Arranged Braille Computer Display Board (ABCD): A Simulative Scholastic Approach towards Analytic Circuitry

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ABSTRACT
Visionless persons find it very difficult to access the screen of computer and mobile. This article presents a preliminary novelty attempt towards the design of Computer Display Board (CBD) with the support of Braille language to solve the problem. Using basic logic designs the system converts computer screen information to Braille Computer Display Board (CBD) signals. A microchip design approach is undertaken in place of the complicated logic circuit to solve the problem. Synchronization table formed towards the implementation of English Digits and Alphabets to Braille Language is established. Simulation based experimental result analysis implemented in this paper with VHDL result considering the word "I LOVE INDIA". The entire process of the designed prototype is presented for Computer Display Board (CBD). This attempted research article strives to facilitate a cyber-communication facility for visionless people.

Keywords
Braille computer, Blind display board, Braille alphabet, Braille cell, Logic design.

1. INTRODUCTION
Science over the years has scaled unimaginable peaks and achieved great heights, but even today some very genuine problems lie unattended. One such major issue is the inability to discover and design a display system for the visually impaired people for whom a display system is an essential thing. Versatility of modern science and technology has presented an innovation form of braille keyboard which gives a ray of hope for the visionless, but display unit related to braille keyboard is still in a conceptual stage [1].

Braille is accepted as the communication medium for the visually impaired people all over the world. This language has enabled them to read, write and interpret a variety of things around. However, in spite of all these advantage the braille system is yet to leave behind a significant impression in the field of computer technology due to the unavailability of any proper braille oriented display device.

This research work is a step forward in developing a screen for the visionless, which will enable them to connect to the world of computers more easily.

2. COMPARATIVE STUDY OF VISUALLY IMPAIRED COMMUNICATION TOWARDS EMERGING TECHNOLOGICAL ASPECTS
Nowadays, Braille has become the most important way to learn and obtain information for visually impaired. Although they are deprived in a way but they are blessed with other sensations like heating touching smelling etc. which in a way are superior to any so called normal persons. Chung et al. introduced the concept of Virtual Laboratory; an interactive Braille monitor which is focused on virtual-interaction of voice-video data information of Internet to communicate with systems and multimedia facilities for vision disabled persons [2]. Electronic Braille panels attachable with computers that allow reading the contents of a display line of Braille characters. Saad et al. proposed system architecture of electronic Braille panels which includes several modules and one storage database of all verses and ayah of Al-Quran for reciting Holy AL-Quran in Braille [3].

Modern research technologies have been enriched with several inventions to maintain equal rights in favors of computer education for visually impaired persons. A tactile display allows information to be communicated by stimulating a user's sense of touch. This is an apparatus where user touches the Braille words. They are communicated through a series of bumps or dots. Refreshable Braille displays contain tactile devices for the Visually Impaired person [4]. Becker et al. invented Braille Computer Monitor, which includes rectangular cells each cell having movable electromechanical impact pins of four rows and two columns which read by a Visually Impaired person. To erase an erasing mechanism provided for driving positively the pins downwardly [5]. Dasgupta et al. introduced a system which allows reading and writing Indian language texts through a computer. Text to speech system is performed bidirectional transliteration of Indian language text document to Braille Language and gives corresponding audio feedback of selected text [6]. Rajarapollu et al. presented an economic system, Braille to Text/Speech converter on FPGA Spartan3 kit. The Braille input is given through braille keypad to the FPGA Spartan3 Kit and FPGA converts text through the decoding logic in VHDL gets Braille language according to input and gives corresponding speech. The information is also gets displayed on the screen [7]. In 2015, Heetha et al. introduced human computer interference for visually disabled. This project enabled the visually impaired people to type on a keypad and to get conformation about what is being typed from an externally attached speaker. Here Braille language gets converted into English language then the corresponding word is converted into speech signal [8]. Neogi et al. presented a communication system having a tactile display board for the blinds which was IPR filed in November 2015. This arrangement helps blind people to access any type of soft data. Precisely, the system interprets English Language in computer screen to Braille Language. First prototype was tested and recognized by blind people. With vibrating Braille dots substantiated more efficient than the traditional raised dots of Braille system. Approaching Arranged Braille Computer Display Board (ABCD) is an economical technology for Visually Impaired [9]. This paper is an extended part of this ergonomics and human factor related research work dealing with an initiative towards the logic design circuit implementation with VHDL testing.

