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Image and Speech Processing for Tamil Braille Patterns

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ABSTRACT: Visual Impairment is a disability affecting people worldwide. As a consequence visually impaired community is facing a tremendous hindrance in communicating with the vision people especially in the written form. Braille is the script used by the visually impaired to read and write. The sighted community have great difficulty in understanding the Braille writing. The development of Braille recognition system augmented with speech synthesis system can bridge this communication gap and also can act as a self-diagnostic aid for the visually impaired. Optical Braille Recognition (OBR) system converts the embossed Braille characters into their equivalent natural language characters. The text to speech synthesis (TTS) system converts the raw input text into its audible speech using speech synthesis techniques.

I. INTRODUCTION

In 2002, World Health Organization (www.who.int) gave an estimate that out of 37 million blind people in the world, 15 million (i.e., two-fifth) were from India. It has been found that 1.7% of India's population is disabled, out of which 0.22% are visually disabled . Hence the literacy rate is low and for their education they use a different scripting language. With the tremendous development of wide band wireless communication, image capture, and transmission has been widely developed for many applications [1 – 2].As a consequence of this, visually impaired community is facing a tremendous hindrance in communicating with the vision people especially in the written form. Braille is a script used by visually disabled to read and write. With the advent of technology, in image processing and computer vision, many researchers have tried to achieve a path of communication, so that, the Braille scripts can be decoded easily. Optical Braille Character Recognition (OBR) is the process in which the punched or embossed Braille scripts are decoded by computers into natural language, with the help of numerous algorithms involved in extraction and conversion of characters. What Optical Character Recognition (OCR) is for the natural text, the OBR is for the Braille text.Braille is code-based system of raised dots that can be sensed through touch with fingers by people.Braille Bank provides facilities for the comparative analysis of the data and the evaluation of proposed algorithms with the standard database[5 - 6].Sixty-four characters can be mapped uniquely, and many other derived characters from the primary set of characters can be achieved. Consideration of using six dots to represent a unique character involves a method to provide the best support for human interaction through hapticfeedback. Braille Image skewing correction plays an important role in automated Braille recognition systems[7 - 8].These rules apply to the dot dimension, cell dimension, distance between the dots within a cell, and distance between the cells in a word. Approximately the dot height is 0.02inch (0.5 mm), spacing between the dots horizontally and vertically within a cell is about 0.1 inch (2.5mm), white space between the dots on adjacent cells is 0.15 inch (3.75 mm) and 0.2 inch (5.0 mm) vertically . A standard Braille page is 11 by 11 inches and has a maximum of 40 to 42 Braille cells per line and 25 lines per page[1] . The reconstruction of the image and the redundancy of noise are done better by compressive sensing and its performance is ranked both computable and conditionally [10 -11].Digitization has almost been engaged in all disciplines of engineering out of which creates an impact on image processing which is used for locating and detecting many diseases more effectively [12 – 13].

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II. GENERALIZED BIT-PLANESLICING ALGORITHM

The steps involved in Bit-Plane Slicing procedure for Braille dot extraction from an image with bit depth of 8 bit is as follows[6],

Step1: Read the input Braille image. The image read may be of different spatial resolution.

Step2: If the input image is a color image, then convert the input image into gray scale image.

Step3: Convert each and every pixel of the image to the binary form.

Step4: Bit-plane slice the image. In this work only the top two Bit-planes are consideredsince it was found experimentally that more information regarding the Braille dots are envisioned in these two planes and also this is valid for Braille documents with varied resolution.

$$T(s7) = \begin{cases} 1, & 128 \leq f(x,y) \leq 255 \\ 0, & 0 \leq f(x,y) \leq 127 \end{cases} \quad \text{----> } 1.1$$

