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Efficient Approach for Braille Conversion of Multilingual Text: Strategic Mapping Solutions

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ABSTRACT
In the today's modern society, people can easily access information from various sources like the internet and newspapers. However, individuals with visual impairments encounter difficulties in harnessing this wealth of information, unlike their sighted counterparts who effortlessly stay informed about current events and knowledge. To bridge this disparity,there is a vital necessity to develop a system that streamlines the conversion of natural language text into Braille, thereby offering enhanced learning prospects for the visually impaired.Visually impaired people face challenges in benefiting from this wealth of information, unlike sighted individuals who can effortlessly stay updated with day-to-day news and knowledge. To bridge this gap, there is a crucial need to develop a system that facilitates the conversion of natural language text into Braille, thereby providing enhanced learning opportunities for the visually impaired.
This research paper presents strategic mapping solutions for Braille conversion, with the primary aim of optimizing the translation process of multilingual text into Braille characters. The proposed approach incorporates the techniques from natural language processing (NLP) and address the challenges associated with converting diverse languages into the tactile writing system of Braille. The focus is on designing an efficient mapping system that takes into consideration the linguistic characteristics of different languages, ensuring accurate and contextually meaningful representation of Braille.
Keywords: Braille, multilingual text, transliteration, natural language processing (NLP), visually Impaired.

1. Introduction:
The World Health Organization projected that around the globe, roughly 285 million individuals encounter varying degrees of visual impairment, with 39 million of them falling under the classification of blindness. A noteworthy segment of this population relies predominantly on Braille as their primary means of participating in reading and writing endeavors.[1]. The majority of Braille materials are available only in a limited number of languages, hindering access to the information for those who speak languages not widely represented in Braille format. Braille system, which relies on tactile reading and writing using the fingers, is utilized by the blind for communication and access to written material.

1.1 Braille Writing System
Braille as a tactile writing system, designed to transmit information to individuals facing visual impairments through the sense of touch. This system is composed of elevated dots organized into units called braille cells, which consist of two parallel rows of three dots each, resulting in six dots per cell. The dots within each cell are numbered one through six, as illustrated in Fig 1. These dots can be combined in different ways, giving rise to 64 possible configurations [2]. A solitary braille

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cell possesses the inherent capacity to signify an individual letter from the alphabet, a numeral, a punctuation mark, or even an entire word.

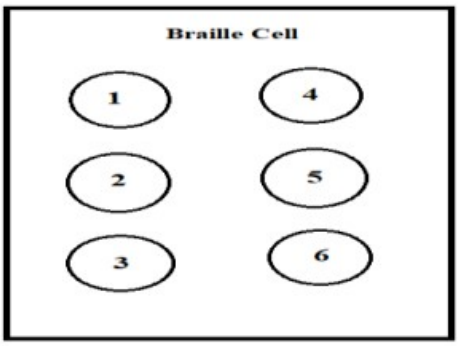

Fig 1: Braille Cell with six dots

1.2 Telugu Literature

India is a linguistically rich country with diverse scripts available in different languages such as English, Hindi, Sanskrit, Kannada, Telugu, Marathi etc. Each script comprises of a vast number of characters, which include both consonants and vowels. The identification of these characters is facilitated by utilizing a dedicated database within the system, which effectively extracts textual content from the documents.

A multitude of Indian languages trace their origins back to the Brahmi script. One such script, known as Telugu script, which belongs to the abugida category within the Brahmic script family, and it serves as the writing system for the Telugu language. The progression of the script's evolution can be observed: the Bhattiprolu Brahmi script transformed into the Kadamba script by the 5th century, and subsequently, after the 7th century, it further developed into the Telugu-Kannada script.Telugu language uses 16 vowels which is also called as Atchulu and 35 consonants as shown in Fig 2 and Fig 3, each

of which has an independent form and a diacritic form used with consonants to create syllables.

Fig 2: Representation of Independent Vowels

Fig 3: Representation of Dependent Vowels

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In Telugu, independent vowel appear at the beginning of words. It's a unique ligatures deviating from standard patterns representing consonant-vowel combinations in certain contexts. Telugu embraces compound characters, combining consonants and vowels to construct syllables, as demonstrated in Fig 4.