3. COMPACT REPRESENTATION OF BRAILLE COMPUTER DISPLAY BOARD THROUGH TECHNOLOGICAL DEPICTION

Braille, a tactile writing system for the visually impaired consists of small rectangular blocks with six dots for character identification of the letters generally represented as combination of dots that can be understood by a person with left to right finger movement over them. Each dot or combination of dots represents alphabets, punctuations or numerical digits involved have a specific notation according to the braille system as per their international recognition. The lack of any braille based display screen has hindered the aspirations of the visually impaired people and deprived them from freely interacting with the modern tech savvy world [10].

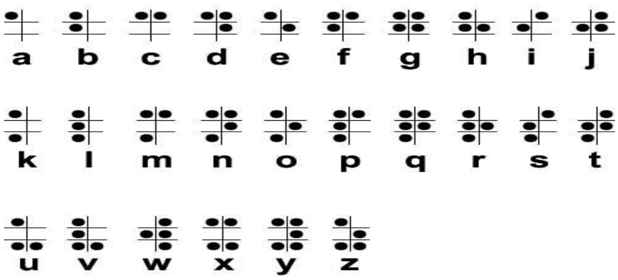

Fig 1: English Braille Alphabet

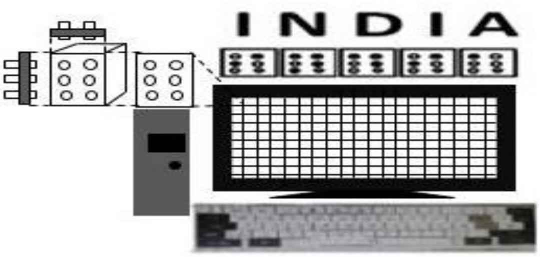

Fig 2: Braille display Artwork Representation

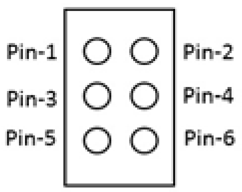

Fig 3: Cell diagram with Vibrating Pins

The compact presentation of this prototype is depicted in fig. 2. The approach uses more natural interactive model, gathers information regarding the write-up and configuration is given exactly like in face-to-face situations. This tactile communication systems [11] is used as low-cost input peripherals consisting of one braille key board that contains conventional braille letters along with the output peripherals consisting of a display monitor having cells those are actually presenting each braille letter. Each cell consists of 6 vibrating pin heads, which responds according to displayed letter represented in fig. 3.

The concept can be explained briefly as "INDIA" is needed to be written, for the first letter "I" the Pin head 2 and 3 should vibrate then for "N" pin head 1, 2, 4, 5 should vibrate. Next letter is "D", pin 1, 2, 4 should vibrate. For another letter "I" the Pin head 2 and 3 should be active and for letter "I" the Pin head 2 and 3 should vibrated. For the last letter "A", Pin head 1 should vibrate. In this manner any word can be recognized by visual impaired person on specially designed tactile display board [12].

4. PROPOSED PROTOTYPE CONSIDERATIONS TOWARDS BRAILLE DISPLAY BOARD

The braille display board [13] is connected through a control box with computer. The display unit follows a computational process to communicate a word or sentence to a visual impaired person through the soft touch over the screen. The computer screen image is captured and projected on the braille display screen in this way the image is fully fitted on it. The display board is basically a grid module consisting of a number of cells. Each cell consists of six pins with vibrator circuits and LED connections behind them. The letters are positioned in a proper co-ordination of axis.

