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Real-Time Communication Braille Glove for Deaf and Blind

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Abstract: It is very difficult for the visually impaired and deaf people to obtain basic and necessary information required for their living. Therefore, they are at a risk of being socially excluded due to poor access to information. Attempts have been made in improving the communication methods for visually impaired and deaf people. Methods have been developed which involve tactile sensation such as finger Braille, manual alphabets and several other electronic devices. But lack of privacy and lack of compatibility to computer environment are problems that remain unaddressed. This paper describes a low-cost Braille hand glove for blind and deaf people using slot sensors and vibration motors with the help of which they can read and write emails, text messages and read e-books. This Glove allows an individual to type characters based on different Braille combinations using six slot sensors. The vibration in six different positions of the glove which matches to the Braille code allows them to read characters.

Keywords: Braille, Braille Glove, Slot sensors, Vibration motors

I. INTRODUCTION

Braille is a series of raised dots that is read with the fingers by people who are visually impaired or deaf and blind. About 37 million people all over the world are visually impaired. They have to depend on conventional and orthodox methods [1] of obtaining information but these methods are tiresome, slow and not efficient enough and are not suitable for the computer environment. Emails, text messages, internet blogs, e-books etc. have become an integral part of life and the visually impaired unfortunately are deprived of such facilities. This is a small attempt by us to try to solve their problems by opening up the digital world to them. 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 used quite less.
- There are hardly any devices for educational purpose and routine communication. [2]

To acquire information necessary to carry out normal day to-day activities, this low cost real-time communication Braille Glove can immensely benefit the visually impaired and deaf people, who work in the computer environment. This concept will go a long way in helping them learn on an equal footing with their sighted counterparts. The main problem with Braille is that proportion of blind people who can read Braille is very low. [3]

In a paper, to bridge the gap between the blind people and the technological advancement in the telecommunication field they decided to design a SMS system for the blind by interfacing Braille pad with the cell phone so that the visually impaired person can have the access to the SMS system. However, this system is a bit bulky and handy. As it reads the SMS character by character, so it is a slow process. The user is also unable to access any digital data [4].

In this paper, we describe a low-cost Braille Glove which is made up of six vibration motors which are placed on the five fingers and on the palm. If a person wants to read a character from the PC, then the character corresponds to a Braille code which is matched to the six vibration motors on the Braille Hand glove. Hence the vibration motors corresponding to the Braille code of that particular character vibrates and the character is read efficiently by the reader. It has a unique feature of typing messages through hand gestures of all the Braille codes. Hence different hand gestures correspond to different Braille codes. Therefore, this paper focus has been on vibration in six different positions in the right hand which matched the Braille codes.

II. MATCHING OF BRAILLE GLOVE & BRAILLE CELL

A braille cell is a rectangular cell which consists of six dots arranged in the form of a 3x2 matrix. Fig.1 shows standard Braille cell. These six dots allow sixty-four different patterns of dot arrangement [5]. Therefore, these dots arrangements can be used to represent sixty-four different characters. The hand glove comprises of six slot sensors, five

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which are placed on the fingers and one placed on the wrist and six vibration motors. Fig. 1 below shows the one to one correspondence between the Braille cell and the Glove. Fig. 2 shows the standard Braille chart which we have use the conversion of Braille to text. This is the basic Grade 1 Braille, which we have used here. This chart has all the alphabets both in the uppercase and lowercase, it has numbers ranging from zero to nine, comma and full stop. A space between characters is represented by no dotes on the Braille cell. Correspondingly on the hand glove it is sensed by vibration of none of the motors.

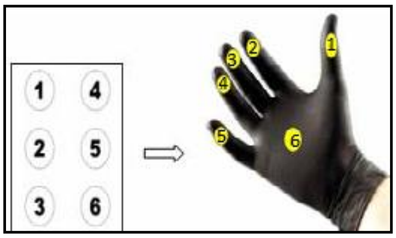

Fig. 1 Standard Braille Cell [6]

To avoid inconvenience & confusion between the timing of the character and a space a time delay of approximately five seconds is kept between two consecutive characters and the character is available for sensing for ten seconds. These time delays can be altered according to the requirement of the user. Fig. 2 is a chart that has all the alphabets both in the uppercase and lowercase, it has numbers ranging from zero to nine, comma and full stop. A space between characters is represented by no dotes on the Braille cell.

