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BRAILLE GLOVE VIBRATION SYSTEM FOR DIABETIC AFFECTED DISABLED PERSONS

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ABSTRACT

All over the world, persons who are visually impaired have used Braille as the primary means of accessing information. Also, the concept of Braille has been accepted as a universal approach that works across the boundaries of the world. Different countries of the world have adapted the system of Braille to suit their languages. As people age, many of them are forced to stop reading Braille because of losing the sensation in their fingertips, a common effect of diabetes and other diseases. In this paper, Braille glove vibration method is a device for the benefit of deaf-blind people having losing sensation in their fingertips, it proposes a new approach to blind persons to know about computer oriented technologies.

Keywords: Braille, vibration, diabetic, disabled person, hand glove.

1. INTRODUCTION

Braille is a series of raised dots that can be read with the fingers by people who are visually impaired or deaf and blind. Teachers, parents and others who are not visually impaired ordinarily read Braille with their eyes. Braille is not a language. It is a code by which all languages may be written and read. Braille is now used in almost every country in the world and has been adapted to almost every known language, from Albanian to Zulu. Braille codes have also been developed to represent many symbols used in advanced mathematical and technical material; musical notation and shorthand. People who have both sight and hearing impairment are known as deaf and blind. Because of their impairments, they face many problems in their day today activities. It is particularly difficult for totally deaf and blind people to acquire vital and sufficient information necessary for daily living, compared with normal people [3][4].

The six dots forming the cell permit sixty four different patterns of dot arrangements. It is matched with alphabets, numbers and special symbols of the English language. These six positions which can be raised or flat, are used in combination to give just 64 different Braille characters. This clearly means that there cannot be one to one correspondence between Braille characters and English characters.

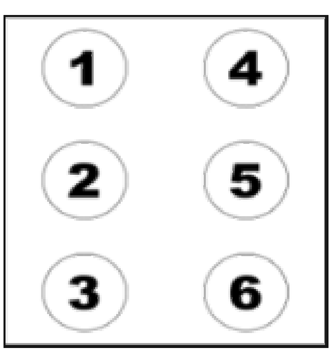

Figure-1. Braille cell.

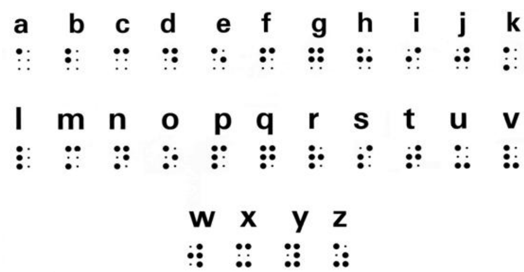

Figure-2. Braille alphabet.

In Braille, all capital letter is indicated by placing a dot in the 6[th] position followed by small case letter values. Braille numbers are constructed using the first ten letters of the alphabet "a" through "j" and a special number Sign (#) i.e., dots 3, 4, 5 and 6 in front of the each value. It is represented as follows:[7][9]

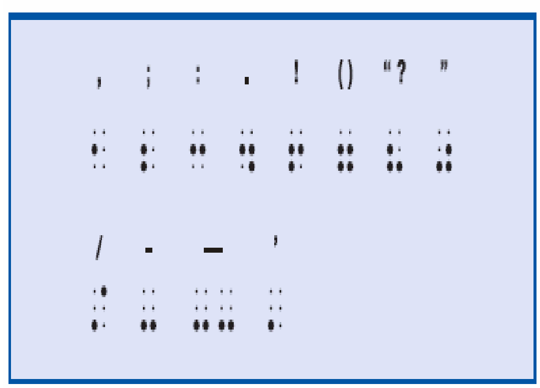

Figure-3. Braille symbols.

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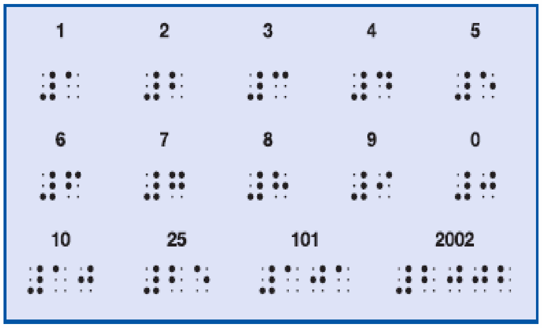

Figure-4. Braille numerals.