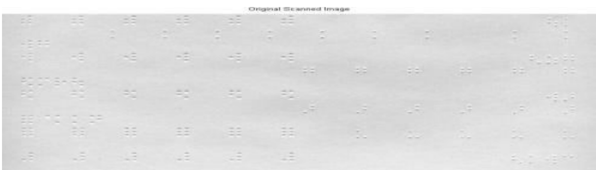
$$T(s6) = \begin{cases} 1, & 64 \leq f(x,y) \leq 127 \ OR\ 192 \leq f(x,y) \leq 255 \\ 0, & 0 \leq f(x,y) \leq 63 \ OR\ 128 \leq f(x,y) \leq 191 \end{cases} \quad \text{----> } 1.2$$

Step5 : An image is then reconstructed using only the bit plane 6 and bit plane 7 information

$$T1(s67)=\{T(s7) \times 128+T(s6)\times 64 \} \text{ —>} 1.3$$

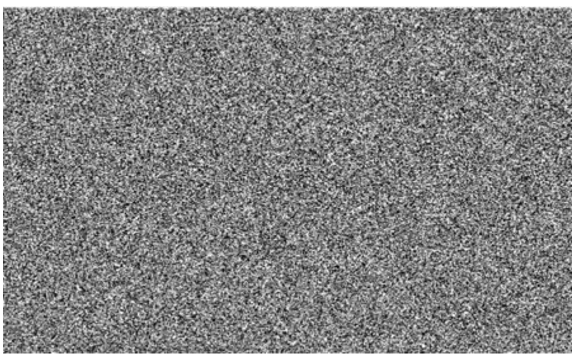
Step6: The resulting image from step5 consists of only three intensity values: 64, 128 and192.

$$T2(s67)= \begin{cases} 1, & T1(s67) \in \{64, 128\} \\ 0, & T1(s67) \in \{192\} \end{cases} \text{ ——>} 1.4$$

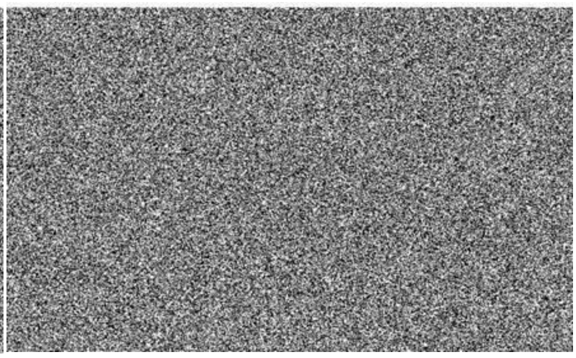


Fragment of an Original Scanned Braille document

In order to clearly identify the dot components from its background a simple threshold function is performed using the which gives the true dot extracted components that can be fed directly to the Braille cell recognition phase of the OBR and is depicted. Also, this threshold is true, even for the Braille documents with varying spatial resolution. Thus the bit plane slicing along with the threshold function *T2* serves as an adaptive approach for Braille dot extraction[7].



