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Embedded Based Embossing Method for Braille Letters by Braille Binary Values

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ABSTRACT

Braille sheets are the only resources for visually impaired students for their education. Digitalizing the Braille symbols is another mile stone to improve the quality and way of their educations. Braille embosser is a tactile device which is controlled by microcontroller; it is processed by binary value of Braille symbols. Microcontroller gives the output as enable and disable the electromagnetic device corresponding to the digital Braille values. These values are used to process the standard languages as tactile electromechanical Braille symbols. This symbol is identified by touching the surface of the electromechanical device called Dynamic Electro Magnetic Braille cell.

Keywords—Braille, Digital, Microcontroller, Electromagnetic, Tactile

I. INTRODUCTION

BRAILLE is a tactile approach for reading and writing for visually impaired peoples. Tactile means sense by touching or rubbing the surface of the corresponding output device. The basic Braille cell is a two dimensional array arranged by six dots like a 2x3 matrix, two for wide and three for high. Each cell has sixty four combinations of embossed sign and flattened sign. In column one, from top to bottom it numbered as one, two and three. In second column, from top to bottom the dots were numbered as four to six as shown in figure 1.

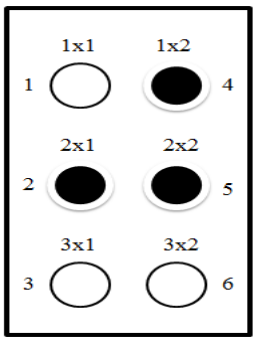


Fig. 1 Structure of basic Braille cell

Braille symbols are identified by the embossing the dots of corresponding dots. Each cell has to states at all combination. They are flat and embossing. In figure 1 the letter 'j' was displayed, the black dots are embossed remaining dots are flattened.

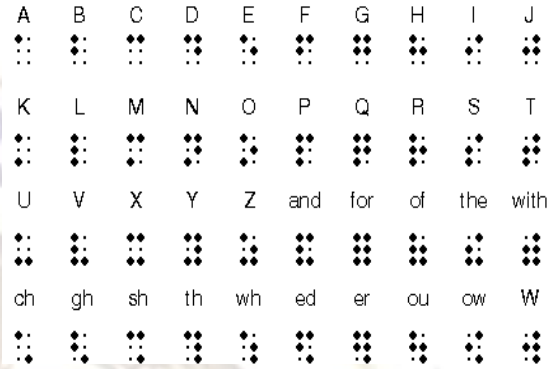


Fig. 2 Standard English Braille chart

The standard Braille symbols of English language is given in figure 2. Numbers and special symbols Braille chart is given in figure 3. Numbers one to nine and zero have the same values of alphabetical small letter 'a' to small letter 'j'. By using identification matrix the input data is alphabetical letter capital and small or numerical value or special symbol. In figure 3 the identification symbol was displayed as left side of the numerical values.In English language this design meets four cases as given below.

1. Small letters
2. Capital letters
3. Special symbols
4. Numeric values

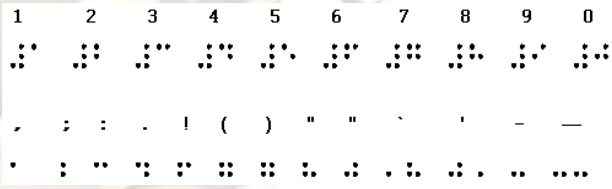


Fig. 3 Standard Braille symbols for numbers and special symbols

II. Digitalization of Braille Symbols

Braille symbol is a universal code, adopting many languages which have the numeric values, symbols and characters. The binary representation of switching process is 'ONE' and 'ZERO' for enabling and disabling the any output device connected with the microcontrollers output pins or ports. These codes will be used for embedded related systems like ON and OFF state tactile output device named as embossers. Braille

binary values are eight bit hexadecimal data to represent a character, symbol or numerical value. Braille cell has six dots as it takes six bits automatically and remaining two bits are dummies.

A. BRAILLE BINARY VALUES

Braille binary code is an eight bit data. Each bit has separate variables named as b0 to b7. This data was separated by two regions, first region has six separate bits starts from B0 and end by B5 serially and carrying binary values according to the desired output of embossing process. B0 starts from third position and B5 end by eighth position of the data format from the left side. The second region has two bits named as B6 and B7 for reserve; they need not to use for six dots Braille cell system. So they are always having 'ZERO'. Hexadecimal value is an eight bit data so to fill the two bits B6 and B7 variables are added and these two bits will have value for eight dot Braille cell system. This data format was got by rearranging the Braille cell as one dimensional array. Figure 4 represents the data format of Braille binary values by changed the dots position as a one dimensional array. Variable B6 and B7 was added left corner of the data format. Figure 5 represents the data variables and the relationship with Braille cell structure.