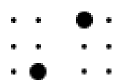

Figure-5. Capital letter A.

So these 64 combinations of six dots cover alphabet, symbols, numbers and mixing of numbers and letters.

Standard Braille is an approach for creating documents which could be sensed through touch. This is accomplished through the concept of a Braille cell consisting of raised dots on thick sheet of paper. The protrusion of the dot is achieved through a process of embossing. A visually impaired person is taught Braille by training him or her in discerning the cells by touch,accomplished through his or her fingertips.The image below shows how this is done The visually impaired person can touch the raised position of eqch cell from left to right in the Braille sheet using their fingertips and understand the equivalent English letter value[8][10]

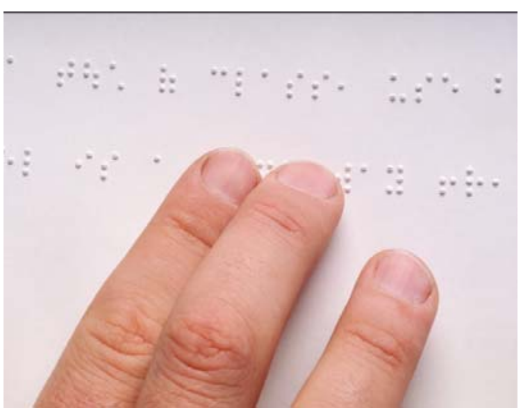

Figure-6. Braille sheet.

Suppose visually impaired person having problem like long term diabetics often have a condition knows as "diabetic neuropathy" [1][5], a circulatory problem causing many of the complications that the diabetics might encounter. Neuropathy causes not only insensitivity in the fingertips and toes; it causes more blindness, kidney failure, heart attacks and other related medical problems. Also the continuous readings in Braille produces swelling in the ankles which cause reading times are very slow [2].

2. LIMITATIONS OF BRAILLE

The main problem with Braille labels is that proportion of blind people who can read Braille is very low (contrary to many people's expectations). Hard statistics are difficult to obtain, but the American printing House of the Blind (APH, 1993) estimates it to be as low as 9% of blind people (and it is only people with a total lack of sight who use Braille at all, those with visual impairments do not). Thus, to the vast majority of people for who the adaptation is intended it is quite useless.

Character recognition for the visually disabled is one of the most difficult tasks since the characters have complex shapes and are very small compared with physical obstacles. In some cases a person with long term diabetics will lose sensitivity in the fingertips leading to inability to continue in reading Braille[2][6]. Also Braille has come under attack in recent years due to the following main reasons

- Most of the Braille equipments are mechanical
- Computer Braille related software and hardware equipments are less in use
- There have hardly been any device for educational purpose and routine communication

Therefore this paper focus has been on vibration in six different positions in the right hand which matches the Braille code.

3. PROPOSED SYSTEM

Braille is a method of representing characters through a pattern of raised dots so that the blind can read by the sensation of touching. Written communication between two people is an easy task provided that they can both read and write the same language. So this paper explains "To design a translator for converting English text to Braille code and this Braille code into vibration signal". The vibration produce more sensitivity in fingers for long term diabetics persons will lose sensitivity in the fingertips leading to inability to continue reading Braille.

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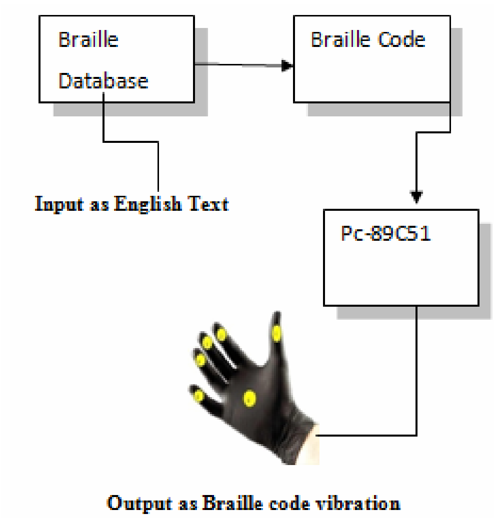


Figure-7. Diagrammatic representation of the problem.

