BrailloComm : A Braille integrated communication software

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***Abstract*—The group of people who are blind or visually impaired is greatly disadvantaged in the academic world. Additionally, they have not kept up with the rapid technological advancement, and portable electronics. Since its origin, braille technology has been extensively researched to address this problem. A tiny step towards the development of smart braille devices is the development of refreshable braille displays. In this study, a single cell refreshable braille display model based on micro servos, rather than solenoids, lead screw actuation, etc., has been developed. It can generate various patterns of braille symbols, each of which can represent an alphanumerical value or a contracted word. Although many refreshable braille displays currently in use operate excellently, the proposed model's portability, ease of use, and cost effectiveness add to the study's uniqueness. The proposed model's prototype has been created in order to run an experiment demonstrating the system's effectiveness, cost analysis, and portability analysis. The findings demonstrate that the proposed approach can be a more advantageous option for straightforward and reasonably priced refreshable braille display implementations.**

***Index Terms*—braille, raspberry-pi, micro-servo, arduino, python**

I. Introduction

It's difficult to convey the struggles of those who are blind or visually impaired using words. For those who are visually impaired, moving around—whether travelling or just walking—becomes incredibly difficult. Their incapacity to see well is a serious threat to their ability to learn. The only natural method of learning is currently listening. While listening is a useful practise, it does not provide the same enjoyment as quietly hearing one's own voice in one's brain as reading does. But Louis Braille developed a reading and writing system for those who are visually impaired in 1824. Braille was created by Louis Braille as an advancement of a technique called Night Writing. Charles Barbier created night writing as a means of communication for soldiers to use when there is no light at all [2]. In 1829, Louis Braille released his first work, which was based on Latin alphabets. Braille is a tactile writing method that has historically been used on embossed paper [2]. Braille is written using rectangular cells or blocks with two columns and three places for three dots in each [2]. One character is distinguished from another by the way the dots are arranged in a cell. One cell can be combined in 64 distinct ways. Many languages have had braille produced; however, the focus of this essay will be on English. The first 10 letters of the English alphabet (a-j) are translated using the first four dots. The pattern is the same for the letters K through T, except each has an additional raised dot at position 3 of the first column. Letters U through Z are arranged in the same way as Letters K through 0 with the addition of a dot at position 3 in the second column. The letter W deviates from the pattern since braille was first created in French [3]. Fig 1. displays a table of English alphabets' equivalent braille codes [4].

II. BACKGROUND STUDY

A sizable amount of study has been done to modernise the Braille system for this age of computers and microprocessors. The limitation to reading Braille alone in embosser has been noted and identified as a disadvantage for the impaired persons because the capacity to read is one of the main problems for the visually impaired. Since then, people with a range of experience have started to show an interest in the virtualization of the Braille symbols.

For those who are blind or deaf, Tajima et al [7] presented a body-braille system that would enable instantaneous communication with the impaired person and enable them to read braille by vibrations at any location on the body surface.

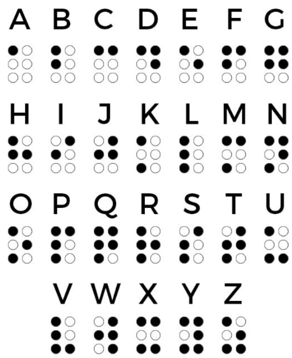


Fig. 1: Braille Language Chart

BrailleEnter and Swift Braille keyboards were compared by Alnfiai et al [8] in order to comprehend and assess the effectiveness of braille inputs on android devices. The study focuses on the speed and accuracy with which a person who is blind may type on the aforementioned keyboards.

