An Effective Approach to Designing Seven Segment Static Display Systems with Complete Character Representation

[1]Ezekwe Chinwe Genevra, [2]Okwu Patrick Ikechukwu, [3]Mbonu ekene Samuel, [4]Ude Nnaemeka Godwill,

[1, 2, 3 & 4] *Electronics Development Institute, Awka,*
National agency for Science and Engineering Infrastructure (NASENI)
Federal ministry of Science and Technology, Nigeria

ABSTRACT: *A seven-segment display, or seven-segment indicator, is a form ofectronic display device for displaying decimal alphabets-numerals that is an alternative to the more complex dot-matrix displays. Normally seven segment display letter from a-g then numbers from 0-9 quite unlike nine-segment, fourteen-segment and sixteen-segment. Due to these limitations, most display projects go for dot matrix display even with the advantages of sharp display and availability of seven segments. This paper presents various ways of combining two seven segment display to achieve other letters from h-z using piece-wise continuous algorithm via an assembly coded microcontroller (AT89C51). The paper also presents an achieved physical project with seven-segment for faculty of science in the form "FACULTY OF SCIENCE". We wrote codes in assembly language via notepad, which must be saved as .asm file. The saved file was built with an assembler (MIDI - 51) which generated three files; hex file, obj file and list file. The hex file was used for the simulation of the design in Proteus 7.7 VSM professional and burning of the microcontroller for construction. The results were overwhelming as the piece-wise continuous algorithm was implemented, creating rooms for manipulation of 7-segments to form nine – segment, 14-segments and sixteen-segment displays.*

Key words: *seven segment, piece wise continuous algorithm, microcontroller*

I. INTRODUCTION

A seven segment display, as its name indicates, is composed of seven elements. Individually on or off, they can be combined to produce simplified representations of the English and Arabic numerals [4]. Often the seven segments are arranged in an oblique (slanted) arrangement, which aids readability. In most applications, the seven segments are of nearly uniform shape and size (usually elongated hexagons, though trapezoids and rectangles can also be used), though in the case of adding machines, the vertical segments are longer and more oddly shaped at the ends in an effort to further enhance readability. In some 7 segment LEDs, an additional segment is used to denote a decimal point and is referred to as DP. In some LEDs an extra triangle is also included to turn this decimal point in to a comma, which improves the readability of larger numbers[2]. This allows for one digit to be placed upside down along with another digit, such that the two decimal points appear like a colon between the digits.
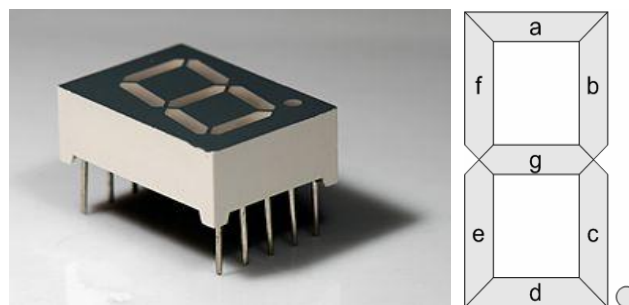

Fig 1.Seven-segment display. [4]

Number	A	B	C	D	E	f	g
0	*On*	*On*	*On*	*On*	*On*	*On*	Off
1	Off	*On*	*On*	Off	Off	Off	Off
2	*On*	*On*	Off	*On*	*On*	Off	*On*
3	*On*	*On*	*On*	*On*	Off	Off	*On*
4	Off	*On*	*On*	Off	Off	*On*	*On*
5	*On*	Off	*On*	*On*	Off	*On*	*On*
6	Off	Off	*On*	*On*	*On*	*On*	*On*
7	*On*	*On*	*On*	Off	Off	Off	Off
8	*On*	*On*	*On*	*On*	*On*	*On*	*On*
9	*On*	*On*	Off	Off	*On*	*On*	*On*

Table 1: Seven-segment truth table

In addition to the ten numerals, seven segment displays can be used to show letters of the Latin[3], Cyrillic and Greek alphabets including punctuation, but only few representations are unambiguous and intuitive at the same time: uppercase *A, B, C, E, F, G, H, I, J, L, O, P, S, U,* , and lowercase *a, b, c, d, g, h,* i, *n, o, q, r, t, u*. Thus, ad hoc and corporate solutions dominate the field of alphabetic on seven-segment displays, which is usually not considered essential and only used for basic notifications, such as internal test messages on equipment under development.