4. BRAILLE CODE VIBRATION TRANSLATION SYSTEM

4.1. Braille software algorithm

When English text is translated to Braille code, the steps are as follows:

a) Read the input value up to the enter key.
b) Separate the words on the basis of blank space.
c) Break the word into single letter.
d) Access the Braille database based on the following major condition:

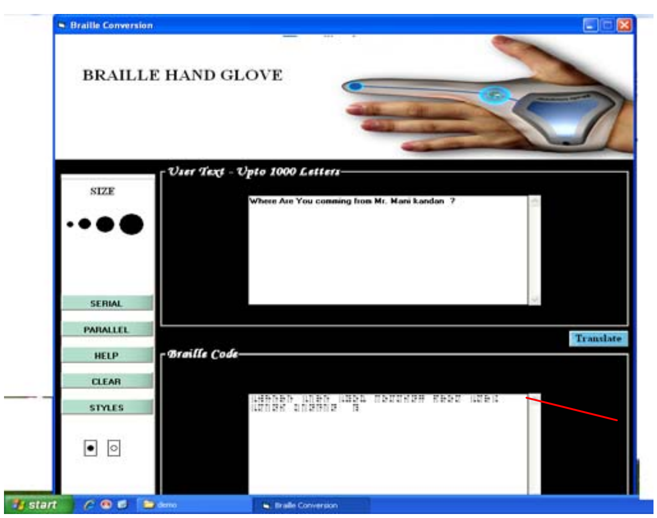
- If the input value is between 'a' to 'z', then it prints the corresponding small letter Braille Symbol from the Braille Database.
- If the input value is between 'A' to 'Z' then it prints the corresponding Capital letter Braille symbol from the Braille Database. (Capital letters are indicated by placing a dot in the 6th position of the Braille cell followed by lowercase Braille symbol of the same letter.)
- If the input value is between '0' to '9' then it prints the Braille Numbers from the Braille Database. (Braille numbers are constructed using the first ten letters of the alphabet "a" through "j" and a special number sign (#) i.e., dots 3, 4, 5 and 6 in front of the each value.)
- If the input value is in special symbol list (! @#$ %^&*()_+:";'<>? []; /, . Etc) then it prints the corresponding Braille symbol from the Braille Database.
- Repeat the step 4 until all the characters of the input values are matched with database.

If a character does not match in Braille Database then appropriate error message is generated.

By following the above mentioned steps, we will be able to convert English to Braille code successfully.

4.2. Software implementation

When we convert English text to Braille code then the Braille software algorithm[13][14][15] is coded in Visual Basic 6.0 and all 64 Braille symbols are stored in MS ACCESS 2002 Database. So it acts as a Braille database. The coding is compiled and run on one of the Microsoft Windows 32-bit operating systems (Windows '95/'98/ME or Windows NT/XP). When compiled to an executable program, in native code, it resides on a machine as a Windows Dynamic Linked Library (DLL). This is a binary executable that supplies a public interface to the Windows operating system and can thus be utilized by other Windows applications with comparative case. Braille notation of letters, Alphabets and special symbols are downloaded and stored in MS ACCESS 2002 database. The designing of Input and output window of Braille conversion tool is as shown below:



Display control button

Input Box

Mode of Vibration

Text to Braille Conversion Button

Output Box

Braille style option

Figure-8. Screen layout for Braille code conversion.

4.3. Braille hardware algorithm

The Hardware algorithm[13][14][15] used in the hand glove is based on the retrieval value of English letter from the user typed in the software tool. The ASCII value is applied to 89 procedures and it activates the corresponding vibration motors as follows:

a) Store the mode of vibration (serial / parallel), default mode is serial mode.
b) Read the input values one by one and convert it into the corresponding ASCII value up to the NULL (enter key) value.
c) Converted ASCII value is applied to 89 procedures as per the following condition:

(a) If the Input value is between ‘a’ to ‘z’ (ASCII Value 97 to 122) then the corresponding ASCII procedure number is activated and vibrates the hand glove.
(b) If the Input value is in special symbol list (ASCII Value 33 -47, 58-64 and 123-126) then the corresponding ASCII procedure number is activated and vibrates the hand glove.
(c) If the Input value is between ‘A’ to ’Z’ (ASCII Value 65 to 90) then procedure number 44 and corresponding ASCII procedure number is activated and vibrates the hand glove. (Capital letters are initiated by a placing a dot in the 6^{th} position of the Braille cell so procedure number 44 vibrates the 6^{th} position of the hand glove).
(d) If the Input value is between ‘0’to ‘9’ (ASCII Value 48 to 57) then procedure number 35 and corresponding ASCII procedure number is activated and vibrates the hand glove. (Numbers are initiated by placing a dot in the 3, 4, 5 and 6^{th} position of the Braille cell so procedure number 35 vibrates the 3, 4, 5 and 6^{th} position of the hand glove)
(e) If the Input value is blank (ASCII value 32) then corresponding ASCII procedure number is activated and vibrates the hand glove.

d) Repeat step 3 until all the characters of input values are matched with ASCII procedure numbers.
Each of 89 ASCII procedure numbers is linked with six digit binary numbers in an array. The presence of 1’s in a six digit binary value is nothing but rising position of the Braille symbol. So the presence of 1’s in a six digit binary value activates the corresponding vibration motors in the hand glove.

