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Designing Segmented Display for Persian (Western Farsi) Numerals

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Abstract: We humans use the decimal code to represent numbers. Digital electronic circuits in computers and calculators use mostly the binary code. Many other special codes are used in digital electronics to represent numbers, letters, punctuation marks and control characters. A common task of decoding from machine language to decimal numbers is encoding. A very common output device to encode English decimal numbers is the seven-segment display. In this study a 12-segment display is proposed for Persian numeric characters display.

Key words: 7-Segment display, persian digits, display driver, LCD (Liquid Crystal Display), LED (Light Emitting Diode), common anode display, decoder, k-map

INTRODUCTION

The Persian language has been written with a number of different scripts, including Old Persian Cuneiform, Pahlavi, Aramaic and Avestan. After the Islamic conquest of the Persian Sassanian Empire in 642 AD, Persian became the language of government, culture and especially religion. Modern Persian appeared during the 9th century. It is written in a version of the Persian script and is full of words of Persian origin. Persian or Farsi, a member of the Iranian branch of Indo-European languages with about 58 million speakers in Iran, Afghanistan and Tajikistan. The form of Persian spoken in Afghanistan is called Dari, while the form spoken in Tajikistan is known as Tajik and is written with the Cyrillic alphabet[1].

English Digit	0	1	2	3	4	5	6	7	8	9
Arabic Digit	٠	١	٢	٣	٤	٥	٦	٧	٨	٩
Persian Digit	٠	١	٢	٣	۴	۵	۶	٧	٨	٩

Notice especially numbers 4, 5 and 6 where the Persian and Arabic differ. Persian is a little kinder than Arabic to non-natives who are prone to mix up the 0 and 5.

The 7-segment display (Fig. 1) is a very common output device used to display the decimal numbers (0-9). Twin 7-segment display is nothing but a joint of two 7-segment displays as Fig. 2.

Segments and joint segments: In a 7 or 12-segment display each unit is known as segment in Fig. 1.

Segment display types: There are two types of displays used to display a segment in the any segment display system.

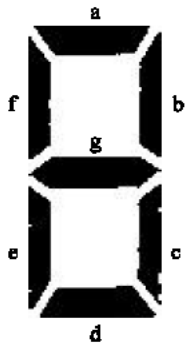

Fig. 1: 7-Segment display

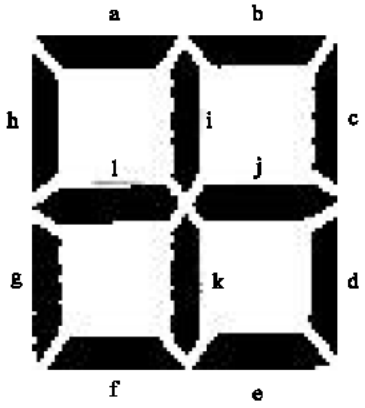

Fig. 2: 12-Segment display

- LED Display: It is a common type of display consists of Light Emitting Diodes arranged as Figure-1.3. Each segment in a LED that emits light when there is current through it. In Fig. 3 (a) the common-anode

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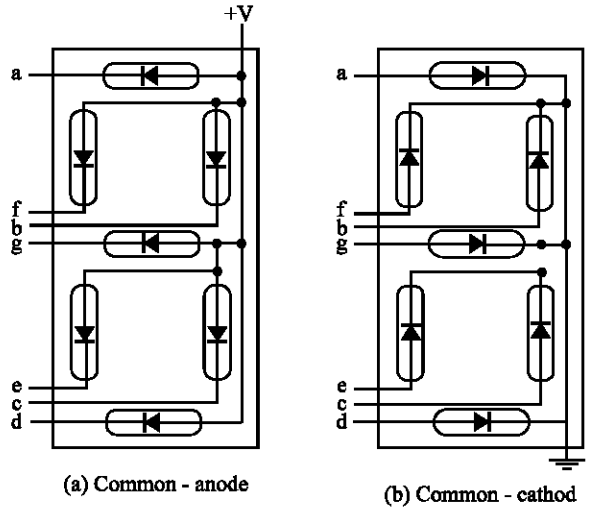

Fig. 3: Common anode and common cathode LED Display

arrangement requires the driving circuit to provide a low-level voltage in order to active a given segment. When a LOW is applied to a segment input, the LED is turned on and there is current through it. If Fig. 3b the common-cathode arrangement requires the driver to provide a high level voltage to activate a segment. When a HIGH is applied to a segment input, the LED is turned on and there is current through it.