II.   STATEMENT OF PROBLEM

In Nigeria, English language is the general language spoken and understood by almost all and there are twenty- six letters of English language. Seven segment display being the most common does not display all upper and lower case alphabet. This has moved most display designers away from seven segment to dot matrix display even when it is the most efficient and effective in luminosity. In order to solve this problem and increase the usability of seven segment, we embarked into this research using FACULTY OF SCIENCE" as our case study through piece-wise continuous algorithm.

III.   OBJECTIVE OF STUDY

This research work is based on the knowledge of seven-segment display and more specifically on the creation of piece-wise continuous algorithm, by manipulating two seven-segments to get an accurate display of the alphabet we want to display. Secondly, we wrote codes in assembly language via notepad, which must be saved as .asm file. The saved file was built with an assembler (MIDI - 51) which generated three files; hex file, obj file and list file. The hex file was used for the simulation of the design in Proteus 7.7 VSM professional and burning of the microcontroller for construction.   Thirdly the programmed microcontroller with other components were used to achieve physical design of the research which is functional.

IV.   RELATED LITERATURE

Seven-segment displays are made with LED's. they are arranged in a pattern that represents the number '8' (see figure 1 above). Numbers like 0-9 can be displayed and some of the alphabets that can be possible in seven-segment by turning different LED's on or off. The various segments may be light up to form the numeric digits from 0 to 9. Displays with more segments yield a much more realistic alphabet[8]. The seven segment display does not allow true descenders on letters such as "g", "j", "p", "q", and "y". It also does not allow diagonal strokes on letters. The boxy nature of the seven-segment display would also make letters such as "O" and "D" and the number "0" indistinguishable. The voltage drop across a LED segment is typically in the 2 volt range. The output from a display driver is in the range of 5 volts. A 220 Ω to 330 Ω resistors is commonly placed in series to limit the current and provide a voltage drop in the 3 volt range.

IV.1 Seven-segment decoder/driver:
[1]**Seven – segment** decoders are used to take a four-bit BCD input and provide the outputs that will pass current through the appropriate segments to display the decimal digit. The 4-bit will be passed to the circuit which will convert it into 7-bit that will control the display. So we have wired the pins that control them to +5v or ground where appropriate.

Since there are seven-segments, one would assume that you would need seven outputs from the PIC to display one digit. Here we are using a chip that will take four bit and convert it to the 7-bit output for the seven-segment display.

51

IV.2 Seven segment connections

There are two important ways of seven-segment display connection.

- Common Anode Display (+)
- Common Cathode Display (-)

In common Anode display, the anode of all the LED's on the segment are collected and joined together and the individual segments are illuminated by connecting to a Low voltage[7]. In a common cathode display, the cathodes of the LED's are joined together and the individual segments are illuminated by connecting to High voltage. 7-segment LED is capable of displaying different digits, according to which of the segments are turned on or off. However, it will be clumsy and inconvenient to have to build the necessary logic gate structure to turn individual segment on or off to display any digit of your choice.

For the purpose of deign, AT89S52 have to be selected. It is specially designed to be able to drive the LED display. One of the most important precautions to take in any 7-segment construction is to ensure that the right kind of display is used before starting the assembling [6].

IV.3 Microcontroller

The 8051 is a family of microcontroller (Ics) developed, manufactured, and marketed by INTEL co-operation. Other (ics) manufacturers such as ATMEL, PHILPS, AMD, MATRA, and SEIMENS are licensed secondsource of the device [5].

