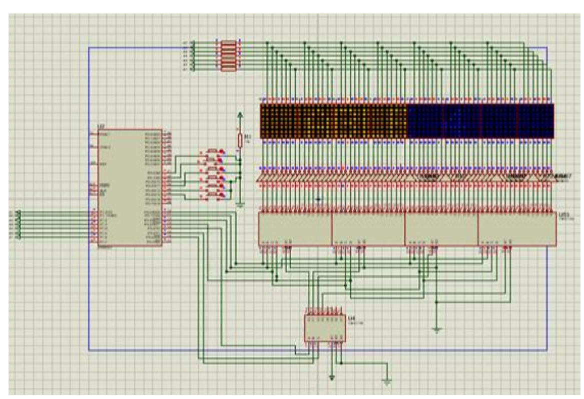


Fig.9. Simulation of the entire circuit on proteus

Open circuit test was initially performed on the hardware, ground was connected to the pins of the decoders and the test was performed on the transistors to check if they were switching and the result was positive, open circuit and continuity tests were performed on the component connections and they read accordingly. Below is a capture of the entire circuits with the packaging.

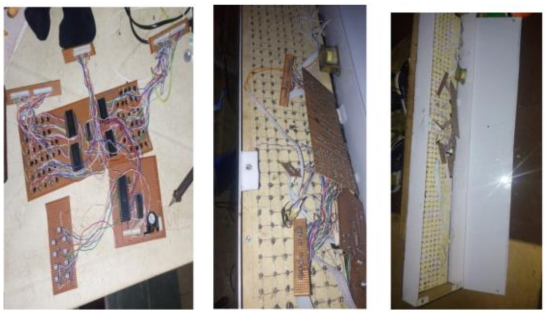


Fig.10. Individual systems and testing

Fig.11. Packaged project mounted in a church premise

III. CONCLUSIONS

Just as buttons were connected to change the message being displayed, gas sensors, PIR etc can be interfaced so that dot matrix does not only display static messages but also displays warning or alarm message whenever a particular condition is detected in the monitored environment. After successful implementation, the messages being displayed on the dot matrix was easily changed by selecting the desired button. The button controlled dot-matrix display designed and implemented in this paper proved to be efficient and cost effective compared to the existing designs of LED matrix display.

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