Smart Tutor for Visually Impaired Beginners

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***Abstract* — Education is the right of every human being. Normal students can learn from teachers by observing & communicating. However, because of visual impairment, learning to read and to write becomes very difficult. The traditional teaching methods for visually impaired students are time consuming and needs teacher's attention and hard work. Due to difficulties in learning Braille using traditional methods and lack of trained teachers, the literacy rate of visually impaired people is very poor. In proposed system microcontroller 8051 and Atmega328 based hardware implementation facilitate Braille learning through a sense of touch. For different alphabets and numbers, Braille script patterns are generated using solenoids. With this tutor system, an adult who does not have formal Braille training can help and assist the visually impaired students to learn Braille and assess their learning levels.**

Keywords* — *Microcontroller 8051, Atmega328, solenoids, Braille script.

I. INTRODUCTION

Braille script is used to read and write by visually impaired people. In Braille raised dots represent normal alphabetical English words. Braille also contains symbols, punctuation marks for representing Braille script. To read Braille, move the fingertips on the raised patterns or symbols. By sensing the Braille patterns, visually impaired people can learn the written word. Braille language gives access for a big source of educational material, literature, information of finances, different sports and culture etc. This helps visually impaired to enrich their educational and cultural activities, to inculcate new hobbies in their daily life.

Fig.1 Braille Sensing Using Solenoid Actuators [1]

Various teaching methods have been developed to make visually impaired people to read and write so that they can communicate with the other people. However, Braille system become successful as it is based on signs designed for fingertips which helps learner to learn with confidence.The objective of smart tutor is to provide electronic reading to get easy access of information to Braille users. It will help to strengthen and boost the knowledge of user. Smart tutor is an economical system. It is portable, compact, of low cost, and easy to use.

II LITERATURE REVIEW

Braille language using Braille keypad is mainly used to educate visually impaired people, so that they can learn and interact with each other. It will help to increase the literacy rate of our country.

A. Braille Alphabets

Braille alphabet, Braille numbers and special symbol characters are made by using six dots. Pattern of six dots are as same as six dots present on dice which is sensed by the user. Pattern of six dots contains two lines in parallel and three dots in each line so total six dots are present. Using six dots we can make many different patterns for alphabet, number and for special symbols in Braille script.

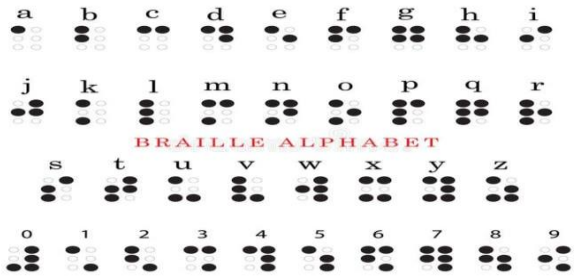

Fig. 2 Braille Alphabets [2]

Fig. 2 shows the different patterns available for different alphabets and numbers. For long words and long digit numbers also shortcut pattern is available in these six dots. It will reduce the time for typing each number and alphabet which is one of the beneficial features of Braille language.

Top first four dots are used to form first ten letters of the alphabet. Adding a dot, number 3 in the first column forms the next ten letters, and last six letters are formed by adding a dot number 3 in the second column. Unique pattern of dots is used to represent punctuation. In the Braille script, patterns are available for many big words. Braille cells are used for entire words or a combination of letters [2] .

B. Braille Keyboard

The Braille keyboard has mainly used to educate the visually impaired people. Fig.3 shows, there are eight buttons, patterns are made using six buttons and two other buttons are for backspace and for space bar. If wrong alphabet has been displayed on the screen, then using backspace it can get corrected. The three dots in one line have become horizontal in Braille keyboard. For the Braille keyboard we can use following types of touch switches.

Fig.3 Braille Keyboard [3]

C. Capacitive Touch Switch

In capacitive touch switch detects any sudden change in the capacitance on the touch plate and accordingly generates the given input. Capacitive touch plate detects the touch and it sources the DC voltage on the load Output.

D. Mechanical Switch

Mechanical switch is mostly used because the visually impaired people are having more powerful sense of touch than other normal people. Because, of that they will come to know which key is pressed. Due to this advantage the mechanical switch is used maximum in labs .

III CHALLENGES

Through literature survey the challenges which can be faced while developing this system are discussed below.

A. Text to Braille Conversion

For text to Braille conversion there are many paid and free text to Braille software and editors available online. So, we have written the codes to convert normal English language into Dot Braille Pattern. As this Dot Braille Pattern will be sensed by visually impaired people on the sensing unit which consist of solenoid valves. Writing and feeding the code for text to braille conversion is difficult task.

B. Braille to Text Conversion

Converting Braille to text is much more complicated as compared to text to Braille. The binary encoding device to write alphabet was used as a method of conversion to convert Braille to English Alphabets. These interpretations are used for different things like mathematics and music etc [4].