A) Bit-Plane 0



B) Bit-Plane 1

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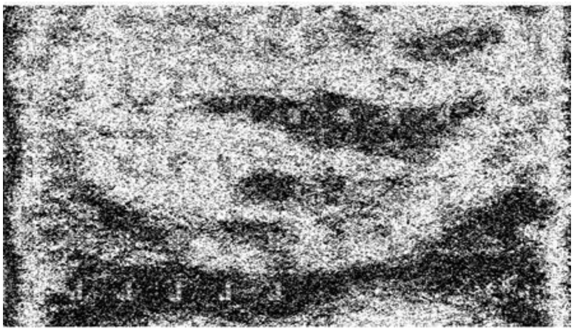
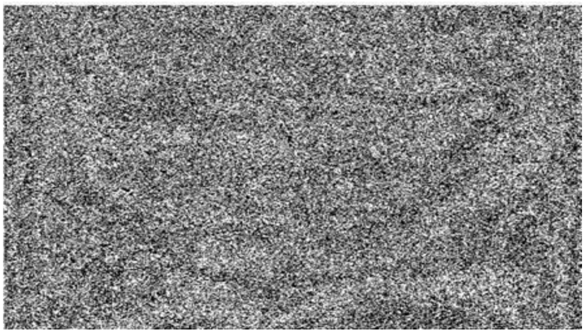
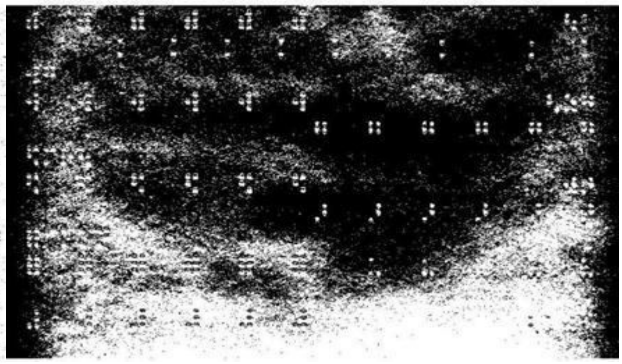


C)Bit-Plane 2



D) Bit-Plane 3

E) Bit-Plane 4



F)Bit-Plane 5

G) Bit-Plane 6

Bit-Planes for a single image shown in Fig.1.3. (a) LSB plane and (h) MSB plane

TDMR may be attributed due to degradation of the dots which in turn is due to ageing of the Braille document. Ageing in sense as the Braille writing is read using the finger touch over the document, after multiple readings it is possible that the dots may deteriorate. TDMR may be attributed due to the surface imperfection of the Braille document and also due to the defacing of the Braille document by anymeans.The proposed algorithm is extended to document with varying spatial resolution and the resolutions are 2121x1501, 1380x985 and 685x503. It implies that this technique can extract the true dots from documents with different spatial resolution. Thus this technique is adaptive. The experimental results show that the bit-plane 6 and bit-plane 7 carry more information about the Braille dots

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III. PROPOSED WORK

TEXT TO SPEECHSYNTHESISSYSTEM

An eventual objective of Text-To-Speech (TTS) synthesizer is to transform an orthographic text into an acoustic signal that is identical to the human speech [49, 50] which in general includes two steps:

A. Text processing(Frontend)

B. Speech generation(Backend)

The intent of the text processing phase is to process the particular input text and produce proper sequence of phonemic and syllable units.TTS Front end works on symbolic level, taking text as input and creating control information as output. It also reveals about document structure detection and text normalization, interprets text markup and performs a linguistic analysis to produce what amounts to tagged text that then undergoes phonetic analysis to create phone-based information and analysis to determine pitch, duration as well as assigning stresses and pauses[2].For building any Braille recognition system, it is necessary to have stored images of the Braille sheets[3]. This database should include:

- Braille documents with differentresolution.
- Tamil Braille characters andnumerals.
- Braille documents of single sided and inter-pointBraille.
- The skewed images of the scanned Braillesheets.
- Braille sheets with noise components and deteriorated dots.

Optical Braille Recognition systems can be categorized by the method they use to convert the Braille characters into equivalent text characters. The recognition system should have the following features [4]:

- Pre-processing should be adaptive innature.
- Recognition algorithms should be datainherent.
- Grid construction should beadaptive.
- System should be able to handle the complex Hindi characters
- System should beaccurate
- Computation time should beminimal.
- The recognition algorithm should be robust innature.

The principal contributions of this research work and of the thesis are represented. They include [5]:

i. Construction of Brailledatabase.

ii. Incorporation of adaptive Brailleper-processing technique forOBR.

iii. Novel approaches to develop data inherent OBRsystem.

iv. Duration analysis of syllables in words of Tamillanguage.

v. Incorporation of duration model for basicunit.

vi. A novel approach in building speech database for Tamil TTSsystem.

