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An Insight into Optical Braille Character Recognition since its Conceptualisation

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ABSTRACT

Language is the finest gift of god, for communication. Optical character recognition (OCR) is one of the active fields for research and development. Several researchers have presented different approaches to recognize various language characters all over the world. Recognizing printed and hand written characters are two different areas of character recognition.

Louis Braille invented Braille language, which is used as the only way for reading and writing communication by blind people all over the world. Although English Braille is very popular, other languages also have their own Braille notations. In this paper we have made an effort to identify the different works carried out by researchers to optically recognize the Braille characters and to convert them into their equivalent normal language notation.

General Terms

Character recognition, Pattern, OBR

Keywords

Braille, Optical character recognition, Braille Cell dimension, Grade- I Braille, Grade – II Braille.

1. INTRODUCTION

Braille is a boon for the visually impaired community. It uses 6 dots notation as shown in Figure 1. The dots are arranged in 3 rows and 2 columns and are numbered from 1 to 6. Braille characters are embossed on a sheet and are read by sensing the embossment by the fingers. The thickness of the sheet used for embossing the Braille is directly proportional to the life of the document. Less the thickness, less the number of times one can read. So this makes digitizing the Braille characters essential. The advancement in the technology has given a chance to convert the hard copy of the Braille punched document into soft copy so that it can be reproduced using Braille printer at the later stages. You can also produce multiple copies easily. Along with this, it is also noted that one can convert a Braille document in soft copy into its equivalent normal version of the language. Whenever needed, one can produce the speech output for the normal language text, which will be useful for illiterate Visually Impaired.

Even though every language has its own Braille language, very little research work has been observed in the literature survey. We have commercially available Optical Braille character Recognition for English Braille, but for other languages it is less focused.

Using a Braille slate and stylus, one can emboss Braille characters on the sheet only on one side. Braille embossing with Braille printer allows embossing the Braille characters on both sides of a sheet. When Braille slate is used for embossing, the punching is done on the reverse side of the sheet, form right to left, so that the Braille reader can read the embossment on the other side from left to right.

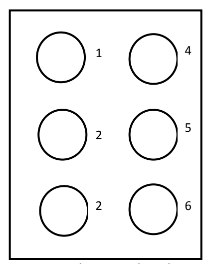

Figure -1

The six dots of a Braille cell

In the early days Braille used 8 dots to represent a character. Later it was reduced to 6; the reason behind this is, in one touch, a person can read only 6 dots comfortably. Using 6 dots, one can have 64 different combinations, and hence 64 different characters of a language can be represented using Braille. This is convenient for some languages like English. However South Indian languages, including Kannada, follow syllable writing, and their basic character set is more than 64 hence it requires 2 Braille cells to represent a character.

Braille language has made the visually impaired life more comfortable. It is estimated that 50 million people are blind in this world and their number is increasing every year. The embossed writing introduced by Louis Braille is accepted throughout the world for reading and writing by blind community.

Technological innovations have introduced a lot of gadgets to educate Visually Impaired community. To name some of them, Braille printer, Optical Braille character recognition, Poet compact reader, Fuser, Braille to normal text converter and so on.

People, who work with visually impaired and are unable to understand Braille, require conversion of Braille documents into a normal language representation. This paper presents a an insight of technology growth and the research work carried out in converting Hard copy of the Braille into soft copy and then converting into normal language representation.

2. DIMENSION OF BRAILLE CELL AND SHEET

The dimensions of Braille dots are set looking into the tactile resolution of the fingertips.

The horizontal and vertical distance between dots in a character, the distance between cells representing a word and the inter-line distance are also specified by the library of congress. Dot base diameter is approximately 1.5 mm. The distance between the centres of two dots within a character cell is approximately 2.3mm horizontally and 2.5mm vertically. The distance between dots in adjacent cells is approximated to 3.75mm horizontally and 5mm vertically as shown in Figure -2.