4.4. Hardware implementation

The principle design of the Braille hand glove is based on the six dots of the Braille cell. The six dots forming the cell permit sixty four different patterns of dot arrangements. It is matched with alphabets, numbers and special symbols of the English language.

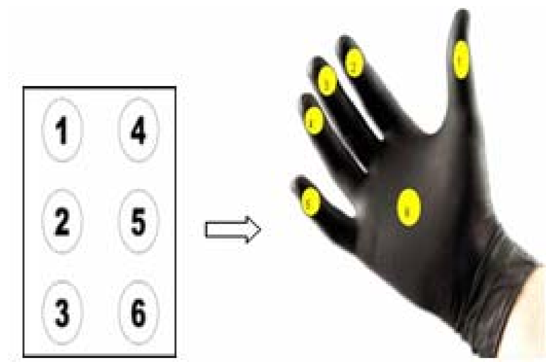


Figure-9. Hand glove with six positions.

Braille glove contains six vibration motors which is equivalent to six dots of the Braille cell. These are fixed in five fingers and centre palm (Thumb finger is assigned to Braille value 1, Fore finger is assigned to Braille value 2, Centre finger is assigned to Braille value 3, Ring finger is assigned to Braille value 4, Little finger is assigned to Braille value 5 and centre palm is assigned to Braille value 6). The basic technique used in the hand glove is based on the ASCII value of English letter from the user typed input in the keyboard [11][12]. It is linked with a 6 digit binary number value. The presence of 1’s in a binary number activates the corresponding six motors. So based on the position of vibration the blind person can understand the value of the letter. For example if the user types the letter “r” then ASCII value for r is 114. The procedure number for 114 is linked with binary number 0 1 0 1 1 1 already in an array. The presence of 1’s in this value is 1, 2, 3, 5 positions (assigning the numbers from left to right in the binary number). So it activates 1, 2, 3, 5 position motors in Braille hand glove. The 1, 2, 3, 5 position is nothing but raised dots position of Braille cell value ‘r’. So instead of touching and reading the Braille sheet the blind person can understand the Braille position through vibration.

Figure-10. Hardware prototype.

The conversion program is written in HITECH C language and it is recorded as a hex file in a micro controller of the hand glove. Any blind person can wear

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this glove on the right hand, and understand the English letters through vibration instead of touching the Braille sheet. Similarly the whole word or sentence or symbols is converted into Braille vibration. Based on this method the visible person and deaf and blind person can communicate effectively. The main component in Braille glove is a vibration motor. It is configured in coin type motor. It is a simple brush motor with a traditional axial design. The centric movement of the weight attached to the motor provides vibration during operation. After clicking the serial or parallel mode in the software editor, the input English characters are converted into Braille value and activate the corresponding motors in a serial or parallel manner. Any diabetic affected disabled person can wear this glove on the right hand, and can understand the English letters through vibration.

5. TESTING OF THE SYSTEM

To test the accuracy of the working principle of the hand glove, it was applied to various types of people like Blind employer, Blind student, Blind and Deaf, Employer, and student who can see. From each group five users were identified for sampling and two users in blind and deaf category due to less availability of person having diabetic. In each group two persons were identified as diabetic person. In this experiment all blind people have fundamental knowledge in Braille, but users who can see have little knowledge in Braille. So totally Braille hand glove was worn by 22 different persons.

Participants read at an average rate of 81.13 words per minute with a standard deviation of 37.81 and a range of 22.91 to 165.75. Half of participants learned Braille notations in public schools, and 13.3% learned Braille from training for few days. Half of the participants (51.3%) were completely blind, 13.3% were legally blind, and 10% were visually impaired. A questionnaire was prepared and various tests like letter test, digit test, word test and simple sentence test were conducted in each group and the success test answers were recorded in the contingency table as Table-1 as follows:

Table-1. Contingency table for Braille users.

