Gujarati Braille Text Recognition: A Review

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Abstract: Braille is a medium of written communication for people with low vision and blindness. It helps visually impaired people to recognize letter, word or sentences. It is traditionally written in embossed form. They can write Braille with the original slate and stylus or type it on Braille writer, such as portable Braille note-taker, or on a computer that prints with a Braille embosser. There are two types: Single side and Double side. In this paper, focus is done on nature of Gujarati script and Braille language along with the method for Optical Braille characters recognition. Detailed literature view is also carried out on Braille Characters recognition. So it will be useful to the researchers who want to work with Braille script.

Keywords: Braille script, Gujarati script, OCR, Pattern recognition.

INTRODUCTION

Braille is a writing system that enables blind and partially sighted people to read and write through touch. It was invented by Louis Braille, a French teacher of the blind Information about Deaf Blindness. Braille is a tactile writing system used by blind and visually impaired. The arrangement of six dots is known as a cell. It is written with embossed dots in the form of cells as shown in figure 1 [9-11, 14-15]. Standard Braille is an approach to create documents which could be read through touch. The arrangements of cells for English letters A-Z is shown in figure 2.
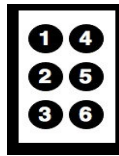

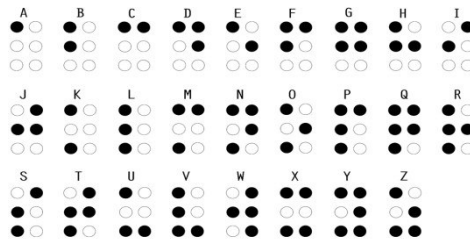Fig 1. Braille cell with 6 dots

Fig 2. English Braille

The dots height is approximate 0.02 inches. Horizontal and vertical space between dots approximate 0.01 inches. Space between dots on adjacent cells is approximate 0.15 inches and horizontal 0.2 inches. A standard Braille page size is 11 inch by 11.5 inches and typically has a maximum of 40 to 43 Braille cell per line. The dimension of the Braille cells is shown in figure 3.

All dots of a Braille page should fall on the intersections of an orthogonal grid (Pair of vectors equal to zero). When texts are printed double-sided (recto-verso), the grid of the verso text is shifted so that its dots fall in between the recto dots as shown in figure 4 [16].
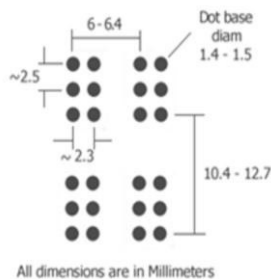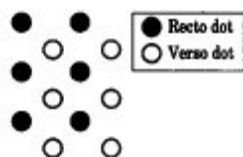
Fig 3. A Braille Cell Dimensions

Fig 4. Positioning of Recto and Verso Braille

Recto dots detection:
It refers to the text written on the "Front" side of a leaf of paper on a bound item.
Verso dots detection:
It refers to the text written on the "Back" side of a leaf of paper on a bound item.

Optical Braille Recognition system can be used to convert Braille document into its equivalent natural text as shown in figure 5.
There are two types:
1) Single side
2) Double side

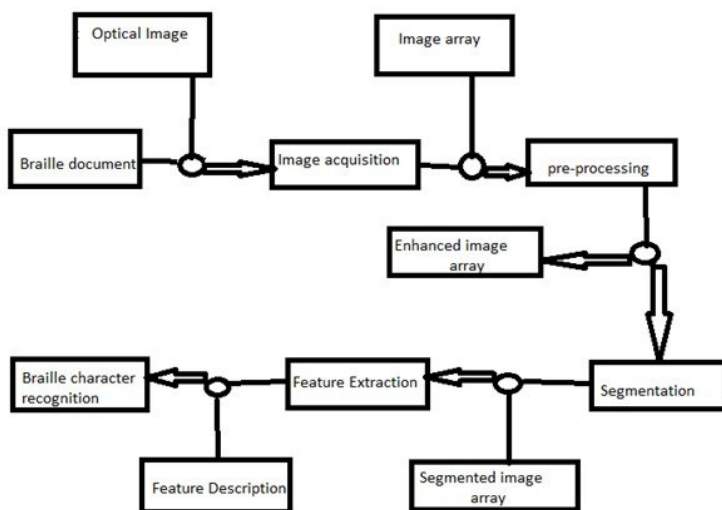(1) Single sided Braille document is embossing is created on one side.