Suppose, the user wants to write the alphabet 'E', he will move his thumb and little finger which represent the 1st and the 5th dots of the Braille cell. Similarly, for 'X', he will move his thumb, middle finger, ring finger and wrist representing 1st and 4th dots and so on.

While reading the text, if the user encounters alphabet 'T', he will sense motion in his four fingers which represent the 2,3,4,5 positions on the Braille cell.

Thus, on knowing the Braille chart, the user can very easily write or read text using the Glove.

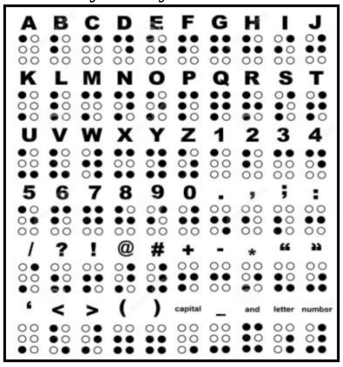

Fig. 2 Standard Braille Chart [6]

A. Module for reading text

The first module represented by Fig.3 is for receiving or reading online text from the PC. In the module shown in Figure 3 the emails and online text is sent to the Graphical User Interface (GUI) on the PC. The American Standard Code for Information Interchange (ASCII) value of the character to be read is sent wirelessly from the PC to the Micro-controller using the wireless CC 2500 Radio Frequency (RF) Trans receiver module.

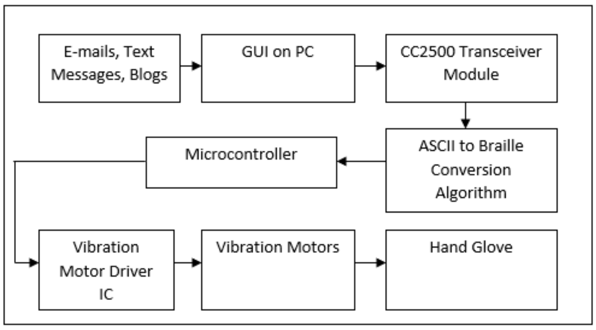

Fig. 3 Block Diagram for the module of Reading Text

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The American Standard Code for Information Interchange (ASCII) value of the character sent from the PC is converted to the corresponding Braille code using a conversion algorithm. This conversion program is written in Embedded C language and it is recorded in micro controller of the Braille Glove.

B. Module for writing text

The block diagram shown in Fig.4 is of the second module of the proposed system is meant for writing online text and replying to emails. This is accomplished by using the low-cost slot sensors for typing characters.

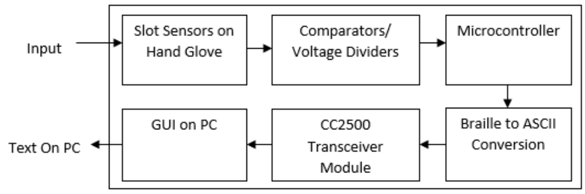

Fig. 4 Block Diagram for the module of Reading Text

A mechanism is developed for the slot sensors such that when a finger is bent the slot sensor which is placed on the finger gets activated and generates high voltage which is approximately 5 Volts. When the finger is in the relaxed state the sensor generates an output of about 0 Volts.

III. IMPLEMENTATION OF THE PROPOSED SYSTEM

A. Hardware Implementation

The electronic circuitry of the hand glove comprises of the following components and modules:

1) Slot Sensors:

The slot sensor used here is MOC7811. It performs Non-Contact Object Sensing. This is used to provide comparator input to indicate the 6-digit binary number.

2) Vibration Motors:

One of the main components is the vibration motor placed on the Glove. These motors are placed on each of the fingers and the palm. The nominal voltage for these motors is about 3 V. The normal operating voltage for these motors is about 2.0~3.5 V.