Dhar et al.'s [9] interactive generalised Bengali keyboard driver for Bangladeshi native speakers was made possible with the assistance of English speakers. It allows blind individuals to communicate in Bengali by hitting particular Braille patterns that would generate Bengali letters and sounds. Wilson et al.'s [10] 3D printed braille map technology allows visually challenged students to easily explore a map in Braille without the aid of an outsider, in addition to increasing communication. A surface-extruded braille heading is used to accentuate everything on these maps, which are printed with topological information, including an exact representation of the roads, pavements, and other infrastructure. The wearable bands that Savindu et al. [11] suggested for visually impaired persons to wear on their hands are composed of six nodes in three bands. A connection between the bands and the user's phone may be made using Bluetooth. Following the establishment of the link, the bands are engaged to generate a tactile feeling that corresponds to the braille patterns of specific characters.

The braille technique is also being used to develop braille to voice conversion devices, which will help people who are speech- and visually impaired communicate better [12]. The user of these tools can select a braille pattern to be converted into a character and its corresponding sound. Similar work was done by Shubhom et al [13], who stored audio representations of English letters on an SD card that was inserted into a braille e-notebook. After connecting the notepad to an input device, the visually impaired person may communicate by entering a certain braille pattern, which the notepad will translate into the appropriate character and play the character's sound from the SD card.acters.

A system of braille to voice conversion for the Malayalam language was developed by Rajan et al. [14] by deviating from the English language and using braille patterns to construct Malayalam symbols that are translated into speech. To read printed papers, Dela Cruz et al. [15] proposed an optical image processing device that converts printed materials into braille patterns. For the gadget to work, images of text or printed documents must be transformed to braille using an optical character recognition engine. The patterns can be read by a device having a piezoelectric-based haptic system. Additionally, the device has many haptic pins that may be used to display the incoming characters' braille patterns in an appropriate manner.

Moise et al. [16] released a software system that works in a manner similar to this one, taking a character or string input from a computer and producing an array of 3x2 dots and blanks to an output device, allowing a visually impaired person to read the character or string from the computer. A lead screw-actuated text to braille display method was suggested by Akhtar et al. [5]. Six small motors are positioned in accordance with the basic 3x2 braille sign placement pattern, and the stem is connected to the motors via lead screws. A hexagonal nut that can only rotate axially is positioned on the lead screws and is used to show the desired symbol through the pins. Their work's uniqueness is affordable because it costs around 53 dollars to utilise six pins to display one letter at a time.

Another similar piece of work may be found in Adnan et al.'s [6] proposal for a portable text to Braille display, which uses electromagnetic solenoids to activate the braille output's dots. The solenoid circuit of the system is linked to an Arduino. The solenoids are used to create the corresponding braille patterns after the Arduino has processed a character. The whole system, which costs $ 43.45 dollars, is said to display one character at a time.

III. PROPOSED MODEL

In order to give a general sense of what the device should appear like and function like, a prototype has been constructed. Low weight is necessary for portability, so PVC boards were used in the construction of the suggested model because of their small weight. For the model to be cost-effective, an Arduino-UNO (R3) has been utilised as the device's processing unit together with other inexpensive sensors and components. The proposed model's block diagram is depicted in Fig. 2.

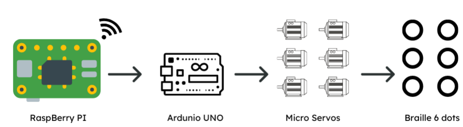


Fig. 2: Braille Language Chart

The system's complete operational procedure is broken down into three crucial parts, as indicated in the block diagram. The first phase is a RaspBerry PI device that uses its internal code to convert spoken input to braille. We'll utilise Google Translate as our translation model for this. The free Google service provides quick translations between English and more than 100 other languages for words, phrases, and web pages. The six pin mechanism of the braille model is powered by six SG90 micro servos, which are driven by a servo driver. The six dots had to be movable freely (up and down) in order to construct different braille patterns, each of which represented an alphabet, a number, or a symbol in order for the braille display to be refreshable. The proposed approach differs significantly from any of the other work in that it uses six micro servos for this specific task. The use of micro servos is justified by their low energy consumption rate, simplicity of implementation, and ease of maintenance. A tiny servo is a useful option for a portable gadget and only weighs 14.7 g [18]. The proposed model is made even simpler by the use of micro servo motors. The six servos have been controlled by a servo driver.