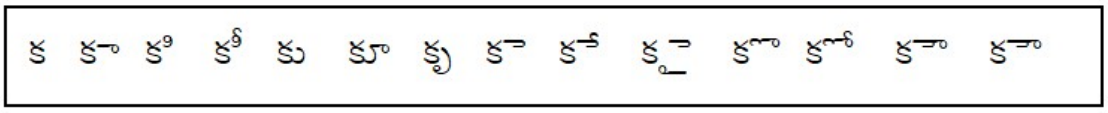

Fig 4: Representation of compound characters Telugu

A single braille cell can provide only 64 combinatorial results and all of the characters in Telugu literature cannot be represented by a single cell. In addition to Telugu literature, numbers and special characters must also be mapped with Braille, which is a challenging task. The Fig 5 represents numbers representation in Telugu.

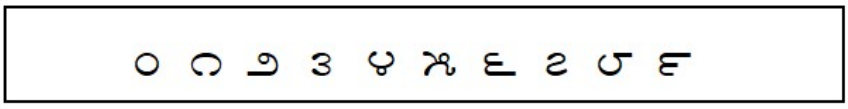

Fig 5: Representation of Numbers in Telugu

As a result, we employ two cells to represent syllables and complex characters. The mapping helps us to convert the character from multi-lingual text to Braille. The same can be done for numbers and special characters.

1.3 Marathi Literature

India is a linguistically diverse nation with a multitude of scripts employed across various languages, including English, Hindi, Sanskrit, Kannada, Telugu, Marathi, and more. Each script encompasses an extensive array of characters, comprising both consonants and vowels.

Numerous Indian languages trace their origins to the ancient Brahmi script. Marathi, a language rich in literary heritage, employs the Devanagari script. This script is employed for the expressive rendering of Marathi, one of India's vibrant languages. The transition of the Brahmi script into various stages led to the evolution of Devanagari, which ultimately became the script of choice for Marathi literature. Devanagari script in Marathi, akin to other languages, manifests itself as a collection of characters, encompassing vowels, consonants, and diacritics. These characters are thoughtfully organized to form meaningful syllables and words.

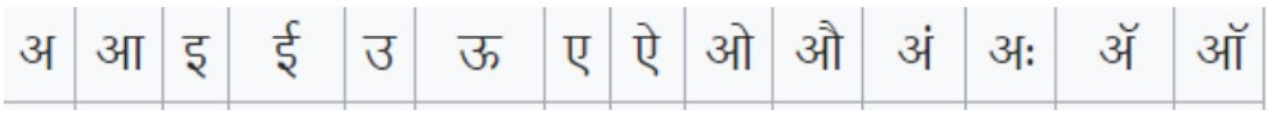

Fig 6: Representation of Vowels in Marathi literature

Fig 6 and Fig 7 visually illustrate the distinct vowels and consonants present in Marathi literature, each holding both an independent form and a diacritic form, which when combined with consonants, contribute to the creation of diverse syllabic structures.

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क ख ग घ ङ
च छ ज झ ञ
ट ठ ड ढ ण
त थ द ध न
प फ ब भ म
य र ल व
श ष स
ह ळ क्ष ज्ञ

Fig 7: Representation of Consonants in Marathi literature

2. Literature Review:

The escalating need for assistive technologies tailored to the requirements of individuals with disabilities is an evident trend. Among the diverse spectrum of disability groups, those who are visually impaired exhibit a notable inclination towards technologies that streamline the transformation of conventional text into Braille. It is noteworthy that languages characterized by intricate scripts, including Telugu and Marathi, pose substantial challenges in the course of this transitional endeavor. This section of the research paper focuses on a comprehensive review of the latest methodologies employed for the translation of Telugu and Marathi text into Braille, addressing the specific complexities associated with this linguistic context.

1)Manzeet Singh, Parteek Bhatia et al. [4] developed an an application that will convert Hindi and English text to Grade1 Braille. They have created a database, which will map the corresponding Braille representation and tested the system.