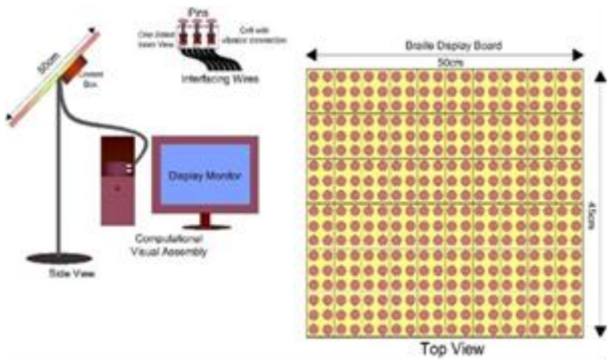

Fig 4: Artwork view of prototype braille display board

In that way, the vibrator circuits and the LED lights of respective cells gets activated. A sightless person can easily understand the written objects vibrated on board through touching over them.

5. SCHEMATIC APPROACH TOWARDS SYSTEM FUNCTION

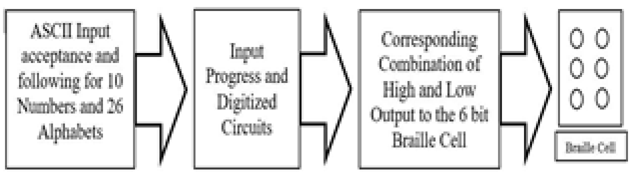

Fig 5: Single Cell Circuit Block Representation of Braille Display

Block Diagram of Arranged Braille Computer Display Board (ABCD) is shown in fig 5. The Diagram consists of 4 blocks and they are marked in circuit diagram, is shown below in fig 6. ASCII Input acceptance and following for 10 Numbers and 26 Alphabets is first block, Second block consider Input Progress and Digitized Circuits, Corresponding Combination of High and Low Output to the 6 bit Braille Cell is in Third block and Final block is Output which is Braille Display Board.