The standard Braille sheet is of size 11 inches wide and 11.5 inches in height. A Braille sheet contains 25 lines horizontally and 40-42 Braille cells in each line.

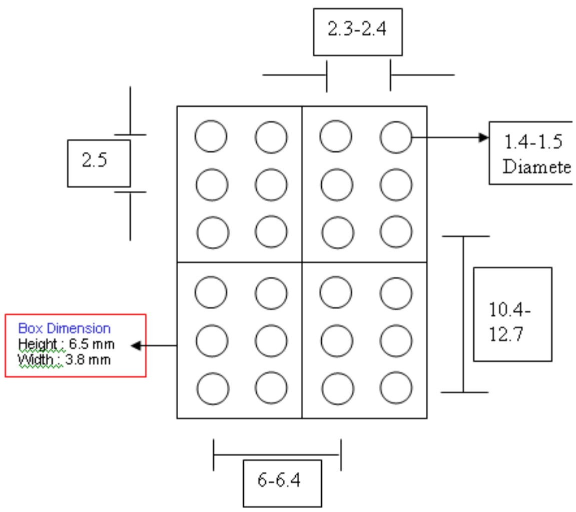

Figure-2

Spacing of dots between Braille characters, and within Braille character. (Dimensions in millimeter)

Due to fragment nature of Braille characters, normal OCR cannot be used for Braille character recognition. Hence the need for development of Optical Braille character Recognition (OBR) system.

A Braille optical recognition has wide applications like in:

People who work with Visually Impaired community and who do not know Braille script, will be benefited by the OBR.

By converting Braille document into softcopy, the Braille documents can be restored for a long time and can be easily moved from one place to another place. The hardcopy of the Braille document deteriorates after many reading, loosing its embossment.

It is an economical alternative for Braille photocopy machine.

Figure -3 shows the details of all 63 combinations of Braille cells allotted to English characters. The 64th combination is an empty box has not been shown in the figure; this is used for a blank space in all Braille languages.

English has only 26 characters, the remaining combinations are used for representing special characters and short hand notations for the commonly used words, which are commonly called as contractions.

If Braille document does not use any contractions, then it is called "Open Braille" or "Grade-1" Braille. If contractions are used then it is called Grade-2 Braille. Contractions are used to reduce the size on the paper and computer. Here a single cell represents an entire commonly used word. This is commonly used in all reading and writing communications.

Like pitman shorthand, Braille language also supports for Braille short hand. This is called Grade-3 Braille. But this is not used in publications.