Fig 5. Stages of Braille Character Recognition

(i) Image Acquisition:
Obtained image of single sided embossed Braille documents using a flat-bed scanner.

(ii) Image Pre-Processing:
Convert the image from the Red, Green, Blue (RGB) color images into gray level images because color feature are irrelevant.

(iii) Image Enhancement:
The main image features are the dots and their relative location.
There are two stages in Image Enhancement:
(i) Noise Reduction
(ii) Contrast Enhancement

(iv) Image Segmentation:
Perform image segmentation to separate the desired dots from the background.

(v) Feature Extraction:
This is a major step where we extract the relevant information from the image for interpretation of the letters and words in the form of cells.

(2) Double sided Braille document is embossing on both side [7].

It has two tasks:--

(i) Recognize the printed Braille dots.

(ii) Differentiate them as recto and verso dots.

This involves few processes such as, thresholding, centroid detection, mask design, placement of designed mask on the centroid detected dots and differentiating recto and verso.

Segmentation: Each dot in a scanned Braille image is composed of light and dark areas separated by background. Therefore, the scanned image is segmented so that only three classes of regions exist:
- dark
- light
- background.

The three modes of a histogram of a Braille image represent the three classes of pixels:
Mode 1: represents the dark region of a recto and verso dot.
Mode 2: represents the background.
Mode 3: represents the light region of a recto and verso dot.

Gujarati is one of the languages used in India. It is written from left to right, with each character representing a syllable [2]. The vowels are called Swar and consonants are called Vyanjan. Gujarati consist of set of special modifier symbols called Maatras, corresponding to each vowel, which are attached to consonants to change their sound [6]. Gujarati characters with its Braille representation is shown in figure 6 [17].

Fig 6. Gujarati Braille

Literature Review

Shreekanth et. al. [4] represents the recognition of double sided embossed Braille document, with simple Braille dot analysis. It has two main tasks, printed Braille dots recognition and other is to differentiate them as recto and verso dots. Thresholding, mask design, centroid detection, placement of designed mask on the centroid detected dots and differentiating recto dots from verso dots like processes is involved.

N. B. Jariwala et. al. [1] describes about Braille script and Gujarati language in detail. They also discussed literature review for the conversion of Gujarati text to Braille. And along with that they have also represent the challenges and problem that can be faced at the time of conversion.

A. Mousa et. al. [5] specified the improvement of each step starting from the image acquisition until the Braille cell recognition final stage. This system includes steps like, image acquisition stage, image pre-processing for noise removal, modified image segmentation, feature extraction and then character recognition.

L. Wong et. al. [10] proposes software solution prototype to optically recognize single side embossed Braille document using image processing and neural network. The output of Braille text document is original document which can be sent to the electronic embosser for reproducing. The letter of words recognition and transcription accuracy over 99% and average processing time is 32.6 sec per page.

A. Malik et. al. [11] describes Arabic Braille bi-direction and bi-Lingual translation/editor system that does not need expensive equipment. Their system can be generalized to facilitate communication among literal people regardless of their disabilities, income, language and geographical locations. They have achieved satisfactory result.

H. Reza et. al. [7] discuss about the objectives of the project that has been split into seven tasks: locates the Braille points, segmenting particular image in Braille text, processing, create parse of the language, constructing the keyboard, integrating and user interface.