As evidence, the 8051 microcontroller 40-pins (IC) functions as I/O port line. However, 24 of these lines are dual purpose. Each can operate as a controller or pin of address or data bus. Designs requiring a minimum of external memory or other external component use this port for general purpose I/O ports. The fixed amount of on-chip ROM, RAM, and number of I/O ports makes them ideal for many applications in which cost and space are critical. In many applications, the space it takes, the power it consumes, and the price per unit are much more critical considerations than the computing power.
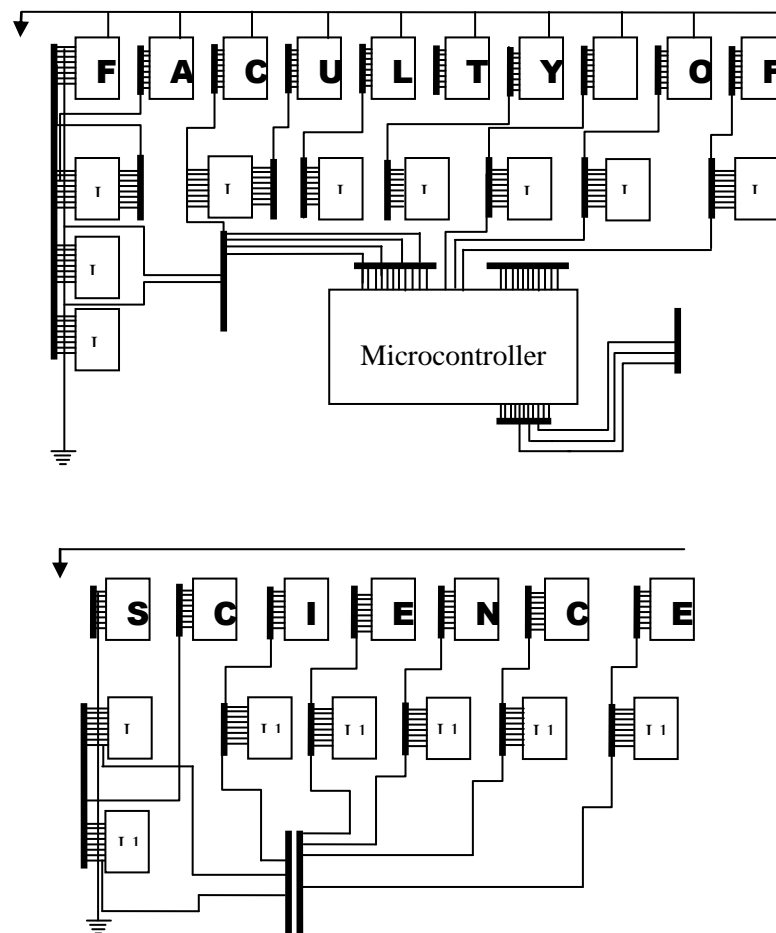

Fig. 2. The microcontroller [5]

The 8051 became widely popular after allowing other manufactures to make and market any flavor of the 8051, but remaining code-compatible.

IV.4 the microcontroller Programmer

A programmer is an electronic device used to burn programming language (especially Assembly language and C language) after compilation into a microcontroller mostly used by digital designers. These programmers come in different sizes and shapes, from different companies.

Fig. 3 the programmer

V.   METHODOLOGY

The methodology used in this project is Rapid Application Development. We wrote codes in Assemble language with notepad, save the file as .asm file extension. The .asm file was opened in M-IDE studio for MCS- 51 where it was build and compiled. After the compilation, three files were generated; .list file, .hex file, .obj file. We used only the .hex file to burn in the compiled assembly language into the AT80C51 with a programmer. With the .hex file also we design a simulated model of the system proteus VSM professional version 7.7 as shown in fig. 4
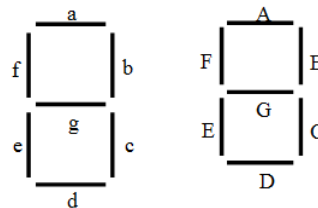

Fig. 4 simulated design of the system in sheet 1 and sheet

From the simulated design the construction of the physical system started which is made up of many electronic and electrical components. This system make used of piece-wise continuous algorithm in which two seven-segments are manipulated to form 14-segments which can display extra characters in Uppercase. The piece- wise continuous algorithm is fully demonstrated below;

