REFRESHABLE BRAILLE MODULE USING CAM ACTUATED MECHANISM

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Abstract. Less than 3% of 145 million blind people in developing countries at present are literate [1]. At present, in most of the cases, speech output has been the medium for blind people to access materials. For content which require deep understanding such as technical texts etc., it is not an appropriate modality, moreover blind people are more accustomed to braille transcripts and adaptability issues to all audio resources is difficult. And thus, arises the need for a cheap, easily adaptable, less complex solution to the problem. Braille points are varied arrangements of raised dots representing characters which are identified by touch by visually impaired people. Here we discuss in detail, development of a dynamic/refreshable Braille display which presents Braille points by the up-and-down movement of pins using a completely new, first of its kind, Cam actuated mechanism with just two actuation points instead of a standard 6 used by every single refresh-able braille board in the world at present. Two nested shafts having 8 arrays of precisely calculated and placed cam, each were responsible for keeping the pins in up and down state. The shafts were actuated using two micro-servo motors placed next to each other. X degree rotation of servo after transmission through gear and subsequently shaft resulted in a particular configuration. Henceforth calibration was done so that all braille alphabet could be produced with specific servo rotations.

Keywords

1. INTRODUCTION

According to the stats of World Health Organization about 285 million people are visually impaired worldwide. Further adding 7 lakhs to 9 lakhs to the figure are those are deaf and dumb. In this modern era of communication where the normal people can interact with their long distant relatives and friends through calls or messages, the disabled section of the society are not able to and are deprived of these basic opportunities. This way the talented ones miss the platform because of visual, speech or hearing inabilities. Braille is permutation and combination system of raised dots which correspond to different letter that allows blind people to read and write because of its versatility and elegance. But despite of that blind people don’t have access to learn this sign code. Absence of knowledge in American Sign Language as a means of communication for deaf and dumb isolates them from the rest of the society. Our research and prototype brings to us not only the solution to cover up this flaw in our current system but also to make these victims aware of such sign languages and train them.

2. NOVELTY

We have planned to replace the heavy bulky models of braille board with our pocket prototype. Also no current technology has in cooperated a mechanism to aid both blind as well as deaf and dumb person at the same time.
Even if the person is not aware of the braille language or the American Sign Language, he/she can easily learn using the app

3. LITERATURE REVIEW
Before going into the death of this project we went through some research papers to bring out the uniqueness in the current system and our proposed system

| Sr. No. | Paper Name                                      | Head 1                                                                                                                                                                                                 |
|--------|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.     | Designing of English Text to Braille Conversion System | In the current era, the world around us is going to be electronic. Everything is at present available at digital and virtual world and the whole world is taking the advantages of that but the problem is arising when the visually impaired person will be concerned about the electronic and digitized world. Approximately 84 million people in this world are not able to see and those blind persons could not be able to take the advantage of the electronic world like reading of digital data from the electronic thing. They use the Braille language to read the data with the sense of touching to it but the problem is arisen when the reading has to be done from the electronic content as they cannot sense it by touching to it. |
| 2.     | Aiding the Visually Impaired: Developing an efficient Braille Printer | With the large number of partially or completely visually impaired persons in society, their integration as productive, educated and capable members of society is hampered heavily by a pervasively high level of braille illiteracy. This problem is further compounded by the fact that braille printers are prohibitively expensive – generally starting from two thousand US dollars, beyond the reach of the common man. Over the period of a year, the authors have tried to develop a Braille printer which attempts to overcome the problems inherent in commercial printers. The purpose of this paper, therefore, is to introduce two prototypes – the first with an emphasis of cost effectiveness, and the second prototype, which is more experimental and aims to eliminate several demerits of Braille printing. The first prototype has been constructed at a cost significantly less than the existing commercial Braille printers. |
| 3.     | Braille Teaching Electronic Prototype          | The developed project aims to introduce an electronic device, in a blind people community, an electronic device, capable of generating an autonomous learning of Braille reading system. In addition, it was decided to develop this project, taking as reference the current rate of 0.3% of visually impaired people in Ecuador, the government's willingness to support projects that involve social inclusion; and the University commitment, to improve the lifestyle of people with disabilities. The electronic board Arduino Mega, is responsible for receiving the input signals and activate the peripherals, which generate the learning of the Braille code. |
| 4.     | Braille Display by Rotating Multi-              | Braille display is a device from which the visually challenged people can actually read the text output from the computer in the form of Braille character. But the commercially available Braille display price is in the range of ₹ 100000 to ₹ 500000 so it can’t be easily avail for poor |
Octagonal Segment | visually challenged people. So, this paper discusses about the making of new type of Braille display, by rotating multioctagonal segments, with low cost. Here the text is converted into Braille character by rotating each octagonal segment, which contains all possible combination of raised dots of one column of Braille cell on its faces, to a particular degree. The required Braille character appears on the top face of the octagonal segments.