A. Circuit Detail of the proposed model

The proposed model's reduced circuit architecture is shown as a circuitry drawing in Figure 3. For the system, a Lipo battery has been used as its main power supply. According to the circuit schematic, the RaspBerry PI and the Servo module are connected by PMW to the Arduino-UNO.

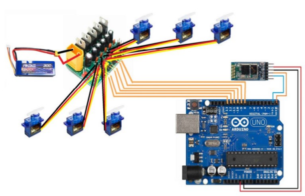
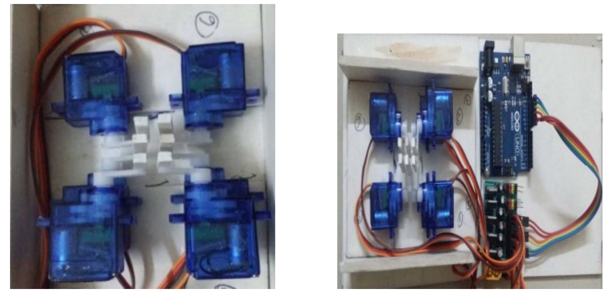


Fig. 3: Circuit Diagram of the System

B. Hardware Implementation

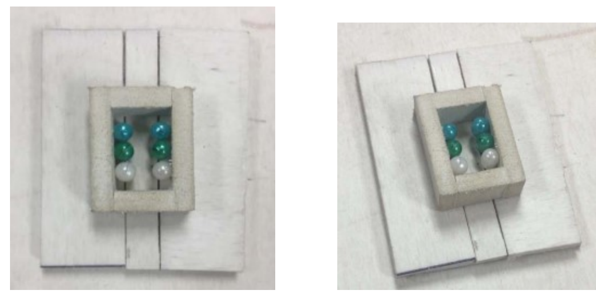
A rectangular cuboid body with smaller rectangular surfaces that makes up a micro servo has a rotator pin that protrudes from one of them that can rotate up to 180 degrees both clockwise and anticlockwise. Six micro servos were set up on the device in two parallel columns of three. The vast volume of the servos made it challenging to guarantee that the braille cell could fit inside a small surface area so that it could be read by the tip of a finger. To solve that issue, the final servo in each column was positioned on top of the middle servo with a projecting edge. The servos needed to be rotated precisely since each had a different alignment.

An container made of PVC board housed the tiny servos. The top surface, also known as the refreshable display, has been constructed with one braille cell using six pins that are perfectly connected to the servo lever so that the pins may freely move up and down to form different patterns. The refreshable display is seen in Fig. 5 with its top completely down.



(a) Servo Arrangement (b) Hardware Implementation

Fig. 4



(a) (b)

Fig. 5: Down all (space) position of the display.

C. Working process of the model

The Google Speech to Text Module is a Python library that is used to convert speech to text. Then, after receiving this text, the Arduino converts each text character into a corresponding braille character. The data will be parsed by the application before being sent as a stream of characters. The PI module then reads the bytes from the character stream and transforms them for the Arduino processor. The characters are then matched with the proper braille pattern. The braille character system, as was already mentioned, employs six raised dots to represent different symbols in different configurations. One character, or the six dots on the tip of just one finger, is all that is necessary for a person who is blind to understand the character. The braille cells must thus be tiny enough to be felt with the tip of a finger. Taking that into account, each dot was made using pins with rounded tips. In order for the servos to spin either clockwise or anticlockwise in line with the character pattern, the servo driver, or Arduino, sends a signal to the servos. A few depictions of the prototype model with different personalities are shown in Fig. 6.

Although the rotation can be adjusted to the user's comfort, the recommended rotation value is 10. A list of the servo motors' rotational speed and direction is provided below. The user's reading speed will determine how conveniently the delay communicates how quickly the characters will change in the refreshable braille cell. Character change default delay has been set to 1000ms.