B6	B7	B0 1X1 1	B1 1X2 4	B2 2X1 2	B3 2X2 5	B4 3X1 3	B5 3X2 6

Fig. 4 Braille Binary values data format

B0 1 1x1	B1 4 1x2
B2 2 2X1	B3 5 2X2
B4 3 3X1	B5 6 3X2

Fig. 5 Braille cell representation for Braille binary values

B. Braille Binary value Bn

The logical output of embossing dot is got from BBV Bn logical equation.

$$BBV\ Bn = \begin{cases} 1 & for\ embossing \\ 0 & for\ flat \end{cases} \quad n = 0, 1\ldots7$$

BBV – Braille binary value

In table 1 the capital letter 'E' has 45H as its ASCII value. By using Bn the Braille binary value of 'E' is 24H. This value is got from compare with Braille chart symbols. If the dot is embossed in Braille chart the BBV has the logical value '1' otherwise BBV has the logical value '0'. According to this rules B5 and B2 bits have the value '1'and remaining bits are flat and last two bits B6 and B7 are '0'. So the letter 'E' gets the value 24H.

TABLE: I Example outputs from Bn

Characters	ASCII Values H	BBV H	Desired output					
			B5	B4	B3	B2	B1	B0
E	45	24	1	0	0	1	0	0
j	4A	1C	0	1	1	1	0	0
$	24	39	1	1	1	0	0	1
5	35	24	1	0	0	1	0	0

III. BBV for Alphanumeric and Symbols

In English language four cases are meet in embossing process. The capital letter BBV and small letter BBV are same but they differentiated by identification symbol. The capital letter will be appearing with the identification symbol value '01H'. The numbers one to nine and zero are having the same BBV of alphabetic 'a' to 'z' or 'A' to 'Z'. But the numbers will be appearing with the identification symbol value '14H'. Table 2 contains the BB values of alphabetical letters, numerical values and symbols.

TABLE: 2 Braille binary value for Alphanumeric and Symbols

Character	BBV	Characters	BBV H	Symbols	BBV H
A	20	a	20	!	1B
B	28	b	28	"	04
C	30	c	30	#	17
D	34	d	34	$	39
E	24	e	24	%	31
F	38	f	38	&	3B
G	3C	g	3C	'	02
H	2C	h	2C	(	2F
I	18	i	18	)	1F
J	1C	j	1C	*	21
K	22	k	22	+	13
L	2A	l	2A	,	01
M	32	m	32	-	03
N	36	n	36	.	11
O	26	o	26	/	12
P	3A	p	3A	:	25
Q	3E	q	3E	;	05
R	2E	r	2E	<	29
S	1A	s	1A	=	3F
T	1E	t	1E	>	16

U	23	u	23	?	35
V	2B	v	2B	@	10
W	10	w	10	[	19
X	33	x	33	\	2D
Y	37	y	37	]	3D
Z	27	z	27	^	17
				_	15
Numbers	**BBV**	**Numbers**	**BBVH**	**Identity**	**BBVH**
0	1C	5	24	Capital	01
1	20	6	38	Small	00
2	28	7	3C	Numbe	14
3	30	8	2C	Symbol	00
4	34	9	18		

IV. BRAILLE EMBOSSER

Braille embosser is a hardware setup which is controlled and processed by microcontroller. It has three parts. Figure 6 shows the block diagram of the entire system.

1. Personal Computer
2. Microcontroller
3. Tactile device

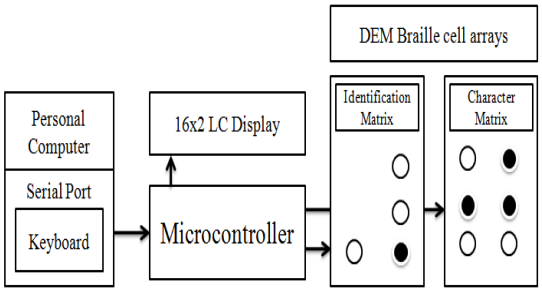
A. Personal Computer

Personal computer is used for entering or transmitting the Hexadecimal data to DEM Braille cell through serial port or comm. port. The passages or required text file will be stored for future use in hard disc or other storage disks. The program was generate and compiled by this same system. If any references or resources will be need from internet for that purpose this personal computer will be used.

