PORTABLE BRAILLE

HEALTH CARE AND LIFE SCIENCES

Victorious Visionaries

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1. INTRODUCTION :

Braille is a system of raised dots that allows visually impaired people to read tactilely. Braille symbols are formed within units of space known as braille cells. A full braille cell consists of six raised dots arranged in two parallel rows each having three dots. The dot positions are identified by numbers from one through six. A single cell can be used to represent an alphabet letter, number, punctuation mark, or even a whole word depending upon the grade used.

Braille is not just a language, rather it's a code by means of which other languages such as English, Spanish, Arabic, and dozens of others may be read. Also, Braille defines the blind literacy. A blind person is considered to be a literate only if he/she knows to read Braille, hence making Braille a day-to-day need for the blind. This is also one of the main reason why Braille is still a standard and not completely obsolete.

Currently, the number of books written in Braille script are less and the cost is high. This project is an approach to solve the problem of unavailability of many of the books and texts in Braille script. The **Portable Braille** consists of a camera module which captures the image of a printed text material and converts it into text format by using Optical Character Recognition(OCR). The characters in the text are converted into Braille characters(3x2 matrix form) and fed to the actuators. The actuators are the pins in the head of a dot matrix printer. The pins are actuated in such a way that it creates pressure at required points in the fingertip similar to how pressure is felt when placed on an embossed braille character. The device sends character by character to the user's fingertip through the actuators. These characters will be sent with appropriate delays to make the user understand words/sentences. Hence a given printed text material can be understood by the blind person through his/her sense of touch.

2. PROPOSED SOLUTION (in Nutshell):

The proposed solution is as shown:

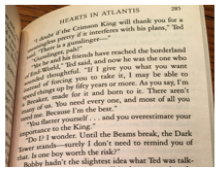


FIG: Normal Text/Image

Image processing and OCR

The quick brown fox jumped over the 5 lazy dogs!

FIG: After OCR we have individual characters identified

Converting OCR Into Braille Characters

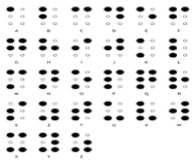


FIG: Recognized characters are now converted to Braille.

Actuating the actuators

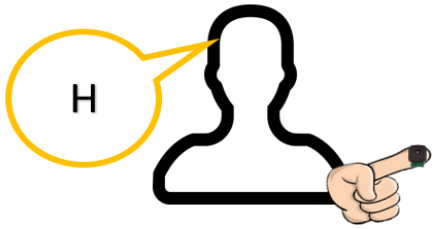
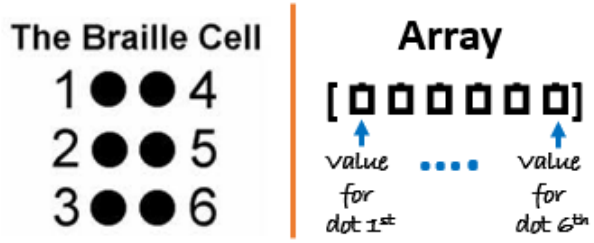


FIG: User sensing this on his fingertips.

User can feel it on the fingertip

FIG: Dot Matrix printer head.

The user will wear a spectacle on which the camera module will be mounted. The camera will capture the view in front of it. The captured image will be processed and the portion having text in it will be considered for further processing and the rest will be discarded. Then the text image or the image under the consideration will be processed further using the OCR algorithm through 'pytesseract' library (this library takes the help from Google Tesseract application and recognizes the text on the image passed to it and return the text in string form) and the text present on the image will be recognized and stored in a string. Now, this string will be converted into its corresponding braille cell, character by character and stored in array form. The array is having six elements in it, representing 6 dots in a braille cell, with elements position mapped according to the braille cells position number. If the dot is meant to be raised the corresponding array element is 1 or else 0. These arrays will be sent and accordingly the actuators will be actuated (for 1 the particular pin will be raised, for 0 no action or initial position).



3. TECHNICAL DETAILS:

The whole process can be divided into 4 sections viz. **Image Capturing**, **OCR**, **Braille Conversion**, **Actuation.** Technicalities of the various section are described below:-

Image Capturing:

Each user will be given a spectacle. On that a camera will be attached which will capture the image. Considering power utilization by the camera, the camera will not be continuously ON. Whenever the user wants to start reading, he/she will press a button and the camera will be turned ON. It will then capture 10-15 images and then turn OFF automatically. From these images a proper image will be chosen(the one with less blurriness and distortion). Hence the desired image is found from the captured photo burst. The best image is finally fed to the microcontroller. Then further image processing techniques like perspective transform and few threshold filters are applied to convert the captured image into a binary image of the required size. And finally, we use the OCR algorithm on this binary image to get the text in string format.