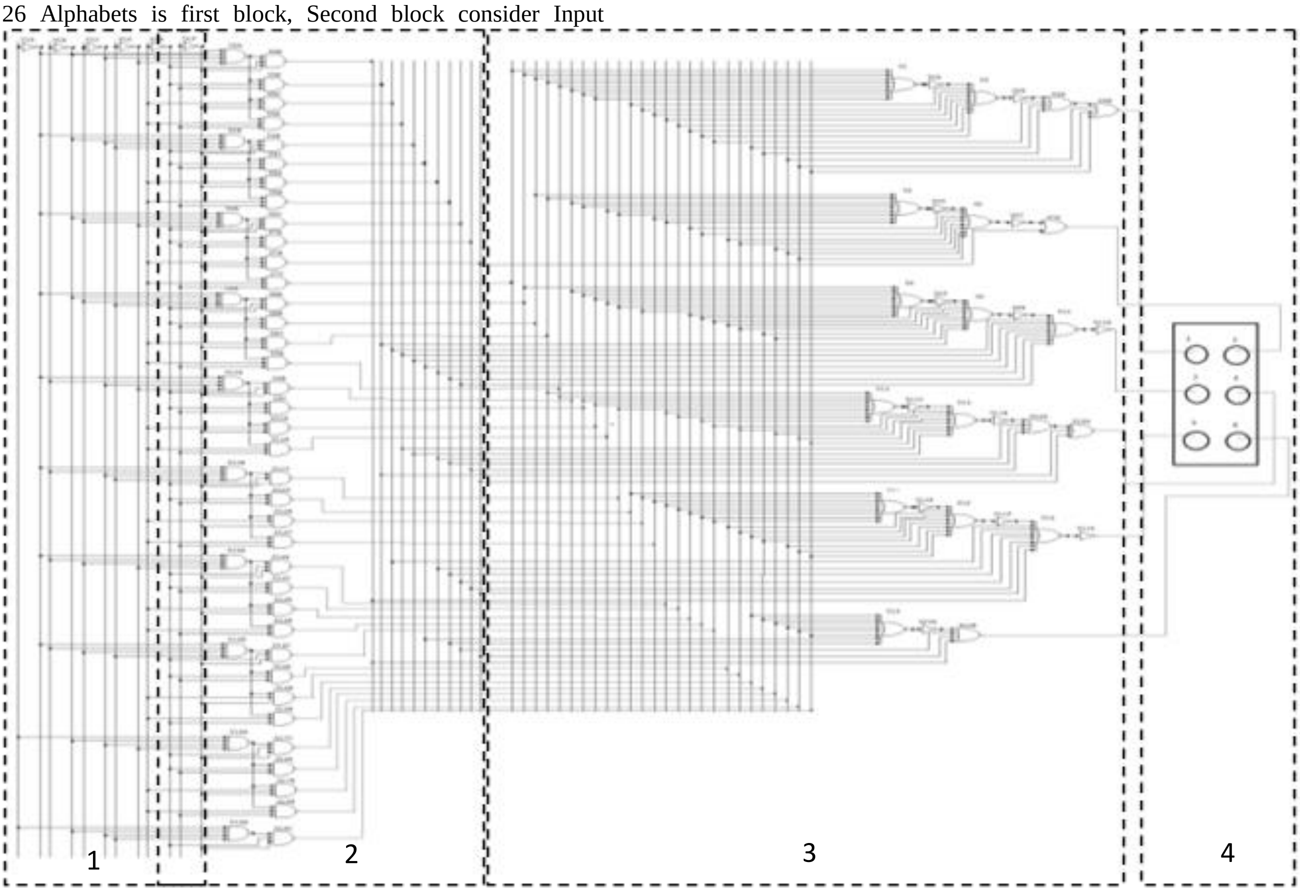

Fig 6: Single cell circuit representation of braille display board

The entire circuit is a schematic approach of braille display board for visually impaired person is signified in fig.6.The entire congested circuitry mechanism is full of Complexity of 47 AND gates, 25 NOT gates and 19 OR gates. Each cell is divided into six consecutive pins and each of them is connected with gate assembly.

Operating the pin 1, 8 input pin OR gate is used to connect input terminals. The output of OR gate connected with a NOT gate and the output is connected with another OR gate with 7 other input pins to generate output that proceeds a NOT gate U2B. Pins r, u, v are connected with OR gate U4A along with U2B gate output. Final operation of pin 1 follows the OR gate U4B with x,y,z three input pins along with U4A gate output.

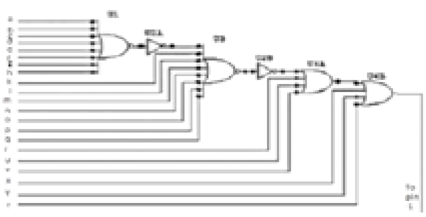

Fig 7: Circuit representations for operating pin 1

Operating the pin 2, 8 input pin OR gate U9 is used to connect b, f, g, h, i, j, l, p input terminals. The OR gate output is connected with a NOT gate U2F and Pins 2, 3, 4, 5, 6, 7, 8 are connected with OR gate U10 along with U2E gate output. Final operation of pin 2 follows the NOT gate U11A with U10 gate output.

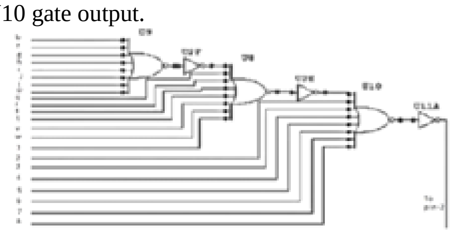

Fig 8: Circuit representations for operating pin 2

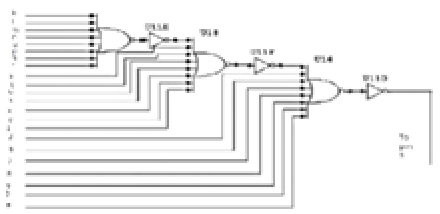

Fig 9: Circuit representations for operating pin 3

Operating the pin 3, 8 input pin OR gate U17 is used to connect k, l, m, n, o, p, q, r input terminals. NOT gate U11E is connected with OR gate output and the output is connected with another OR gate U1B with 7 other input pins s, t, u, v ,x, y ,z to generate output that precedes a NOT gate U11F. Pins 2,6,7,8,9,0,# are connected with OR gate U16 along with

U11F gate output. Final operation of pin 3 follows the NOT gate U11D with U16 gate output.