B. Microcontroller

Microcontroller is a small scale computer that designed for specific application. After the character was entered in the personal computer it will come to microcontroller and the data will process by it. It has some program memory to store the program as .HEX file format. It has four eight bit parallel input output ports. The output binary data will be given to the tactile device.

Fig. 6 Block diagram of the entire system



In microcontroller the output port pins are arranged in parallel. The electromagnetic array was connected with controller's corresponding output pins. Figure 6 shows the connection of that array as a 2x3 matrix. The identification matrix maximum possible for English language is four so that array has only four solenoids. Remaining two solenoids are absence.

C. *Tactile device*

This tactile device gives the output as shift up the electromagnetic device called solenoid array. When the input is given to this tactile device it shift up and on the OFF state it will goes to flat state. The visually impaired friends touch its surface or rub it to get the output.

V. LOGICAL OUTPUT FOR ALPHABETICAL LETTERS AND NUMBERS AND SIMULATION RESULTS

A. Logical output by Karnaugh Map Solver

The logical output is derived by Karnaugh-Map Simplification method. Each bit of microcontroller's output pins are controlled or switching by this K-Map reduction logical output. The logical formulas of each bit for small, capital alphabetical letters and numerical values are given below.

6th bit B5 = AB'CD'EG + AB'CD'EF + AB'CDE'F' + AB'CDE'G'

5th bit B4 = AB'C'DFG + AB'C'DE + AB'CD'E' + AB'CD'F' + AB'CD'G' + AB'CE'F' + AB'CE'G'

4th bit B3 = AB'C'D'EF' + AB'C'DE'G' + AB'C'DEF + AB'CE'F'G + AB'CE'FG' + AB'D'EF'G' + AB'CD'EFG

3rd bit B2 = AB'C'E'FG' + AB'D'EF + AB'C'DE'F' + AB'C'DF'G' + AB'CD'E' + AB'CD'G'

2nd bit B1 = AB'D'EF'G' + AB'C'D'EG' + AB'D'FG + AB'C'DFG' + AB'C'DF'G + AB'CE'F'

1st bit B0 = AB'C'DF'G' + AB'C'E + AB'C'FG + AB'D'F'G + AB'D'FG' + AB'CE'F' + AB'CE'G'

B. Simulation output

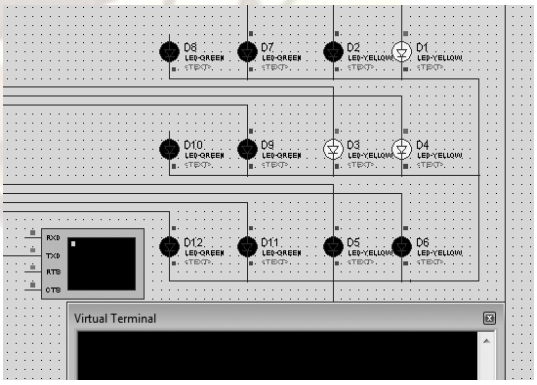


Fig. 7 Simulation output of letter 'j

The above formulas were programmed by using Keil micro version 3 Integrated Development

Environment for NXP 89v51RD2 microcontroller and this results were verified using PROTEUS simulator using two LED arrays replaced for electromagnetic arrays. Left array uses for identification matrix and right array uses for character matrix. Light Emitting Diodes were replaced to electromagnetic device for simulation. The output was verified by 2x3 two LED matrixes with microcontroller. The input is HEX value of the alphabetical characters and the output is the Binary value of the Braille symbols. The embossed sign is indicated by glowing the LED matrix corresponding pins.

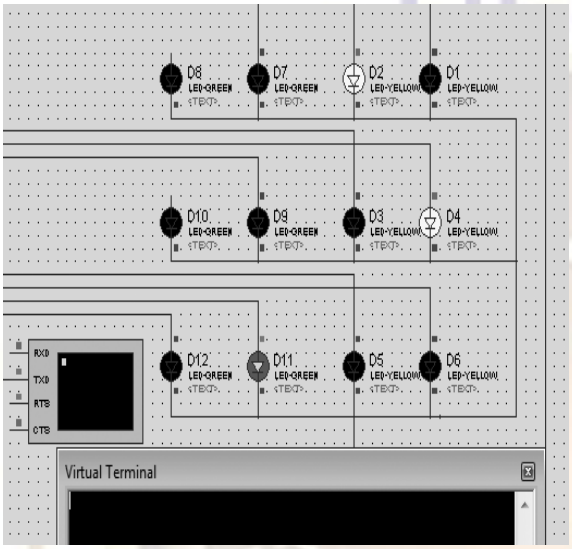


Fig. 8 Simulation output of letter ‘E’