Optical Character Recognition:

Google's Tesseract-OCR (Optical Character Recognition) is used to identify individual characters in the image. 'pytesseract' is used as wrapping library for the Google's Tesseract-OCR. Hence the given image can be converted from image format to text format as shown below.

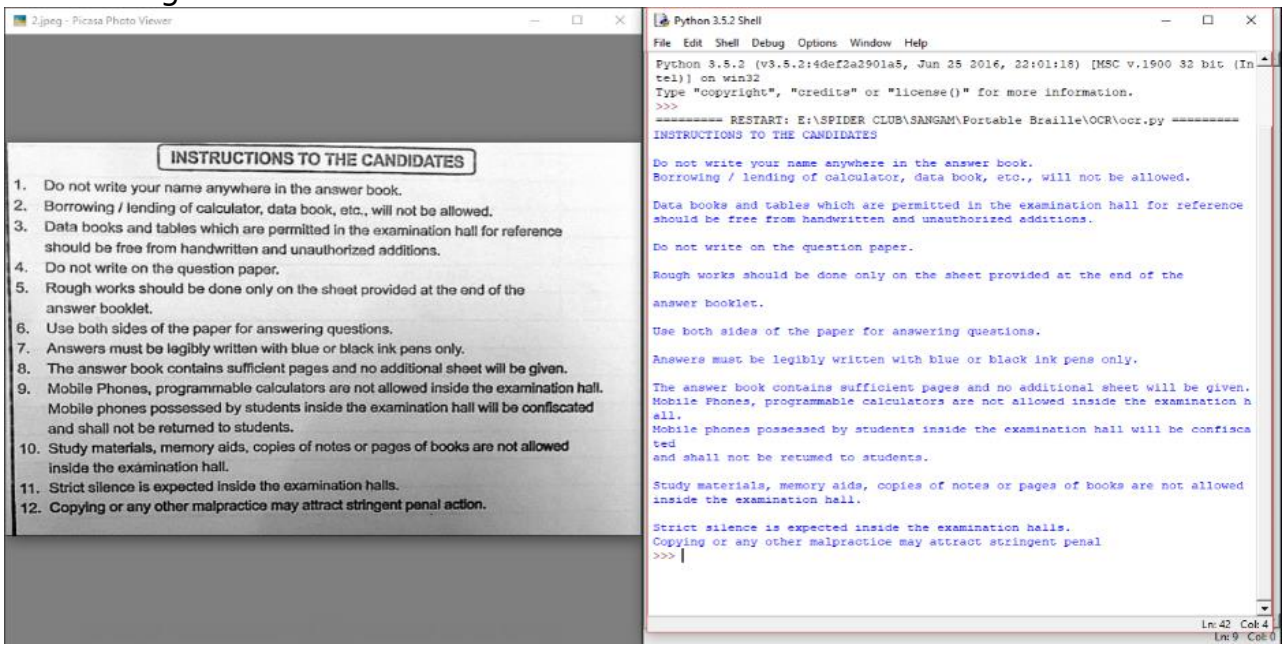


FIGURE 1: *Sample test image after OCR. (Lang: English)*

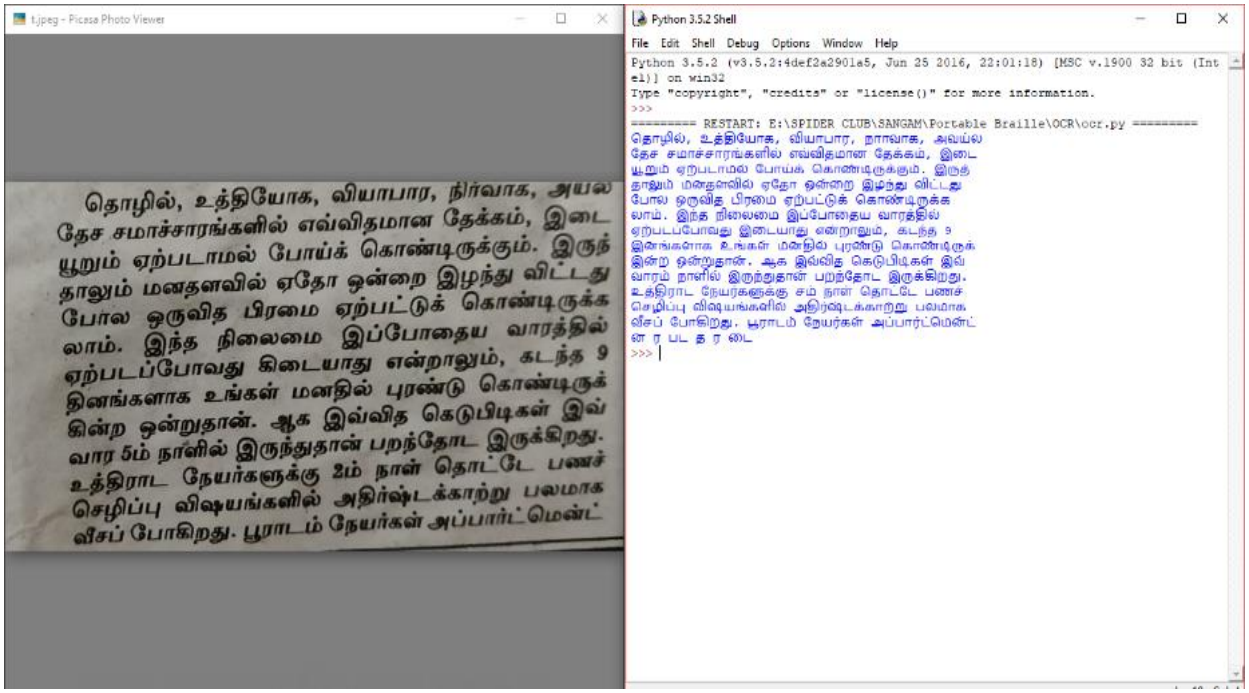


FIGURE 2: *Sample test image after OCR. (Lang: Tamil)*

The OCR will return the whole text in a string form. The string is stored and sent for braille conversion where each character will be converted into a 3x2 matrix.

Braille Conversion:

The string obtained after applying OCR algorithm is translated into its corresponding braille cells character by character. Each character is converted into an array of 6 elements having 1 or 0 as its value, 1 if a dot is meant to be raised, 0 if not. The braille cell dots number is mapped according to the elements of the array. For example, **H** in braille form is represented as - ⠓, now the corresponding array form will be [1 1 0 0 1 0] since in the cell, dot 1,2,5(start numbering dots from top to bottom and starting from left) are raised and rest are not. So accordingly, 1^{st},2^{nd},5^{th} element in the array is 1 and rest all are 0. Like this, all the characters are converted into its braille form and fed into the actuators. These actuators simulate braille by creating pressure in the fingertip at appropriate places. Also, the braille conversion can be done in two ways- using **GRADE 1** or **GRADE 2** Braille. Our code can convert according to both grades, the user has to choose it in its first run. If at all he/she wants to shift to another grade later he/she can do that. The difference in the Grades are as follows:

Grade 1 Braille: In this grade, each possible arrangement of dots within a cell represents only one letter, number, punctuation sign, or special Braille composition sign - it is a one-to-one conversion. Individual cells cannot represent words or abbreviations in this grade of Braille. Hence books were bulkier and larger than normally printed textbooks. This type of Braille is typically used only by those who are new to learning the grades of Braille.