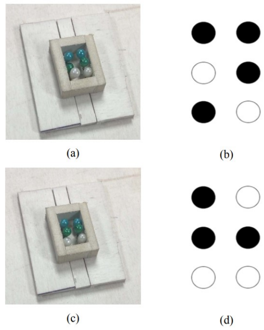


Fig. 6: (a) Letter N (b) Diagram of N (c) Letter H (d) Diagram of H

IV. Experimental Analysis

To demonstrate the system's originality, a three-step experimental examination was conducted. a readability test to demonstrate how well people can recognise letters through touch, Cost study, which demonstrates the system's cost effectiveness, is followed by a portability analysis, which contrasts the system's weight and size with those of existing models.

A. Accuracy Analysis

We tested all possible braille characters excluding symbols as part of the device's readability test. The test's results showe promise. The readability test's comprehensive findings ar shown in Table I.

TABLE I : READABILITY TEST

Letters	*Correctly Identified*	*Confused*	*Identified Incorrectly*
A -J	100%	0	0
K-T	98.2%	1.3%	0.5%
U-V, X-Z	96.5%	1.5%	1%
W & Other symbols	97.23%	2.2%	0.57%

B. Cost Analysis

One of the primary motivations for the micro servo-based technique was to lower the high cost of refreshable braille displays that is now the case. Because cost is a significant issue for the majority of visually impaired people globally [20]. Currently, refreshable braille devices may be purchased for as little as $62 [6] per cell. The study in [6] found that using a solenoid for a braille cell might reduce that cost to about $43. In the prototype that was on exhibit, the price was reduced to $29, or around 30% less. Table II displays the prototype that was the subject of this paper's cost study.

There are numerous refreshable braille instruments available. A cost comparison of the available models and devices is

TABLE II : COST ANALYSIS

Name of the part	*Quantity*	*Price*
Arduino-UNO (R3)	1	$5.25
SG90 1.5 kg /0.3sec 9g Micro Servo	6	$11.25
Bluetooth Module Breakout (HC-05)	1	$4.125
Servo Power Supply	1	$2.45
Battery, wires etc.	N/A	$5.9
Total – $28.98		

shown in Fig. 7. The cost of gadgets that are mass produced has been scaled down to one cell.

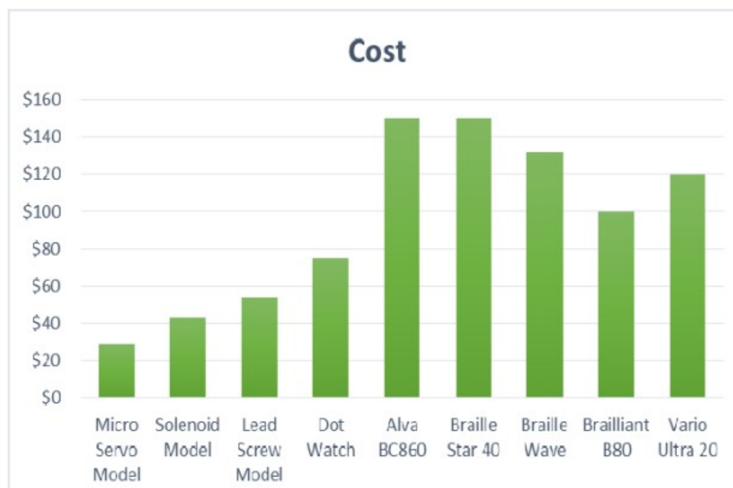


Fig. 7: Cost comparision among refreshable braille models

C. Portability Analysis

Devices that we must use constantly as technology develops are becoming more portable by becoming smaller. In the current technological era, a device with less features that fits in your pocket is significantly more effective and appealing than one with more functionality that is not portable. The Dot watch, a wristwatch made for people who are blind, is now the most effective device in terms of portability [22]. It has a thickness of 12.5 mm, measures 43 mm broad, and weighs up to 27 gm. The prototype, which was created based on the suggested model, is a box-shaped device with dimensions of 3.8 cm in thickness, 12.7 cm in width, and 22.8 cm in length.