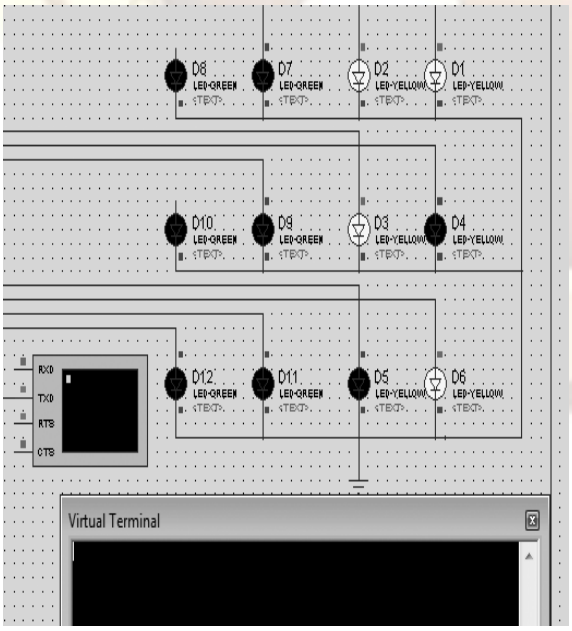


Fig. 9 Simulation output of Symbol ‘$’

Fig 7 represent the model output of character small ‘J’. In this image the LEDs D1, D3 and D4 are glowing. It is indicated as white color. Input letter is small ‘J’ so left side LED array did not glow.

Fig 8 represents the model output of character E. In this image the LEDs D2 and D4 are glowing. It is indicated as white color. Input letter is capital letter E so left side LED array D11 glow as grey color and rest of the LEDs are OFF state.

Fig 9 represents the model output of symbol $. In this image the LEDs D1, D2, D3 and D6 are glowing. It is indicated as white color. Input letter is special symbol ‘$’ so left side array LEDs are OFF state.

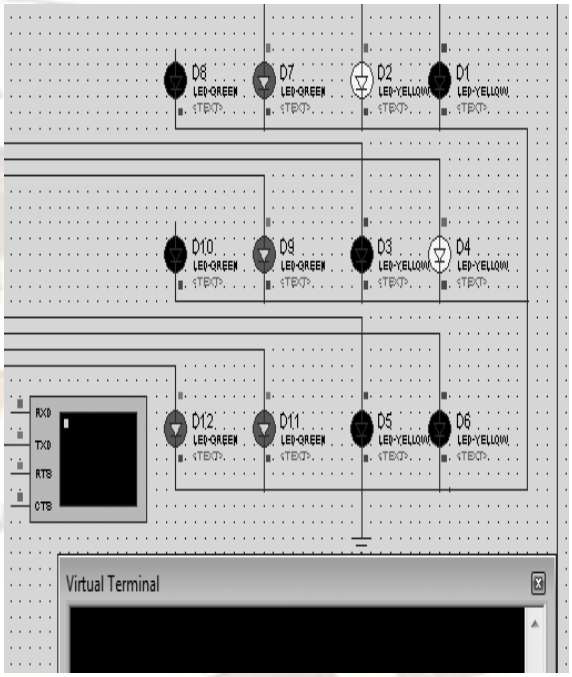


Fig. 10 Simulation output of Number ‘5’

Fig 10 represents the model output of number ‘5’. In this image the LEDs D2 and D4 are glowing. It is indicated as white color. Input letter is a number so left side array LEDs are ON state except D6 and D10.

VI. CONCLUSION

Braille learning scheme has three grades. This paper describes the algorithm result for grade I level for English language. The algorithm was designed to all sixty three combinations. This system designed for only one user and teacher. In future this system will develop by adding graphical displays for teacher interaction and multiuser facilities and increase these with the help of adding higher end microcontrollers. The output formulas were verified by using 2x3 LED matrixes in PROTUES simulator. This verified code will be dumped in the program memory of microcontroller and the electromagnetic device will be connected with its output pins. In future more than one character will add with microcontroller connected by additional solenoid arrays.

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Boaz received Bachelor of Engineering in Electronics and Communication in C.S.I Institute of Technology in Thovalai under Anna University in India at 2010. Currently he is pursuing his Master of Technology in Embedded Systems and Technology in Electrical and Electronics Engineering in Kalasalingam University at Krishnankoil in India.