ALGORITHM TO DISPLAY "**FACULTY OF SCIENCE**" using seven-segment display

a, b, c, d, e, f, g, as Boolean variables
On =1
Off =0
IF "a" is on display "1"
Else display "0"
To display 'F'
A, B, C, D, E, F, G,
 When A=1
          B=0
          C=0
          D=0
          E=1
          F=1
          G=1
'F'= 1000111

To display 'A'
 When A=1
          B=1
          C=1
          D=0
          E=1
          F=1
          G=1
'A'= 1110111

To display 'C'
 When A=1
      B=0
      C=0
      D=1
      E=1
      F=1
      G=0
'C'= 1001110

To display 'U'
 When A=0
      B=1
      C=1
      D=1
      E=1
      F=1
      G=0
'U'= 0111110

To display 'L'
 When A=0
      B=0
      C=0
      D=1
      E=1
      F=1
      G=0
'L'= 0001110

To display 'T' (this is where piece-wise continuous algorithm is applied to achieve "T" in upper case).

For Segment (1)	For Segment (2)
When A=1,	when A=1
B=1	B=0
C=1	C=0
D=0	D=0
E=0	E=1
F=0	F=1
G=0	G=0

 Segment 1 + segment 2 = F = 11100001000110

To display 'Y'
 When A=0
      B=1
      C=1
      D=0
      E=0
      F=1
      G=1
'Y'= 0110011

To display 'O'
When A=1
      B=1
      C=1
      D=1
      E=1
      F=1
      G=0
'O'= 1111110

To display 'S'
 When A=1
      B=0
      C=1
      D=1
      E=0
      F=1
      G=1
'S'= 1011011

To display 'I'
 When A=0
      B=0
      C=0
      D=0
      E=1
      F=1
      G=0
'I'= 0000110

To display 'N'
 When A=1
      B=1
      C=1
      D=0
      E=1
      F=1
      G=0
'N'= 1110110

To display 'E'
 When A=1
      B=0
      C=0
      D=1
      E=1
      F=1
      G=1
'E'= 1001111
Display "FACULTY OF SCIENCE"

VI.   DESIGN AND IMPLEMENTATION

As mentioned above all the electrical and electronic components were connected and soldered together by us, several testing and corrections were done on the system to bring out a functional system. The overall design flow was summarized in fig. 5.to power on this display system , an alternating current (AC) of 220v enters the transformer from the step-down point, the step-down reduces the current from 220v to 18 to 12v needed to display each segment after passing through resistors of (100w -70ohms) and capacitors which helps to control the flow of high voltage from the segments in order not to cause damage to the LEDs inside the segment, and also stores electrical charges respectively. To display any particular segment of each digit, the controlling integrated circuit will turn on the cathode driver for the selected digit and the anode driver for the selected digit too; with the help of the clock cycle on the circuit, it produces a short blinking interval which will help a new segment to light.

VII.1 Detailed implementation plans
These are the various steps for the implantation of this seven-segment display system.
Step 1
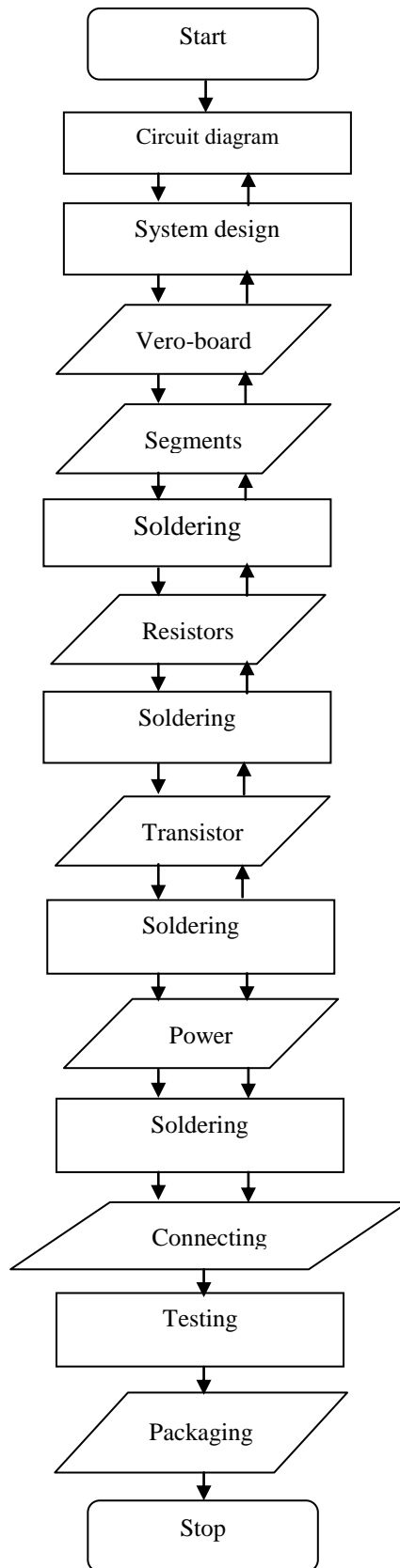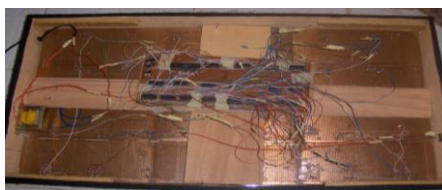Simulation of the display system in proteus VSM professional 7.7