It may easily stow away in a tiny bag or a backpack. Table III shows the prototype's weight distribution. Although there are smaller devices available, the novelty and effectiveness of the suggested model are enhanced by the combination of comparatively low weight and low cost.

TABLE III : WEIGHT ANALYSIS

Name of the part	*Quantity*	*Weight (gm)*
Arduino-UNO (R3)	1	25
SG90 1.5 kg /0.3sec 9g Micro Servo	6	88.2
Bluetooth Module Breakout (HC-05)	1	9
Servo Power Supply	1	11
Battery, wires, body	N/A	520
Total – 653.2 gm		

V. CONCLUSION

Those who have visual impairments are falling behind in the recent wave of technological improvements. Furthermore, there aren't many choices for both reading and writing styles. Refreshable braille screens have been used in an attempt to solve this issue. However, the high price of these devices and their immobility have been a major problem in this market. In the work that has been given, a paradigm for a refreshable braille display that is portable and economical has been proposed. The suggested device is more compact and was made with the use of micro servos, as opposed to the 40–80 cells in today's refreshable braille displays. The experiment conducted on a prototype of the proposed model's gadget shows that the model outperforms preceding versions in terms of mobility, price, and simplicity. Ultrasonic sensors or other touch-sensitive sensors may be used in future work to improve the model and make it smarter and more useful.

REFERENCES

[1] K. Beck, "Challenges That Blind People Face", LIVESTRONG.COM, 2018. [Online]. Available: https://www.livestrong.com/article/241936-challenges-that-blind-people-face/. [Accessed: 10- Mar- 2018].

[2] R. Noelle, Louis Braille 1809–1852, a French genius, 2009 [Online].

[3] Rabiner, Juang, Fundamentals of Speech Recognition, 1993.

[4] Techniques For Feature Extraction In Speech Recognition System : A Comparative Study.

[5] Feature Extraction For Speech Recognition, Electronic Systems Group, EE. Dept, IIT Bombay,2003.

[6] Automatic Speech Recognition Features Extraction Techniques: A Multi-criteria Comparison, (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 12, No. 8, 2021

[7] An overview of recent window based feature extraction algorithms for speaker recognition, August 2012.

[8] Voice Recognition System: Speech-to-text, Journal of Applied and Fundamental Sciences, November 2015.

[9] Speech to text and text to speech recognition systems, IOSR Journal of Computer Engineering (IOSR-JCE), April 2018.

[10] Design and Implementation of Text To Speech Conversion for Visually Impaired People, International Journal of Applied Information Systems (IJAIS), April 2014.

[11] Conversion of speech to Braille: Interaction device for visual and hearing impaired, 2017 Fourth International Conference on Signal Processing, Communication and Networking (ICSCN).

[12] A Braille Transliteration on Tamil Vowels and Consonants Text Image, International Journal of Applied Engineering Research ISSN, Volume 13 Number 11, 2018.

[13] Conversion Of Text Image Document In Southern Indian Languages Into Braille For Visually Challenged People, International Journal of Computer Engineering & Technology (IJCET) Volume 9, Issue 4, July-Aug 2018.

[14] A Relatively High-Resolution Reading Aid for the Blind, Bliss J. C. 1969.

[15] An Electronic Aid for Visually Impaired in Reading Printed Text, 2013.

[16] Sensory Aids for the Blind: A Challenging Problem with Lessons for the Future, IEEE, VOL. 58, NO. 1.

[17] Design and Implementation of a Low-Cost Printer Head for Embossing Braille Dots on Paper, International Journal of Emerging Trends & Technology in Computer Science, 2020.

[18] Speech Recognition Systems – A Comprehensive Study Of Concepts And Mechanism, Acta Informatica Malaysia, 2019.

[19] Speech Recognition Using Deep Neural Networks: A Systematic Review, IEEE, 2019.

[20] Speech Recognition by Machine: A Review, (IJCSIS) International Journal of Computer Science and Information Security, Vol. 6 No. 3, 2009.