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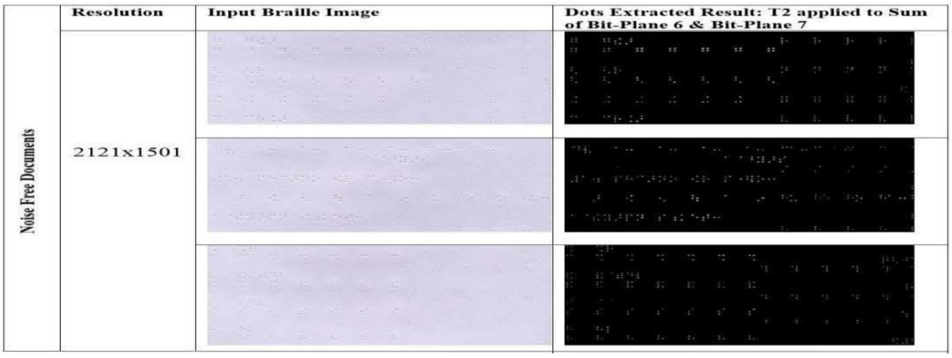
vii. Implementing speech unit concatenation algorithm to generate synthesized speech using the database.

IV. RESULT ANALYSIS OF ADAPTIVE BIT-PLANE

The methodology has been evaluated quantitatively and qualitatively on 15datasets ofthe Inter-point Braille with varying spatial resolution. This image set consists of scanned Braille documents with Inter-dot deformation and Recto-



Verso dots with varying spatialresolution.For evaluating the efficiency of the proposed method, we have considered the parameter called True Dots Miss identification Rate (*TDMR*). TDMR is the ratio of number of recto and verso dots that are classified as non-dots in the dot extracted image to the total number of dots in the ground truth image [8]. TDMR may be attributed due to degradation of the dots which in turn is due to ageing of the Braille document. Ageing in sense as the Braille writing is read using the finger touch over the document, after multiple readings it is possible that the dots may deteriorate. TDMR may be attributed due to the surface imperfection of the Braille document and also due to the defacing of the Braille document by anymeans[9].The proposed algorithm is extended to document with varying spatial resolution and the resolutions are 2121x1501, 1380x985 and 685x503. It implies that this technique can extract the true dots from documents with different spatial resolution. Thus this technique is adaptive. The experimental results show that the bit-plane 6 and bit-plane 7 carry more information about the Braille dots.randomly .
An example Braille document to illustrate this is depicted which consists of inter- dot noise components caused due to brittleness in the paper which arises during the embossing process due to the surface tension of the paper. braille

Performance comparison of adaptive bit-plane slicing technique

Algorithm	Resolution	Execution speed (seconds)	Accuracy (%)
[6]		3.23	92.8
[7]	2121x1501	2.9	90.2
[41]		2.04	89.4
Adaptive Bit-plane slicing technique		**1.05**	**99.73**

A significant drawback of the proposed technique is its inability to extract the dots which are deteriorated due to ageing. Although this occurs very rarely, the overall error rate of the proposed systemcan be attributed to the quality of the acquired image of the Braille document.

V. CONCLUSION AND FUTURE SCOPE

The primary objective of this work is to develop adaptive inter-point Braille recognition algorithms for Tamil Braille which can accommodate the variation in the spatial resolution of the Braille document being scanned. Such an OBR for Tamil language is necessary as Tamil being the national language of India, lacks an efficient OBR system. The existing approaches for OBR are template-based approaches, which are non-adaptive in nature. Due to the unavailability of the

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adaptive algorithm for Braille in any language, herein the adaptive algorithms are designed for Braille dot extraction, inter-point Braille character recognition and for grid construction[10]. . Many authors have tried to address the issue of inter-point Braille recognition through template-based approach. The fact that the Braille documents can be acquired with varied resolution makes the usual method of template matching to fail. The developed adaptive algorithm redesigns the templates by itself based on the changes in the spatial resolution of the Braille document image being scanned.

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