C. Text to Speech Conversion

The major problems in text to speech conversion are text to Phonetic Conversion. The text to speech is the conversion of input text into phonetic conversion. In languages like Hindi or Telugu, written text and its pronunciation is same hence conversion is simple. However, for other languages the conversion is complicated. For correct pronunciation, knowledge of several rules and their exceptions is important [5].

D. Pronunciation

Pronunciation for homographs, is another difficult problem. Homographs are words that have same spelling but can have different meanings and pronunciations. (e.g. minute). The word minute is for example pronounced differently in sentences "She waited for a minute before she closed the door" and "There was a minute tear in the fabric". The characters 'ti' in “tire” and “tick” are pronounced differently. Finding correct and exact pronunciation for all words is a difficult task for any TTS system .

E. Skill Set of Teaching People

The teaching people must possess teaching skills strategies towards visually impaired students especially to those who are reluctant about learning braille. As most of the visually impaired people has number of myths and think that learning braille is difficult task. So, to change their perspective on learning Braille, the teachers must encourage and guide them positively.

Here are some suggestions that will help to motivate the visually impaired in a positive manner and encourage them to learn Braille. By changing negative attitudes about Braille. They should be explained that braille doesn't "make you visually impaired” or reading or writing Braille in public is a symbol of lack of ability. Also learning braille is a sign of literacy and independence. Ensure students that this is another new method to learn, and they can learn it. Increase positive attitude among people who are visually impaired. Encourage students to have communication with other people. Even visually impaired volunteers who learnt Braille should be encouraged to mentor new students.

F. Sensing Braille Patterns

The visually impaired people are not aware about different Braille Patterns for different alphabets, Special Characters, Numerical Digits. Different Braille Pattern should be taught. For sensing Braille patterns solenoid valves are used in this system which will generate different Braille Patterns. As they are not aware about Braille, educating them is a must. As the touch sense may vary for every individual visually impaired person. Design of sensing unit in such that, the time for energizing the solenoid valve must vary (i.e. for quick learner the energized timing for raised solenoid valve must be less and for slow leaner the energized time must be more). But we can’t set variable time because controller will not come to know whether the quick or slow learner is sensing. Therefore, more energizing time along with reset switch is set.

Existing Commercial Devices are based on Piezoelectric Actuation in which sensing unit is not affordable because of use of Braille cell. For the visually impaired people, sensitivity of vibrating motor is not good for sensing the braille. For this solenoid valves are used for Braille pattern sensing unit. It is understood that regular maintenance of the system is needed. If the solenoids are handled improperly then malfunction or damage can take place. Replacing the damaged solenoid valve may become a difficult task .

IV PROPOSED SYSTEM

The aim of this paper is to make visually impaired people educate with less effort. It can be done if any responsible tutor makes them understand each character representation in Braille code. Using this device any person can act as a tutor for visually impaired. Using their smartphone, they can give input wirelessly which reduces the complexity of project or device. The keyboard consists of 6 sensible dots which will be sensed by a learner.
Also, speech will be produced so that visually impaired people should understand the pronunciation of characters sensed by them. Following technological options are available under the wireless domain, RF module or Bluetooth module. Fig. 4 shows the block diagram of proposed system. The proposed system is divided in two sections:

A Hardware Implementation

Microcontroller interfacing will be done with LCD display, DC power supply, bluetooth module, braille keypad, solenoids and Atmega328 microcontroller along with amplifier and speaker. All these makes two unit one the sensing unit and another feedback unit.

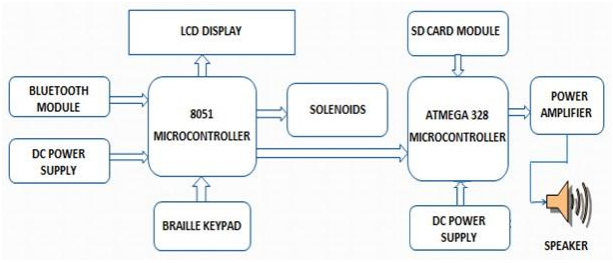

Fig.4 Block Diagram of Smart Tutor for visually impaired beginners

i. Power Supply

The microcontroller requires 5v constant DC supply for its operation. Regulator IC 7805 provides constant positive 5v DC supply. As the 230V alternating voltage fluctuates it affects the constant adapter voltage, IC 7805 maintains it to constant required voltage.

ii. Bluetooth Module

In proposed system Bluetooth module HC-05 used for wireless purposes to connect smartphone with Braille device so that user can give input using their smartphone. It will also reduce the interfacing complexity, size and cost of the system which will make it compact. Pairing of HC-05 and Smartphone needs to be done. HC-05 module has two modes of operation. Data mode allows exchange data between devices and command mode is used to change setting of HC-05 using AT commands.

iii Liquid Crystal Display (LCD)

As the microcontroller receives the data it will display the given data i.e. characters or numbers on the LCD display and simultaneously it will perform text to Braille conversion. LCD display will display the given input characters alphabets or numbers. A 16x2 LCD display is used in proposed system. It displays 16 characters per line. This display has 2 lines. To display each character 5x7 pixel matrix is required. This LCD has command register to store command instructions used to clear screen, to set cursor position, to control display etc. and data register is used to store the data to be displayed on the LCD.