Grade 2 Braille: This grade was introduced as a space-saving alternative to grade 1 Braille. In grade 2 Braille, a cell can represent a shortened form of a word. Many cell combinations have been created to represent common words, making this the most popular of the grades of Braille. There are part-word contractions, which often stand in for common suffixes or prefixes, and whole-word contractions, in which a single cell represents an entire commonly used word. Words may be abbreviated by using a single letter to represent the entire word, using a special symbol to precede either the first or last letter of the word while truncating the rest of the word, using a double-letter contraction such as "bb" or "cc", or removing most or all of the vowels in a word in order to shorten it. A complex system of styles, rules, and usage has been developed for this grade of Braille.

For example: - If you convert word “braille” into Braille cells, according to grade 1 the result will have 7 different cells representing each of the ‘b’, ‘r’, ‘a’……(all the letters), whereas, if you go with grade 2, the result will have only 3 cells for ‘b’, ‘r’, ‘l’ since “Braille” in grade 2 is abbreviated as “brl”. Hence, grade 2 saves space.

Actuation:

The head of an old dot matrix printer is used as the actuator to simulate the Braille characters on the fingertip of a blind person. This is preferred compared to other alternatives such as Shape Memory Alloys(SMAs) and servos as the actuators in dot matrix printers are small enough to simulate a whole Braille character(3x2 matrix) in a single fingertip. An appropriate 3D printed structure can be used to change the arrangement of these actuators from linear fashion(9x1) into 3x2 matrix format.

After the Braille conversion step the array will be processed and where ever 1 is found, the signal will be pulled to HIGH in the printer head(terminal) for the corresponding pin to raise it. If 0 is found, signal will be pulled to LOW. Proper delay will be given to differentiate between words and sentences.