User type	Letter test	Digits test	Words test	Sentence test	Total
Blind Emp	5	5	5	4	19
Blind Stu	5	5	3	2	15
Blind and Deaf	2	2	0	0	4
Visible Emp	5	5	2	1	13
Visible Stu	5	4	2	0	11
Total	22	21	12	7	62

Chi-squired test has been applied to Contingency table using IBM SPSS tool. The observed and expected value has been automatically calculated in IBM SPSS tool. It is recorded in Table-2. The Decision rule for Chi-squired test as follows:

Accept H_0 if $\chi^2 <= \chi^2_\alpha$ (n-1) x (m-1) and reject $\chi^2 >= \chi^2_\alpha$ (n-1) x (m-1)

where

$$\chi^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$$

Calculated value of chi-square obtained on using above formula and χ^2_α (n-1) x (m-1) is the tabulated value of chi-square for (n-1) x (m-1) degree of freedom and level of significanceα. Where n is the number of rows and m is the number of column in the Contingency table.

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Table-2. Calculation for χ^2.

			VAR00002			
		Braille testing	**Count** (O)	**E. Count** (E)	**$(O-E)^2$**	**$(O-E)^2/E$**
VAR00001	Blind employee	Letters test	5	6.7	2.89	0.4313
		Digits test	5	6.4	1.96	0.3063
		Words test	5	3.7	1.69	0.4568
		Sentence test	4	2.1	3.61	1.7190
	Blind student	Letters test	5	5.3	0.09	0.0170
		Digits test	5	5.1	0.01	0.0019
		Words test	3	2.9	0.01	0.0035
		Sentence test	2	1.7	0.09	0.0529
	Blind and deaf	Letters test	2	1.4	0.36	0.2572
		Digits test	2	1.4	0.36	0.2571
		Words test	0	0.8	0.64	0.8
		Sentence test	0	0.5	0.25	0.5
	Visible employee	Letters test	5	4.6	0.16	0.0347
		Digits test	5	4.4	0.36	0.0818
		Words test	2	2.5	0.25	0.1000
		Sentence test	1	1.5	0.25	0.1667
	Visible student	Letters test	5	3.9	1.21	0.3103
		Digits test	4	3.7	0.09	0.0243
		Words test	2	2.1	0.01	0.0048
		Sentence test	0	1.2	1.44	1.2000
					$\sum(O-E)^2/E$	6.704

From the above Table, Calculated Chi-square value = 6.704.
Degrees of freedom = (n-1) x (m-1) = (5-1) x (4-1) = 12.

The tabulated $\chi^2_{0.05}$ for 12 degrees of freedom = 21.02. Since calculated value of χ^2 is less than the tabulated value ($6.704<21.02$), it is not significant and the null hypothesis is accepted at 5% level of significance. Hence we conclude that Braille hand glove is the best suited device for diabetic affected disabled persons.

6. CONCLUSIONS AND FUTURE WORK

The software algorithm which is coded in Visual Basic 6.0 reads the sentence from the Input box of the Braille software tool and breaks them into characters and are counted up to the value of the enter key. The Braille code equivalent of each character is generated in the output box of the tool. The hardware algorithm which is coded in Hi-Tech C language reads each character from the Input box of the Software tool and converts in to ASCII value. The procedure for the corresponding ASCII value is called and each procedure number is linked with six digit binary number. The presence of 1's in a six digit binary value is nothing but raised position on the Braille symbol. This activates the corresponding vibration motors in the hand glove. Through this vibration signal the blind person can infer the corresponding English letter. In order to interact with the blind or blind and deaf person, the visible person types on the Input box of the software tool and this interaction is sent as vibrating signal to the blind or blind and deaf. The Braille code vibration process is a single step and the data transfer rate is normal and it is controllable. It is the best tool for diabetic affected disabled persons to have more accurate sensing, low error rate, small electronic product and it proposes a new approach to blind persons and diabetic affected disabled persons to know about computer oriented technologies. This work can be extended with the same translation technique for various languages like Tamil, Bengali, Hindi, French etc. The reverse engineering process for the same problem which converts Braille signal to English text if constructed can prove to be an effective bi-directional communication between the blind and deaf person and the normal person. This tool can also be extended by introducing online chatting which would help the diabetic affected disabled persons in socializing.

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