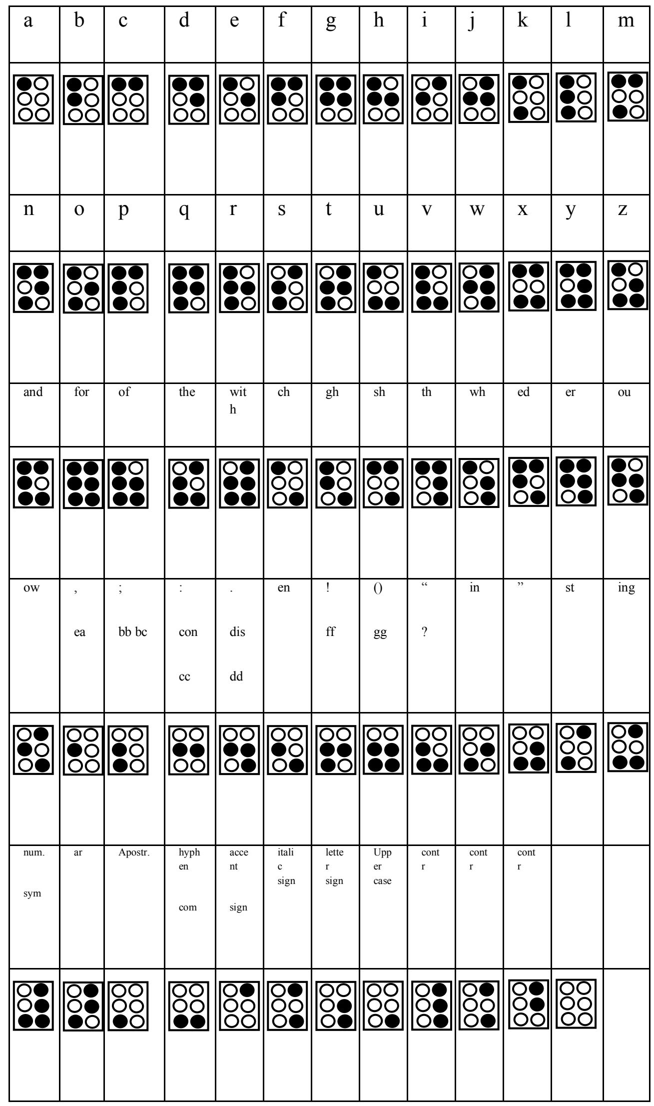

Figure -3
Braille notation for English Language.

3. SIGNIFICANT EVOLUTIONARY APPROACHES IN RECOGNITION OF BRAILLE CHARACTER:

Attempts have been made to optically recognize embossed Braille using various methods. In 1988, Dobus and his team designed an algorithm called Lectobraille which translates relief Braille into an equivalent printed version on paper [1]. The principles of relief-acquisition, with the use of a camera and a frame memory controlled by a microcomputer were presented. The use of spatial filtering techniques, especially polynomial filtering, followed by median filtering, erosion, and dilatation, permits the contrasted relief to be extracted from the bottom. After threshold, an adaptive recognition method is applied, using projection of the Braille characters to supply the Braille-coded chain of the text. It used CCD camera with 512x512 pixels to digitize the image. The resolution was poor and it took an average conversion time of 7 Seconds per line.

In 1993 & 94, Mennens and his team designed an optical recognition system which recognized Braille writing. It used scanner for digitizing the Braille document [2-3].

A grid was constructed consisting of horizontal and vertical lines that run through all the dots, and then verification of dots present in the line intersection points. The method proved to be good, when the embossing was in good condition. Effort was also made to recognize Braille embossing on both sides of a single sheet in one scanning, but the deformation in the dot grid alignment was not handled.

In 1999 Ng and his team approached the problem using boundary detection techniques to translate Braille into English or Chinese [4]. The paper presented an automatic system to recongize the Braille pages and convert the Braille documents into English/Chinese text for editing. They separated embossing on two sides of a sheet into two standard templates. Using both single side and double sided Braille pages as the specimen; the system has been proved to be 100% and 97% accurate respectively. The system took the advantage of regular spacing between Braille dots within a cell, and the regular spacing between cells. The paper did not discuss anything about grid deformation. The capturing device used in this experiment was a digital camera, which was placed directly above the Braille page.

In 2001, Murray and Dais designed a handheld device which handles the scanning as well as the translation [5-6]. Since the user is in control of the scanning orientation, and only a small segment is scanned at each instance, grid deformation is not a major concern and a simpler algorithm was used to yield efficient, real-time translation of Braille characters.

In 2002, Morgavi and Morando published a paper where they described the use of a hybrid system using a neural network to solve the recognition problem [7]. The paper also provides a means of measuring accuracy in Braille recognition, and the result show the system can handle a large degree of image degradation compared with the algorithms that use more conventional and rigid image processing techniques. However no mention was made of the accuracy of the formatting conservation.

Lis Wong and team in the year 2004 presented an algorithm in which, Braille characters of 3 rows and 2 columns are divided into 2 half characters [8]. The two columns of a character are processed separately. In this paper, the columns were referred to as “half-characters”. The proposed system consisted of three components: Half- character detection, half-character recognition, and text file transcription. The half character detections algorithm determined the whereabouts of the characters by detecting the possible dot positions. The half character recognition determines the half character that the dots represent by using a probabilistic neural network. After the half characters were recognised the grid would be determined with the text file transcription algorithm to produce a Braille text file where the formatting was preserved as much as possible.