- LCD Display: Another common type of display is the Liquid Crystal Display (LCD). LCD operates by polarizing light so that a nonactivated segment reflects incident light and thus appears invisible against its background. An activated segment does not reflect incident light and thus appears dark. LCDs consumes much less power than LEDs but can't be seen in the dark, while LEDs can.

DESCRIPTION OF PROPOSED DISPLAY

The proposed display may be made up of 12 separate LED in a single package. The LEDs are oriented to form ⊞. In our proposed display we have an 13th LED to use for a decimal point. The job of the decoder is to convert the 4-bit BCD code into a proposed segment code that will turn on the appropriate LED segments to display the correct decimal digit.

Common anode LED display for proposed system: The physical layout of a 12-segment display is shown in Fig. 4. This Figure shows that the anode of each LED (segment) is connected to the +5 V supply. Now to illuminate an LED, its cathode must be grounded through a series limiting register as shown in Fig. 4. The value

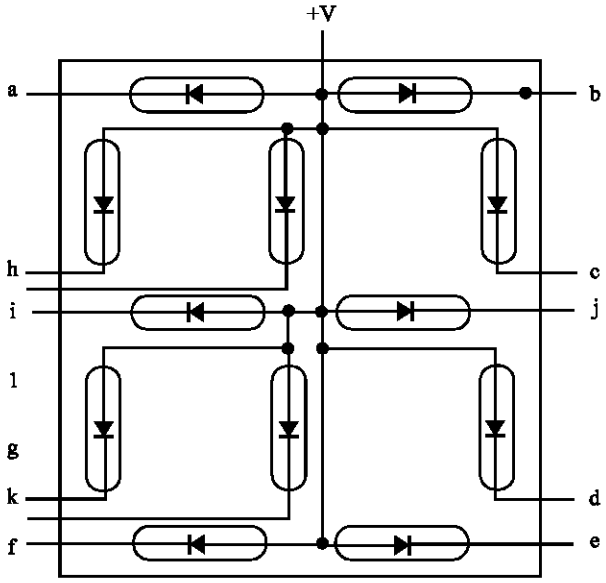

Fig. 4: Common Anode LED display for the proposed system

Table 1: Active and inactive segments for each decimal digits

Persian digits	Equivalent english digits	Segments activated	Alternatives
۰	0	d, e, j, k	f, g, k, l or a, h, i, l or b, c, i, j
۱	1	i, k	c, d or h, g
۲	2	c, i, j, k	h, i, k, l
۳	3	c, g, h, i, j, l	
۴	4	a, b, g, h, i, j	
۵	5	d, e, f, g, i, j, l	
۶	6	c, d, i, j	h, i, k, l
۷	7	c, d, e, i, k	f, g, h, i, k
۸	8	b, c, d, i, k	a, g, h, i, k
۹	9	b, c, d, i, j	a, h, i, k, l

of the limiting resistor can be found by knowing that the voltage drop across an LED is 1.7 V and that is it takes approximately 10 mA to illuminate it. Therefore, R_{limit} = (5.0V-1.7V)/10mA = 330Ω.

Each segment in the proposed display unit may illuminate in the same way.

Common anode displays are active low (low enable) device because it takes a low to turn on (illuminate) a segment. Therefore the decoder IC used to derive a common anode LED must have active low outputs.

DESIGNING THE PROPOSED DISPLAY SYSTEM

The numeric designations for the 10 allowable decimal digits are shown in Fig. 5.

For example if the segment i and k are lit then a decimal 1 of Persian is displayed, on the other hand if a, b, c, d, e, f, g, h, j and l are no lit then the decimal 1 is displayed. By another way (c and d) or (g and h) can be

Table 2: Truth table for proposed segment logic

	BCD Inputs				Segments											
Digits	A_3	A_2	A_1	A_0	a	b	c	d	e	f	g	h	i	j	k	l
0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0
1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0
2	0	0	1	0	0	0	1	0	0	0	0	0	1	1	1	0
3	0	0	1	1	0	0	1	0	0	0	1	1	1	1	0	1
4	0	1	0	0	1	1	0	0	0	0	1	1	1	1	0	0
5	0	1	0	1	0	0	0	1	1	1	1	0	1	1	0	1
6	0	1	1	0	0	0	1	1	0	0	0	0	1	1	0	0
7	0	1	1	1	0	0	1	1	1	0	0	0	1	0	1	0
8	1	0	0	0	0	1	1	1	0	0	0	0	1	0	1	0
9	1	0	0	1	0	1	1	1	0	0	0	0	1	1	0	0