iv. Solenoids

The 12v electromagnetic push pull solenoids are directly given to the adapter DC voltage because solenoids operate on 9v to 12v DC power supply. Six electromagnetic solenoids are connected to port 0 of microcontroller i.e. port 0.0 to port 0.5 through IRF540 MOSFETs. The IRQ540 MOSFETs act as drivers to trigger the solenoids. Out of these six solenoids microcontroller will trigger solenoids to generate Braille Pattern of the given input one by one for each character. These triggered solenoids will be raised in upward direction which will be sensed by the learner [6] .

v. Voice Module

The voice module circuit consists of the Atmega328 IC, SD card module, amplifier and speaker. At the same time the microcontroller will send input data to the Atmega328 which compares the input data with the stored sound files which are stored in .wav format and plays the matched sound file using amplifier and speaker. Through touch and voice announcement the given input will be recognized or read by visually impaired people.

vi. Feedback unit

Feedback unit is planned in this system to know whether learning process is happening correctly.

B. Interfacing

The interfacing of both the Microcontrollers (i.e. 8051 and Atmega328) together is very difficult. Compatibility of both Microcontrollers is important. Bluetooth Module and Solenoid Valves are interfaced to 8051 Microcontroller. SD card is interfaced to the Atmega328. Care must be taken, that through the Microcontroller 8051, solenoid valves must get energized to generate Braille Pattern for sensing purpose.

For text to speech conversion we need to take care that the entire unit must give proper output for the given text input. Because first the input will be given to the 8051 Microcontroller IC and then accordingly it will give signal to Atmega328 to generate text to speech output. But for this

conversion we have interfaced SD card, audio power amplifier, speaker to Atmega328 IC.

V RESULTS AND DISCUSSION

As mentioned before, wireless transmission has been achieved using Bluetooth module which is being interfaced with microcontroller. As per the tests, approximately 6 meter of range is feasible with the module used. The transmission of data within this range has been received by the microcontroller without any garbage value or data been added. All the sent characters i.e. alphabet, or numbers are received successfully. The tests have been performed by setting the baud rate to 9600. All the received character will be present for two second and then single character will be shown for getting feedback from the visually impaired people. Fig.5 shows the received data characters which are displayed on LCD display.

Fig. 5 Received Data displayed on LCD

Transmitted data can be monitored at the display by the tutor, but the visually impaired people is unable to see given data characters. Thus, solenoids are used to generate the Braille Pattern which can be sensed by the visually impaired people with the help of their fingers by touching each solenoid and realizing which solenoid is been raised or trigger. The solenoids which are raised will generate Braille Code or Pattern and the visually impaired people will recognize it by touching them. The provision of speech which will help them to recognize what the Braille Pattern is provided. For e.g. if alphabet "a" is given then solenoids will generate Braille pattern accordingly and simultaneously using speaker which will generate the voice of alphabet "a" helps the visually impaired people to recognize the given input by hearing the sound and touching the generated Braille pattern. The Braille pattern will be generated by solenoids till the proper feedback is not given by the learner. The sound speech will be generated initially and will be generated if the invalid or valid feedback is given. For this provision Keil software is used in which the coding is done in basic C language. Fig.6 shows the Braille pattern generated for the given number '1' using solenoids.

Fig. 6 Braille pattern generated on Solenoids

The Braille keypad is designed for getting proper feedback of the given characters. As discussed earlier six keys are used with enter key to give the Feedback. If the valid or proper feedback is given, then buzzer will not turn ON which will indicate the visually impaired people that the given feedback was correct and if the buzzer turns ON it will indicate incorrect feedback is given. Fig.7 shows the received feedback on LCD display.

Fig. 7 Received Feedback displayed on LCD

The main aim to design this tutor system to make the visually impaired people habitual to the Braille typing. Once the visually impaired people become familiar with the Braille pattern of every alphabet and number then the Braille pattern will be identified in less time. This will help them to directly type the message or content that they want and can sent it to others. Even we can send the feedback on the mobile phone through Bluetooth.

CONCLUSION

This device satisfies the needs of the visually impaired individuals to read and communicate. It is a system with a microcontroller that performs text to Braille conversion which is having the fast conversion from programmed text into the tactile Braille. It is low cost device that generates Braille pattern for sensing (reading). It helps them to type Braille Pattern to give feedback and communicate using electronic means. The main aim to design this tutor system is to make the visually impaired people habitual to the Braille script and Braille typing. This, also encourage and educate them to keep pace with technological era.

FUTURE WORK

In future work more feature can be added to it such as piezoelectric actuators for sensing multiple characters. Also, multiple language (Hindi, Guajarati, Tamil, etc.) codes or translators can be added which can be converted to braille for vernacular medium users. Instead of connecting LCD display we can directly connect this device to PC by making changes in the circuitry or even feedback on the mobile phone through GSM module can be send which will make it universally usable to transmit and receive the contents or messages wirelessly.

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