In 2005, Nestro Falcon and his team developed further more efficient techniques for Braille writing recognition using Image processing Techniques [9]. The paper presented the development of BrailLector, a system able to speak from Braille writing. By means of dynamic thresholding, adaptive Braille grid, recovery dots techniques and TTS software (Text-To-Speech). BraileLector is a robust application with innovative thresholding and Braille grid creation algorithms which detects and read Braille characters with 99.9% of correct symbols and error variance below 0.012.

An effort to recognize Arabic Braille recognition was found in the paper presented by Abdul Malik and his team in 2007 [10]. The algorithm was developed to recognize an image of embossed Arabic Braille and then convert it to text. It aimed at building fully functional Optical Arabic Braille Recognition system. The conversion of Braille to text was complicated because two or more cells would represent a single symbol, and some times a single cell would represent one text symbol or two or more symbols. The algorithm also tested for variations of Braille documents; skewed reversed or worn-out.

In 2008 Ahenfei Tai and his team [11] presented a high adaptive Braille documents parameters estimation method to automatically determine the skewness, indentations, and spacing in both vertical and horizontal directions. The key element in determining the skewness of the images was based on Random transform, which was generated from the integral of a function over straight lines, and was nicely applied in this case.

Detecting the Dots of the Braille character has been developed by Amany Al and his team in 2008 [12]. The core of the proposed method was the use of stability of threshold with Beta distribution to initiate the process of thresholds estimation. Segmented Braille image is then used to form a grid that contains recto dots and another one that contains verso dots. Using the segmented image, Braille dots composing character on both single sided and double sided documents are automatically identified from those grids with good accuracy.

In the popularity of Mobile devices, new techniques were introduced to detect the Braille characters using mobile devices by Jussi Rantala and Team and as well as Shanjun Zang Team.

Jussi Rantala presented methods for presenting Braille characters on a Mobile Devic with a Touch screen and Tactile Feedback in 2009 [13]. They developed a prototype device based on Nokia 770 Internet Tablet. Nokia 770 is a hand held tablet which has a large touch screen (800 x 480 pixels). The prototype was equipped with a piezoelectric actuator solution which was embedded under the touch screen of the device. By utilizing this actuator technology, tactile feed back on the touch screen with various pulse shapes and displacement amplitudes were produced. The sharpness of the feedback pulses was controlled by the current fed to the piezoelectric actuator and the displacement amplitude by the driving voltage. This control method expanded the variability of the tactile stimuli enabling much more freedom for haptic stimuli enabling much more freedom for haptic stimuli design compared to the actuator solutions commonly used in mobile devices.

The tactile feedback created by device cannot be targeted at any specific location on the screen. As the entire display vibrates, the traditional layout of six simultaneously presented physical dots could not be used. Instead, Braille characters were read by receiving each dot individually. This created an impression of localized feedback. When a user touched the screen, the feedback was felt to be located right under the contact point. Thus, it effectively produced location specific tactile feedback to provide spatiotemporal information.

Shanjun ZHANG and team designed a new system that recognizes Braille characters from a photo taken by a mobile phone with embedded camera in 2010 [14].

Saad D Al-Shamma and Sami Fathi [15] presented Image processing technique in 2010 to convert Arabic Braille into equivalent Arabic and also to voice.

To conclude, no software has been successfully developed to convert Braille of Indian languages into its equivalent. The main reason behind this is the complexity involved in writing Indian languages. Most of them adopt syllable writing, and hence becomes a complex task to convert. Research can be carried out to convert Braille of Indian languages into its equivalent normal version.

4. CONCLUSION

Optical Braille character Recognition has lot of scope for research, especially in the Indian scenario, with so many vernaculars. Each language is different and its requirement is also different. Contributions to OBR will help the visually impaired community as well as the people associated with them.

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