3) Motor Driver IC:

We have made use of DRV777 motor driver IC to drive the six vibration motors. The vibration motors have a very low operating voltage a proper circuitry has to be designed to drive these motors without causing any damage to them. It is a 16 pin Surface mount device (SMD) package which has seven input pins and seven output pins. Since the motors are driven by the output of the microcontroller voltage has to be converted to a level suitable for driving the motors.

4) Comparator IC:

The slot sensors used here give an analog output. Since the slot sensors are to be interfaced to the microcontroller the output of the slot sensors is digitized by using comparator IC LM324. The output voltage of the slot sensor is compared with the fixed reference voltage which can be varied using a voltage divider circuit with a 100k ohm variable resistor. Therefore, the output of the IC is either logic high or logic low. The schematic of comparator circuit was designed using Eagle software. Fig. 5 shows the block diagram of the circuit.

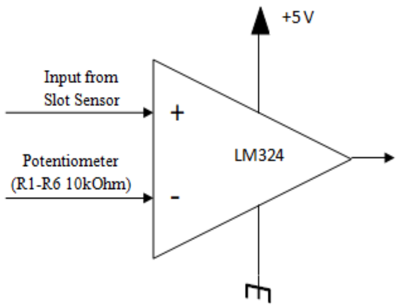

Fig. 5 Block Diagram of Comparator Circuit

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5) AVR Microcontroller Development Board:

The AVR development board includes the following features.

a) Atmel's ATmega8 Microcontroller
b) 5V USB Supply (No Need of Any External Supply)
c) Read/Write the Microcontroller Flash
d) EEPROM
e) Six Pin Polarized ISP Interface Connector
f) 5KB/sec Maximum Write Speed.
g) Onboard RS232 Interface for serial communication with jumper.
h) On board power indication & Power plug-in jack
i) GND Bus & Vcc Bus (5V and 12V DC) to Supply Power External Device
j) ISP Programming Pin Out
k) Extra User Peripheral(Onboard)

The microcontroller development board is the processing unit of the proposed design. The conversion algorithm for the system is stored in the microcontroller. This forms the control unit of the system. The slot sensors and the vibration motors have to be interfaced to this development board.

6) CC 2500 Trans Receiver (Radio Frequency Module):

The CC 2500 Trans receiver module is used for transmitting data wirelessly from the PC to the hand glove and vice versa. This wireless module has a range of up to 100 meters. This makes the hand glove portable, comfortable to use and eliminates the use of unnecessary wires and cables for interfacing the hand glove to the PC. This module transmits characters in the form of its American Standard Code for Information Interchange (ASCII) values.

7) Power supply:

It is used in the circuit is a 9V DC battery. The microcontroller development board requires an operating voltage of 3.3 Volts and other electronic circuits involving different ICs like the comparator IC and the motor driver IC require a voltage of about 5 Volts. Therefore, we have designed voltage regulator circuits using some passive components and special voltage regulator ICs. Fig.6 shows the circuit diagram of a 5 Volt voltage regulator circuit. The IC used here is the LM7805 5 Volts, 3 pin voltage regulators. This is a low power, low cost IC.

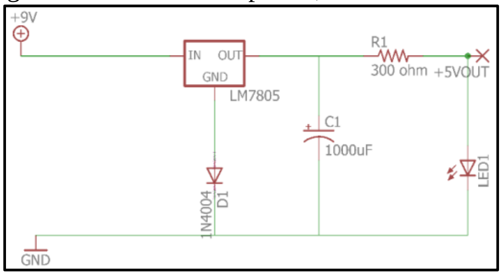

Fig. 6 Schematic of 5V regulator

Fig.7 shows the circuit diagram of a 3.3 Volt voltage regulator circuit. This circuit comprises of capacitors and a special IC TLV1117 by Texas Instruments. This IC is an adjustable positive low-dropout voltage regulator capable of producing different output voltage levels, but we have used this for generating 3.3 Volts.

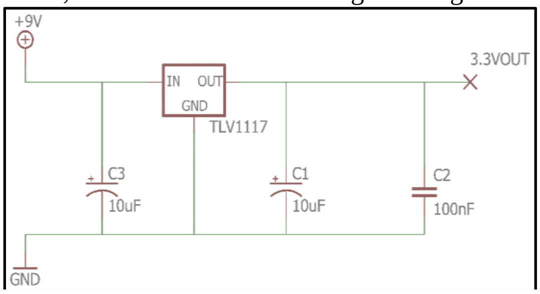

Fig. 7 Schematic of 3.3V Regulator

B. Software Implementation

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.