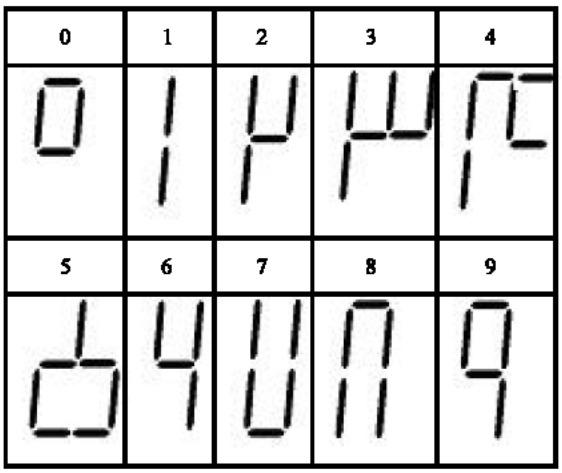

Fig. 5: Segments layout for Persian numeric digits

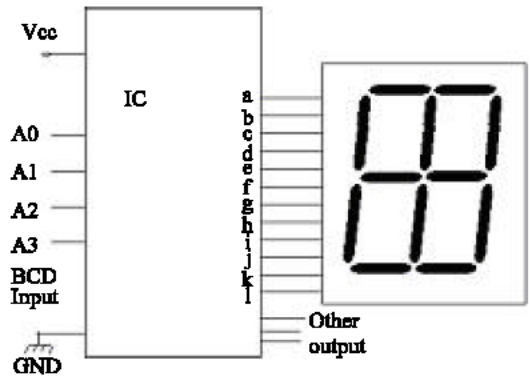

Fig. 6: The segment logic block diagram

used for display 1. But for better combination first one is chosen (it is discussed later).

Segment decoding logic: Each segment is used for various decimal digits. But no one segment is used for all ten digits. Therefore each segments must be activate by its own decoding circuit that detects the occurrence of any of the numbers in which the segment is used. From Fig. 5 the segment that are required to be activated for each digit are determined and listed in Table 1.

Truth table for the segment logic: The segment decoding logic requires four Binary Coded Decimal (BCD) inputs and 12-segment outputs, one of each segment (or joint segment) in the display as indicated in the block diagram of Fig. 6. The multiple output truth table is shown in Table 2. A 1 in the segment output columns of the table indicates an activated segment.

Since the BCD code does not includes the binary values 1010, 1011, 1100, 1101,1110 and 1111 these combinations will never appear on the inputs and therefore be treated as don't care (x) conditions to analyzed while minimizing the logic circuits. To conform to the practice of most IC manufacturers, A_0 represents the least significant bit and A_3 represent the most significant bit in the application.

Boolean expression for the segment logic: From the truth table a standard Sum of Product (SOP) of all segments are as follows:

The minimum implementation of segment logic using k-map: We obtained the minimum SOP expression for all segments as under using karanagh map (k-map):

$a = \Sigma(4)$ $b = \Sigma(4,8,9)$ $c = \Sigma(2,3,6,7,8,9)$ $d = \Sigma(0,5,6,7,8,9)$
$e = \Sigma(0,5,7)$ $f = \Sigma(5)$ $g = \Sigma(4,5,6)$ $h = \Sigma(3,4)$
$I = \Sigma(1,2,3,4,5,6,7,8,9)$ $j = \Sigma(0,2,3,4,5,6,9)$ $k = \Sigma(0,1,2,7,8)$
$l = \Sigma(3,5)$

CONCLUSION

In this study a brief description of Persian numerals representation in the LED display is described. It is also analyzed that in the seven-segment display of English digit representation the Persian digits may also possible to represent. Although the digits 0, 2, 3, 5, 6, 8, 9 are in carved shape and 1, 4, 7 are in straight shape in English but in seven-segment representation every digit follows the digitized shape (all digits bound in a upper, lower, left and right margin) and thus the actual shape of some digits are changed from carved shape to the straight forward

shape. If the strategy of seven-segment is followed it is also possible to represent the Persian numerals in seven-segment format (except the 3 and 4 in Persian). Thus the joint seven-segment (twelve segments) is proposed. That may be implemented to use in industrial purpose.

REFERENCES

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