Fig. Design flow
Step 2 Burning of the compiled codes into microcontroller AT89C51 with a wenon programmer.

Step 3 Construction of the control unit with the microcontroller with other components.

Fig. 6 step 3 diagram
Step 4 Construction of display unit with the piece wise continuous algorithm.
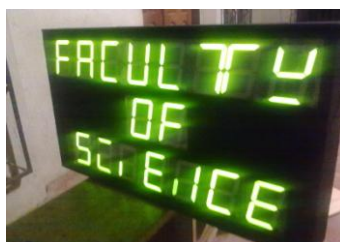

Fig. 7 the piece wise continuous algorithm

Fig. 8 the display unit
Step 5 The combination of the control unit and the display unit to achieve a functional system.

Fig. 9 step 5 diagram
Step 6 Packaging of the working system.

VIII. RESULT

This main aim of this research is to show how seven-segment can be manipulated to display all letters both upper and lower case. This was achieved and it was very interesting through the use of piece-wise continuous algorithm thereby creating room for manipulation of 7-segments to form 14-segments, 9- segment and 16- segment. As researchers, we believe that there is always a room for more improvement on this research work. This project can be widely used in many sector of our economy like in banks, schools, offices, churches and traffic control. Therefore, if more improvements are made on this research, it can have wider application areas,

REFERENCES

[1]   Robert, Optimizing the zilog Z8 Forth Microcontroller for Rapid Prototyping, p3-4, 1996

[2]   J. Ronald, (Monroe community college) and neals, S. (purdue University). Digital systems, principle and applications (8th edition) . Retrieved on August 9, 2011, from http://en.wikipedia.org/wiki/Seven-segment_display , 1998

[3]   L. Huelsman,. Basic circuit Theory with Digital Computations. Series in computer applications in electrical engineering. Englewood cliffs: prentice –Hall. Retrieved on September 9, 2011, from http://wikipedia.org/wiki/seven-segmentdisplaycategories, 1970

[4]   Seven-Segment Displays:http://www.electronics-project-design.com/sevensegmentdisplays.html

[5]   MacDonald, A *Survey of Digital Programming Systems*, Proceedings of the Australasian Conference on Digital System and Display, Brisbane, Australia, 2003

[6]   Mantegazza, Real Time Application Interface (RTAI) in low cost high performance motion control, Motion Control 2003, a conference of ANIPLA, Associazione Nazionale Italiana per l'Automazione (National Italian Association for Automation), Milano, Italy. Retrieved on March 27, 2010, 2003 `.

[7]   Richard, Alpha Architecture, Digital Technology journal, Digital equipment corporation. 4 (4) pp. 55-58,1993.

[8]   Eom, S-R. 0h - "Disturbance Observer Based Force Control of Robot Manipulator without Force Sensor" - proc. of the IEEE International conference on Robotics & Automation – Leuven, Belgium – May 1998. Retrieved on July 22, 2011, 1998