Operating the pin 4, 8 input pin OR gate U6 is used to connect c, d, f, g, i, j, m, n input terminals. gate U5 with 7 other input pins p, q, s, t, w, x, y to generate output that proceeds a NOT gate U2C. Pin # is connected with OR gate U7A along with U2C gate output for showing final operation.

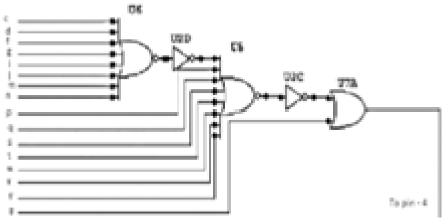

Fig 10: Circuit representations for operating pin 4

Operating the pin 5, 8 input pin OR gate U14 is used to connect d, e, g, h, j, n, o, q input terminals. OR gate output is connected with a NOT gate U11C and output is connected with another OR gate U13 with 7 other input pins r, t, w, y, z, 3, 4 to generate output that proceeds a NOT gate U11B. Pins 6,7,9 are connected with OR gate U12A along with U11B gate output. Final operation of pin 5 follows the OR gate U15A with U12A gate output, 0 and #.

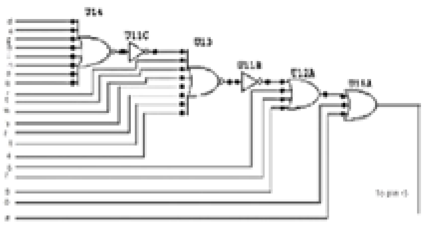

Fig 11: Circuit representations for operating pin 5

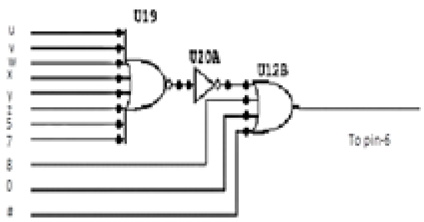

Fig 12: Circuit representations for operating pin 6

Operating the pin 6, 8 input pin OR gate U19 is used to connect u, v, w, x, y, z, 5, 7input terminals. NOT gate U20A is connected with output of OR gate and the output is connected with another OR gate U12B with 3other input pins 8, 0,# to generate the operation of pin 6.The circuit connection is described for one cell. The Braille display board consists of numerous numbers of cells. On pressing the desired key, the information is sent to the designed control unit to get the desired pattern that has been decided and tabulated before. The table containing pattern for respective keys is discussed in table I.

Table 1. Input Values of Respective Keys

Digit and Alphabets	Required Pattern					
0	LF 0	LE 0	LD 0	LC 0	LB 0	LA 0
1	LF 0	LE 0	LD 0	LC 0	LB 0	LA 1
2	LF 0	LE 0	LD 0	LC 0	LB 1	LA 0
3	LF 0	LE 0	LD 0	LC 0	LB 1	LA 1
4	LF 0	LE 0	LD 0	LC 1	LB 0	LA 0
5	LF 0	LE 0	LD 0	LC 1	LB 0	LA 1
6	LF 0	LE 0	LD 0	LC 1	LB 1	LA 0
7	LF 0	LE 0	LD 0	LC 1	LB 1	LA 1
8	LF 0	LE 0	LD 1	LC 0	LB 0	LA 0
9	LF 0	LE 0	LD 1	LC 0	LB 0	LA 1
#	LF 0	LE 0	LD 1	LC 0	LB 1	LA 0
A	LF 0	LE 0	LD 1	LC 0	LB 1	LA 1
B	LF 0	LE 0	LD 1	LC 1	LB 0	LA 0
C	LF 0	LE 0	LD 1	LC 1	LB 0	LA 1
D	LF 0	LE 0	LD 1	LC 1	LB 1	LA 0
E	LF 0	LE 0	LD 1	LC 1	LB 1	LA 1
F	LF 0	LE 1	LD 0	LC 0	LB 0	LA 0
G	LF 0	LE 1	LD 0	LC 0	LB 0	LA 1
H	LF 0	LE 1	LD 0	LC 0	LB 1	LA 0
I	LF 0	LE 1	LD 0	LC 0	LB 1	LA 1
J	LF 0	LE 1	LD 0	LC 1	LB 0	LA 0
K	LF 0	LE 1	LD 0	LC 1	LB 0	LA 1
L	LF 0	LE 1	LD 0	LC 1	LB 1	LA 0
M	LF 0	LE 1	LD 0	LC 1	LB 1	LA 1
N	LF 0	LE 1	LD 1	LC 0	LB 0	LA 0
O	LF 0	LE 1	LD 1	LC 0	LB 0	LA 1
P	LF 0	LE 1	LD 1	LC 0	LB 1	LA 0
Q	LF 0	LE 1	LD 1	LC 0	LB 1	LA 1
R	LF 0	LE 1	LD 1	LC 1	LB 0	LA 0
S	LF 0	LE 1	LD 1	LC 1	LB 0	LA 1
T	LF 0	LE 1	LD 1	LC 1	LB 1	LA 0
U	LF 0	LE 1	LD 1	LC 1	LB 1	LA 1
V	LF 1	LE 0	LD 0	LC 0	LB 0	LA 0
W	LF 1	LE 0	LD 0	LC 0	LB 0	LA 1
X	LF 1	LE 0	LD 0	LC 0	LB 1	LA 0
Y	LF 1	LE 0	LD 0	LC 0	LB 1	LA 1
Z	LF 1	LE 0	LD 0	LC 1	LB 0	LA 0