FIG: DOT MATRIX PRINTER HEAD

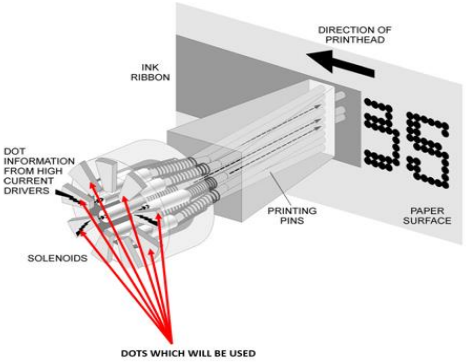


FIG: INTERNAL SCHEMATIC

FIG: ACTUAL LOOK(TOP VIEW).
[ALL PINS ARE IN 1D MATRIX FORM]

After using 3D printed Top Head

FIG: SAMPLE NEW LOOK(TOP VIEW).
[NOW THE PINS ARE IN BRAILLE CHARACTER FORM]

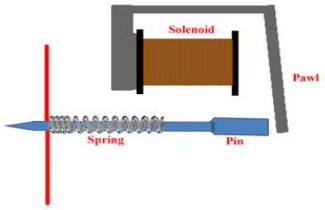


FIG: SCHEMATIC OF HOW A SINGLE DOT IS ACTUATED

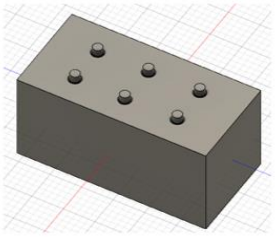


FIG: Sample 3D Model of the Top head

FIGURE 3

4. EXTENSION :

- Provision for controlling the speed at which braille characters are sent to the actuating units.
- Provision for storing text materials which can be read again later.
- Provision for choosing the language of the text to be read.
- Provision to have a memory so that user can roll back (10-15 characters) and once again start reading it.

5. INNOVATIVENESS :

- The existing prototype which has a similar objective can be found in the reference link. It uses Shape Memory Alloys as actuators in 3 fingers to simulate Braille characters.
- Our prototype is more practical as we are able to simulate the characters in a single fingertip.
- The actuation of Shape Memory Alloys is very slow compared to the actuation of the pins in the dot matrix printer head.
- Cost of our actuators is almost NIL(E-Waste) while Shape Memory Alloys are comparatively costlier.
- Reusing of e-waste (obsolete dot matrix printer head) for a useful cause.

6. COMPONENTS AND COSTS :

COMPONENTS/PARTS	ROLE/FUNCTIONALITY
Raspberry Pi 3B	The main part of the project where all processing will take place.
Dot Matrix Printer Head	Used for miniaturized actuators
Pi Cam	Used for capturing the required image
Batteries	For powering the circuit
Few 3D printed parts	For fabrication
Other Electronic Components **(Wires, Resistors, etc. ….)**	For connection, limiting current, etc.