5. Braille Grade 1 Learning And Monitoring System | Braille is a standard code for people with visual disabilities that consists of an array of high points. This paper explains the implementation of a low-cost prototype for reading, writing, and audio-assisted evaluation. This didactic and user-friendly system aims to improve the learning of disabled people by providing teachers new and modern alternatives to lead and monitor the student's activities. The Braille Grade 1 system consists of the following four stages: (a) writing, by the use of 10 buttons placed in matrix form, (b) reading, through 10 push-pull solenoids, (c) memorization, and (d) evaluation by using a touch display where the generated letters are displayed and assisted by audio messages.

6. Blind Aid: A Self-Learning Braille System for Visually Impaired | Braille is vital to all visually impaired individuals and it's the only system through which visually impaired children can learn to read and write, yet the rate of Braille literacy among visually impaired people belonging to developing countries including Pakistan is alarming low. Thus, Braille literacy is the key to employment and full participation in society. This research paper presents the design of a low-cost, low-power, portable, self-learning, and user-friendly Braille system. The designed system serves as Braille writing and reading tutor, so visually impaired people can enhance their Braille writing and reading skills without the assistance of a Braille teacher. The designed system takes the input through Braille keyboard and produces the speech output and it also has the capability to read documents. It is believed that by implementing the designed Braille system in schools and homes, Braille literacy rate can be increased and visually impaired people can be employed and can fully participate in society.

7. Research Investigating Implications of Adopting the Unified English Braille Code | The purpose of this report is to present the outcome of a project supported by the Braille Authority of North America (BANA) to conduct research on the Unified English Code (UEBC). We will begin by presenting a listing of the research questions given to us by BANA that we felt we were able to address within the limits and resources available for these studies. Following this list is a brief description of the structure of the research that was carried out. There are three distinct phases to this project which include focus groups, experimental reading studies, and text analysis. Each phase is reported separately. Finally, we will end with implications of our findings and concerns for needed further research on issues related to the adoption of UEBC.

8. Multi | India is now a home to the world's largest number of blind people.
Technologies are developed day by day principally in communication mobile phones which plays a crucial role. But visually impaired people can’t able to use message application in mobile phones. The proposed system is to help the blind to know the letters through voice communication. This system designed so as to make thing easy for the blind people. In this system we use 6 dots Braille system which mostly used in blind school. Normally speech recognition software, audio interface is mostly used features to use computers by the blind. Here the same features are introducing in the mobile with Braille system. In this system, we receive messages by using modem. All that messages are recognized by audio interface and sending acknowledgment for that particular message by using speech recognition with help of Braille system. So with this system blind peoples can able to use all the applications in mobile phone as a normal people. in future this system will be helpful to blind people to communicate whole the world with simple interface.

4. INTEGRATED IMPLEMENTATION OF MODULES
The entire mechanism has been divided into three modules. Each module has its own contribution in bringing the universality and elegance of the system.

3.1) The Mechanical Design
3.2) The Android App
3.3) Actuation of the servo motors.

3.1 THE MECHANICAL PROTOTYPE
The basic concept of cam shafts are used to design the dynamic braille board, we are using two cam shafts driven individually by one servo motor each. One shaft is used to control 3 pins out of the six pins in the braille board. Cam shaft id a cylindrical rod with different cam geometries placed around it according to the application. A cam is a curved eccentric shape placed around a shaft to move the follower (in this case pins) as per the requirement. Cam shafts are widely used in many mechanical actuation units such as in IC engines to timely open and close the inlet and outlet valve. The complete design of the mechanism is designed on Solidworks

![Figure 1. Side by side view of the Solidworks model and the actual manufactured module](image)
Each shaft has three portions of cam divided lengthwise for controlling each pin as shown in Fig 1. In order to obtain all $2^3=8$ (since each pin can be up or down at a time) combinations for the three pins controlled by one shaft the cams are placed at $360/8=45$ degrees angle around the shaft, each cam has maximum extension of 3mm for the pin to be raised and 2mm width for ensuring that the required pin is raised even when the angle of rotation is not 100% accurate. The length of the cam is 4mm to ensure free axial moment of the shaft so that the motor can rotate the shaft without taming much load as to when the shaft is not free to move and may get stuck in between to put stall on the motor. The shape of the cam and the positioning of the cam are designed so that minimum angle of rotation and minimum torque is required to move pin in between orientation for different braille alphabets.