As per the matched pattern, electrical signal has been generated for six different wires. For displaying ‘A’ in Braille monitor six wires LA’, LB’, LC’, LD’, LE’, LF’ has been connected with the main wires LA, LB, LC, LD, LE, LF by NOT gates to send reverse voltage of wires LA, LB, LC, LD, LE, LF respectively. AND gate has been used to get a high voltage at output by getting connected with required wires according to the pattern. For Letter A, AND gate inputs will be connected to the wires LA, LB, LC’, LD, LE’, LF’. Similarly, for all alphabets and digits AND gates has been used to get High voltage at output. One Braille letter block for representing one Braille alphabet or digits contain 6 pin heads connected with vibrating motors [14] for each pin. Form conventional Braille letter table it has been found that each pin head is getting vibrated for few letters/ digits, mentioned in Fig 13.

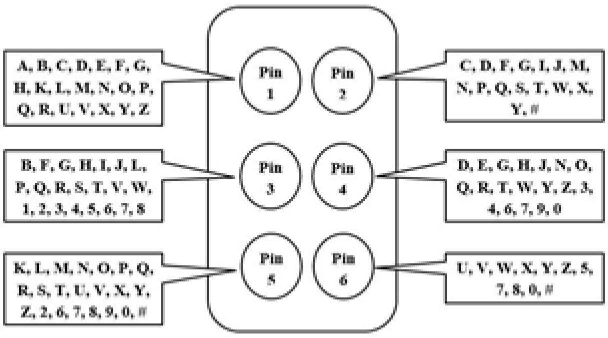

Fig 13: Output Values of Vibrating Keys

Venn Diagram for the vibrating pins for respective signals is given in fig 14 for 26 Alphabets and in fig 15 for 10 Numbers.