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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 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.

The Integrated Development Environment (IDE) used for the proposed system is AVR Studio for compiling and running the code on the ATmega8 development board. The conversion code for converting Braille to text and vice versa is written in Embedded C.

The boot loader flashing tool used for burning the code on the development board is HID boot flash [7]. The RF module can transmit the text data in the form of its American Standard Code for Information Interchange (ASCII) values to and fro in the Microcontroller using the GUI created in MATAB. This terminal displays the text to be read/written using the Hand Glove. This Terminal is linked with Graphical User Interface which enables the user to link the text read/written to the internet.

The Graphical User Interface (GUI) can be coded in PYTHON Language. The 'email';'smtplib' & 'imaplib' modules in Python are used for sending and receiving mails on the computer. Atmel Studio 7 is the integrated development platform (IDP) for developing and debugging Atmel AVR microcontroller (MCU) applications. Studio 7 supports all AVR and Atmel SMART MCUs. The Atmel Studio 7 IDP gives you a seamless and easy-to-use environment to write, build and debug your applications written in Embedded C and assembly code. It also connects seamlessly to Atmel debuggers and development kits.

The GUI:

Fig.8 Login page for user authentication

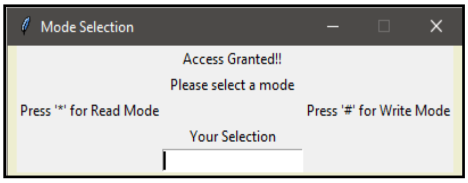

Fig.9 Mode Selection for Read and Write

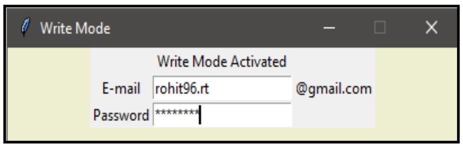

Fig.10 Selection of Write Mode for sending E-mails

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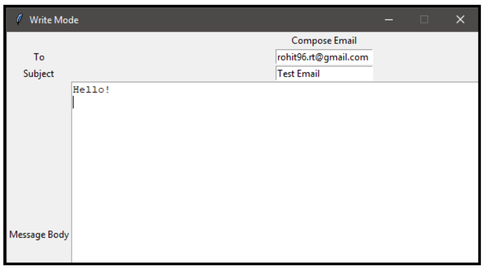

Fig.11 Test Mail

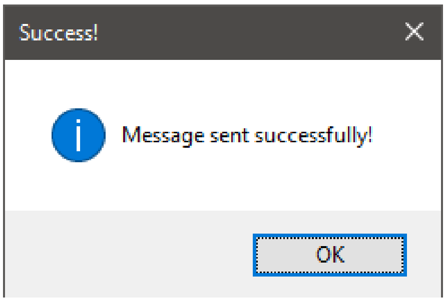

Fig.12 Mail sent successfully

Fig.13 Mail received successfully

Fig.8 shows login page created for authentication of deaf blind users. There are two modes of selection which are read and write as seen in Fig.9. On pressing '*', read mode will be activated and on pressing '#', write mode will be activated as shown in Fig.10. On entering valid username and password, the user will be logged into his account. In Fig.11, user has composed a mail which was sent successfully as seen in Fig.12. The mail was received. Fig.13. shows the inbox of the recipient.

IV. CONCLUSION

The Braille Glove can be successfully used to receive as well as transmit text data from the PC to the glove and vice versa based on the different standard Braille combination. In this paper we have used Grade 1 Braille conversion chart. The efficiency of the glove can further be improved by using the Grade 2 Braille conversion chart, in which we transmit and receive an entire word for a particular Braille pattern and hence increase the speed of receiving and transmitting text with very good efficiency. This Braille Glove can also be used by blind people for other applications like opening web pages and reading E-books independently with the help of Graphical User Interface (GUI) and other Integrated Development Environment (IDE) like Code Composer Studio.

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