Since the design of the cam shaft and the whole assemble is no conventional, small and complex, it is not a feasible option to manufacture it by conventional manufacturing and machining processes therefore this model is made by additive manufacturing (Fusion deposition modelling 3d printing) technology. This model is manufactured using PLA (polylactic acid) plastic filament since it is the most widely used and available used material in the market but ABS filament can also be used for better strength and durability of the model.

For printing this model the desktop printer Creality Ender3 was used, for printing the parts all the Solidworks design files are saved in STL file format and then sliced in the software Cura to obtain the g-code for running the printer, the part orientation, layer thickness and infill percentage are set for each part according to the requirement and after printing all the parts are assembled together with the servo motor to obtain the braille board.

### 3.2 THE ANDROID APPLICATION

The implementation of the voice assistance app was a tedious task as the app menu had all icons which were controlled through gesture.

- a) Contacts
- b) Personal Assistance
- c) Speech to Text
- d) Book
- e) Keyboard
- f) Text to speech
- g) Camera

Gestures like right swipe allowed the user to select a particular icon and left swipe to return back to the previous menu. There is a counter which detects every right sweep icon as it is updated after every consecutive swipe. Recent contacts has also been incorporated which allows the user to call as shown. Methods to control the gesture like up down right left swipe were merged. Up swipe and down swipe. The Keyboard part as shown allows the user to text and at the same time learn the ASL if he/she is unaware about it. Book reading is another key feature. We have Firebase real time storage, we have certain number of books uploaded, as soon as the user double swipes right, we convert the book into text. To sync the letters with braille we have in built Google speech to text after that app is connected to real time firebase. In braille child the value is updated then the data in Python is also simultaneously updated.

### 3.3 ACTUATION OF SERVO MOTORS
In order to rotate the two cam shafts two servo motors are used (in this case micro servo sg90) to get a closed looped system for accurate rotation of shaft by closed loop system. The servo motor used offers the rotation range of 0-180 degree but in order to obtain all orientations of pins the shaft should be rotated complete 360 degree. In order to obtain this complete 360 degree rotation of shaft using 180 degree rotation a set of gears are used with reduction ratio 2. The module of gear used in this model is 0.5, the bigger gear which is attached to the servo motor has 24 teeth and teeth smaller one which is attached to the cam shaft has 12 teeth, both the gears have 4 mm face width. The gears are meshed together and thus the partial rotation of servo is converted to complete rotation of the cam shaft. The step of angle required to change the orientation of pins to the next alphabets is $45/2=22.5$ degree. With each rotation of 22.5 degree of the servo motor next alphabetic orientation is obtained.

4 GENERAL ARCHITECTURE

4.1 Ways of interpersonal communication from a disabled to a normal person

Figure 2. Ways of interpersonal communication from a disabled to a normal person

4.2 Ways of interpersonal communication from a normal to a disabled person

Figure 3. Ways of interpersonal communication from a normal to disabled person

5. METHODOLOGY
We have several cases to be considered.

- Case 1: Firstly a blind person interacting with a normal
- Case 2: A blind person interacting with a blind
- Case 3: A visually impaired person interacting with a deaf and dumb.
- Case 4: A deaf and dumb interacting with a normal person.
- Case 5: A deaf and dumb interacting with someone having the same problem.
- Case 6: Deaf and dumb interacting with a blind

For the above mentioned cases we planned to develop a universal system in which we have integrated several modules into one. Now case by case we will solve the mentioned cases. Taking Case 1 into consideration whenever a blind person wants to talk, he/she can simply make a phone call through the app. The app has a gesture control feature with sweep down and sweep up feature which allows the user to choose the various icons available. And right sweep allows selecting the icon. Now coming to case 2 where a blind person one side speaks words which are converted letter by letter into corresponding braille segments so that the blind person on the other side can decrypt the message.

Now case 3 is a condition where the person on the other side is deaf and dumb. In this case google speech to text has been cooperated in the app which allows the person to see the message on app.

Now we will be seeing into the cases where deaf and dumb will be interacting. Focusing on Case 4 where the deaf and dumb can simply text his or her message through the keyboard feature on the app. Now Case 5 can be solved through simple text to text conversation as the person on both side are having same disabilities. Last case is when the person on the other side is blind. In such case we expect the deaf and dumb will be texting message will be letter by letter converted into braille characters.

The cases have been depicted in the figure. Fig 3. shows an interpersonal communication between a deaf and dumb with a normal person, a deaf and dumb and a blind person.

6. CONCLUSION

Using innovation in multiple areas and using first of a kind actuation mechanisms we were able came up with a low cost high performance model which integrates the solution of all the disabilities at a time. This would overall serve as a great aid to people facing issue with daily interpersonal communications, learning and other areas which people could implement this system in.

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