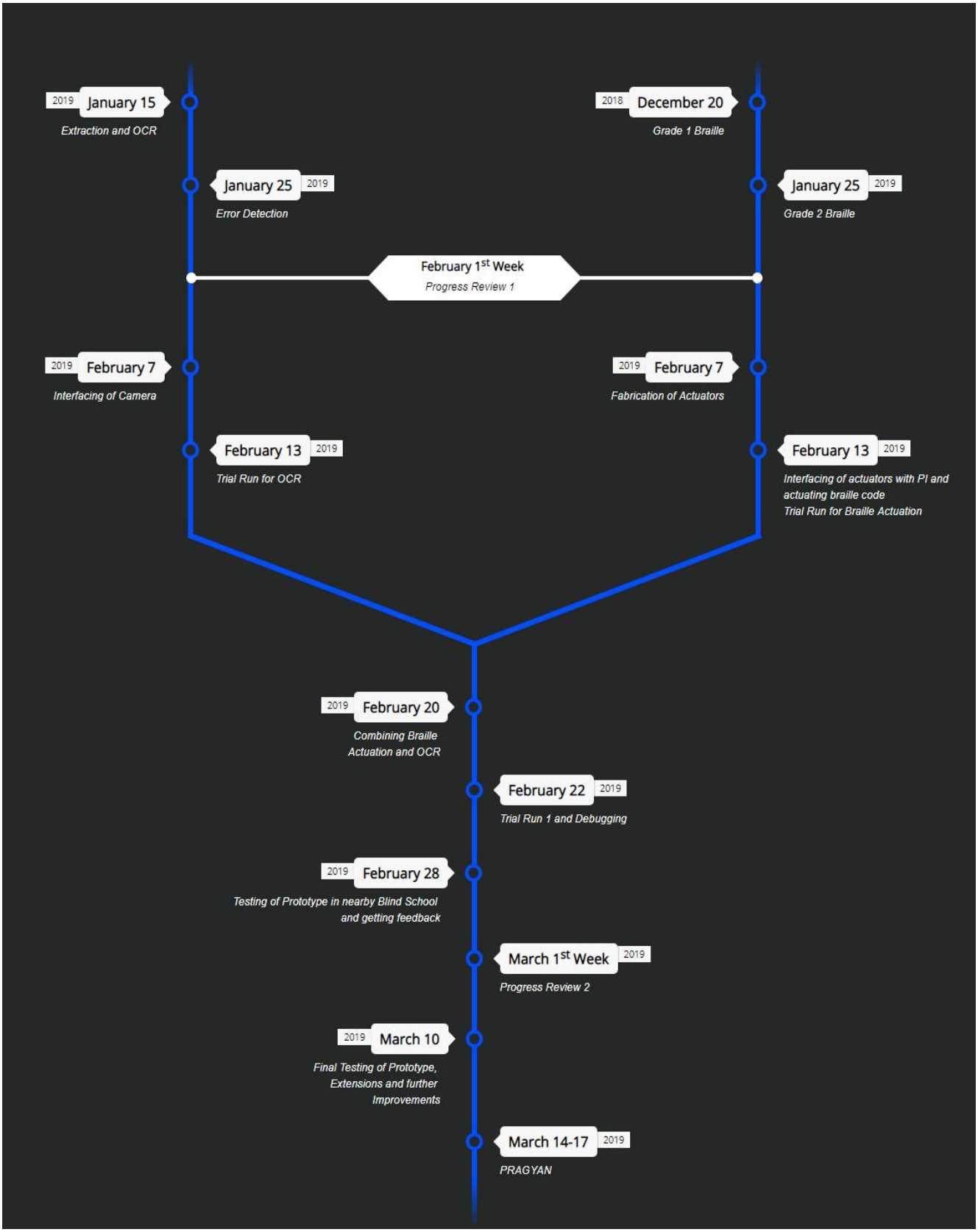
BUDGET:

The total estimated budget of the project is **₹ 6000/-**

Budget breakdown is as follows:

Raspberry Pi 3B	**₹ 2749**
Dot Matrix Printer Head	**₹ 0**
Pi Cam	**₹ 1199**
Battery (LiPo 11.3V)	**₹ 1599**
3D Printing	**₹200**
Other Electrical Components (Wires, Resistors, etc. ….)	**₹ 200**

7. TIMELINE :


2019 January 15
Extraction and OCR
2018 December 20
Grade 1 Braille
January 25 2019
Error Detection
January 25 2019
Grade 2 Braille
February 1st Week
Progress Review 1
2019 February 7
Interfacing of Camera
2019 February 7
Fabrication of Actuators
February 13 2019
Trial Run for OCR
February 13 2019
Interfacing of actuators with PI and actuating braille code
Trial Run for Braille Actuation
2019 February 20
Combining Braille Actuation and OCR
February 22 2019
Trial Run 1 and Debugging
2019 February 28
Testing of Prototype in nearby Blind School and getting feedback
March 1st Week 2019
Progress Review 2
2019 March 10
Final Testing of Prototype, Extensions and further Improvements
March 14-17 2019
PRAGYAN

8. STATISTICS AND IMPACTS:

- The National Federation of the Blind states that a blind person is considered to be a literate only if he/she knows Braille.
- According to the statistics of NCBI(National Centre for Biotechnology Information) of India, there are around 15000 blind schools in the country with about 200,000 blind students. All of them learn Braille and depend on it for their education. Hence this portable system has a direct impact on them as it gives access to all the texts a normal student could get.
- A major part of the blind population falls under the age category of senior citizens. These people use Braille for leisure activities unlike the children and young adults who use it for learning. This makes it more difficult for them to get the Braille form of texts they need, like daily newspapers.
- According to the Forbes article in the reference, the number of books available in Braille is well under 1% of the total literature. According to the website a Braille reader costs around 3000-15000(₹2,00,000 - ₹10,00,000Rs) which is too expensive compared to this portable reader which costs just ₹6000.

LINKS:

GitHub Repository link:

https://github.com/adityasingh3007/Portable_Braille

Google drive link:

https://drive.google.com/drive/folders/1wH5ih7TGFLmzVzSVHatiSTikoFH5W4lT