N. Falcón et. al. [9] has shown development of BrailLecto system. A system can be used for Braille writing. Braille scanned images can be translated into normal text and also translate text by BrailLector. BrailLector is an innovative thresholding and Braille grid creation algorithms with robust application, which read and detect Braille characters with 99.9% of correct symbols.

S. Padmavathi et. al. [2] proposes a method to convert scanned Braille document to text, which can be read through the computer. The Braille documents are pre-processed to enhance the dots and reduce the noise. They also provide the mechanism to type the Braille characters through the number pad of keyboard. The typed Braille character is mapped to the alphabet and spoken out.

A. Al-saleh et. al. [3] explains about Recto and verso dots. They have also discussed about how to detect recto and verso dots in the Braille script document printed on both the sides. They got satisfactory result.

Srinath et. al. [6] says that the language is the finest gift of god for communication. They describe a system made with the OCR technique to recognize English Braille characters and convert it into text. They got satisfactory result.

Saad D. et. al. [12] presents a design and implementation of Optical Character Recognition with voice and text conversion. Algorithm is implemented which is based on Braille dot position. They discuss about basic modules, i.e. image processing, image acquisition, dot localization, segmentation and dot recognition. By following these steps, Braille Recognition has been successfully completed. The author has also described decimal Braille code generation.

X. F. Hermida et. al. [8] has developed an Optical Character Recognition (OCR) for Braille language. They considered five main steps in OCR: Scanner control, processing of the scanned images, processing of points for lines and columns, convert points into ASCII text and user interface.

M. Yousefi et. al. [13] describes the parameters of Braille document such as skewness, scale, spacing of the page, lines and characters. Specially skewness, scaling and line spacing is a solution of maximum-likelihood (ML). They propose line detection method in which each point may be either raised (on) or flat (off). They also show the concept of thresholding which is the part of image preprocessing.

Bhattacharya et. al. [14] displays the Braille printer developed by Central Mechanical Engineering Research Institute (CMERI). They also discuss about concept like image thresholding with beta distribution for the recognition of Braille characters and convert it into simple language text. They analysis vision based printing.

Dr. S S. Baboo et. al. [15] explains the uses of digitize and reproduce texts of Braille. They discussed the framework which will implement image capturing technique on an embedded system and also describe the method that convert Tamil Braille characters to Text. The author has work on Tamil Braille and has described the Braille script according to Tamil alphabets.

H. A. Vyas et. al. [16] describes the characteristics of Gujarati script and Braille language. They have also worked on the challenges related to the recognition of the Gujarati Braille characters and also discussed detailed literature review. They explain that the characters can be recognized in two ways: online and offline. In case of online character recognition, there is real time for characters recognition. For doing recognition, online systems have better information. In the case of offline character recognition, they avoid the initial search step of locating the character.

CHALLENGES

In Braille, total 64 characters can be written. But in Gujarati there are total 75 characters. So in Gujarati Braille as shown in figure 6, there are some characters which are identical. Example, there is no separate character available to specify compound or half characters. So, there is identifier that is 4th dot to indicate that following character is half character. 0-9 digits are represented in the same way as some vowels and consonants i.e. 1 is represented in the same way as , 2 is represented in the same way as   and so on. There are some Gujarati characters which are written in Braille as a combination of more than one character. For example, in Gujarati, Braille is written as combination of 4th dot, (3 characters). Some Braille word also depends on the pronunciation. It is spelled as it is pronounced. So in Gujarati Braille recognition all the above mention Challenges are to be considered.

CONCLUSION

In this paper detailed literature review is carried out for the recognition of Gujarati Braille characters. We found that reasonable amount of work is done for the conversion of Braille to other languages. But still we did not come across the literature which describes the recognition of Gujarati Braille characters and its conversion. So we aim to carry out the work on Conversion of Braille text to Gujarati Language which will help visually impaired people to communicate with sighted people.

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