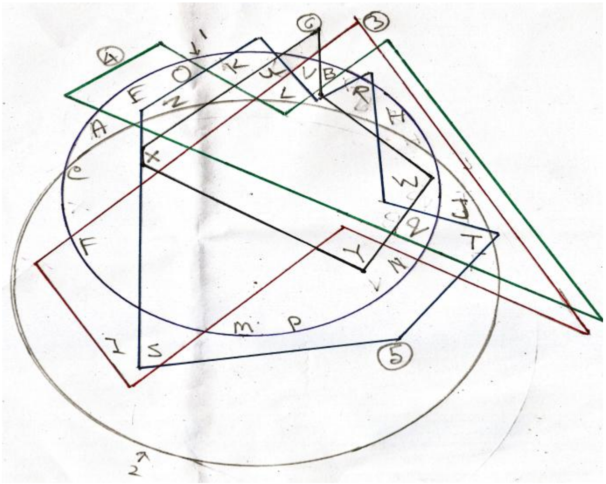

Fig 14: Venn diagram for 26 Alphabets

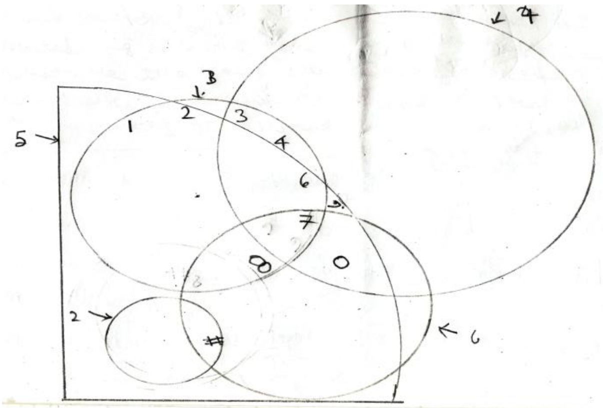

Fig 15: Venn diagram for 10 Numbers

The implementation of micro-chip based design approach was successful for conversion of Text to Braille Computer Display Board (CDB). Through ModelSim [15] software input was given in VHDL Language to simulate the program generated waveform. Fig. 16 and Fig. 17 are shows the simulation result for the word "I LOVE INDIA". The VHDL programming for any word have been implemented experimentally. The presented logic circuit supposed as generalized from of English Digits/ Alphabets to Braille Language converter.

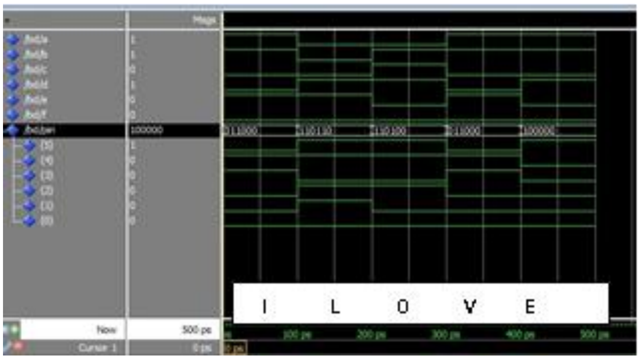

Fig.16. Simulation of Waveform for "I LOVE"

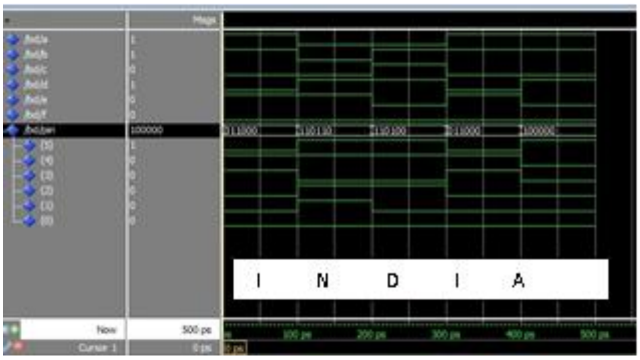

Fig.14. Simulation of Waveform for "INDIA"

However, designed control unit contains a huge number of logic gates requiring a lot of ICs in order to be implemented for a single Braille block design. To overcome these issue research work ongoing for implementing it at micro level chip design instead of huge operational circuit. Noise or interference affects the total operational circuit for huge number of ICs, using microchips these noise can be minimized [16]. IN and OUT time rises with the increasing number of ICs making propagation delay notably high, depending on included features and IC fabrication materials. Better response time with minimized delay can be obtained in microchip concept [17]. On extension of this research; the IC chip design approach will be initiates for grid oriented Braille cell of haptic computer screen.

6. CONCLUSIONS

Nowadays blind people are capable to understand by hearing with the help of software converting data files to audible sound, but they are not very user friendly apart from that, this software is not compatible with many Web Pages and are unable to read them aloud. To present a better solution, this concept is introduced. Till now, success is achieved for six cell of braille letter with this designed prototype. In future aspects, the overall system will be developed with a VLSI based processer chip for a single braille computer display board. Apart, from this design the direct sift-register based concept is also in the design phase and is being successfully tested. Presently, a short initiative has been taken to implementation this processes for mobile screen. With several engineering attempt, this product based research will be a big step forward towards the usher for blind people of our society.

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