2) Minhas Kamal, Dr.Amin Ahsan Ali et al. [5] designed a translator for the Bengali language. This translator was designed, featuring distinct and autonomous components, rendering it highly adaptable across diverse settings. As part of their research, the team compiled a comprehensive database containing both Braille writing images and corresponding text. This database played a pivotal role in assessing the efficacy and efficiency of the translation process.

3) Nisheeth Joshi, Pragya Katyayan [6] employs a combination of methods. Initially, the Indian language text is processed by a rule-based system. If any uncertainty arises, it is subsequently addressed using an LSTM based model. Testing of the created model has demonstrated its ability to yield highly precise outcomes.

4) BijetMaynoherSamal et. al [7] presented a Braille publications in Odia, Hindi, Telugu, and English language. The have transformed these different publications into their respective native languages. The process entailed various techniques, including histogram analysis, segmentation, pattern recognition, letter arrays, as well as database creation. They carried out software testing and the resulting dot patterns for the alphabets, eventually implemented onto a Spartan 3e FPGA kit.

3. Algorithm

An algorithm is developed to map multilingual text like Telugu and Marathi into Braille. Look-up tables has been constructed for Braille characters corresponding to Telugu and Marathi such as vowels, consonants, digits, punctuations and special symbols based on the standard Braille translation rule. Algorithm steps are as follows:

Step 1: Accept the input as a digitised text from the file or from input device (Keyboard) which contains text in Telugu or Marathi.

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Step 2: Prepare the Braille character mapping : Create a mapping of Telugu and Marathi characters to their respective Braille representations as shown in Table 1 and Table 2. Braille uses a combination of dots in a 2x3 grid to represent characters.

Telugu	Braille
అ	⠁
ఆ	⠜
ఇ	⠊
ఈ	⠔
ఉ	⠥

Table 1: Mapping of Telugu text to Braille

Telugu	Braille
अ	⠁
आ	⠜
इ	⠊
ई	⠔
उ	⠥

Table 2: Mapping of Marathi text to Braille

Step 3: Preprocess the Input Text:Take the input text in Telugu or Marathi and normalize it by removing any diacritics or special characters that do not have corresponding Braille representations.

For Example:
Input Telugu Text:

"తెలుగు భాషా అత్యంత సుందరంగా ఉంది!"

Diacritics are special marks that modify the pronunciation of characters. In Telugu, some vowels and consonants can have diacritics.

"తెలుగు భాష అత్యంత సుందరంగా ఉంది"

Braille has limited representations for special characters, so we need to remove any characters that do not have corresponding Braille representations. In this example, the exclamation mark "!" is a special character.
Input Telugu Text after preprocessing:

After preprocessing, the input Telugu text remains:

"తెలుగు భాష అత్యంత సుందరంగా ఉంది"

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In this example, we removed the diacritic in the word "భాషా" (bhāṣā) to become (bhāṣa) and "భాష" removed the exclamation mark at the end of the sentence as it does not have a corresponding Braille representation.

Step 4: Split the Text into Individual Characters: Divide the preprocessed text into individual characters (including vowels, consonants, and other symbols).
For Example:

"తెలుగు భాష అత్యంత సుందరంగా ఉంది"

Slit the individual characters like this:

1. త (Consonant)
2. ె (Vowel)
3. ల (Consonant)
4. ు (Vowel)
5. గ (Consonant)
6. ు (Vowel)

Step 5: Convert Each Character to Braille: Look up each character in the Braille character mapping and convert it to its corresponding Braille representation.

Step 7: Concatenate Braille Characters: Combine the Braille representations of individual characters to form the final Braille representation of the entire Telugu or Marathi text.

Step 8: Display or Output Braille: Display the Braille representation using the appropriate Braille dots or output the Braille text to a Braille embosser or display device for tactile reading.

For example,

"తెలుగు భాష అత్యంత సుందరంగా ఉంది"

Concatenated Braille representation of Telugu text:

⠞ ⠑ ⠇ ⠥ ⠛ ⠥ ⠃ ⠷ ⠱ ⠁ ⠞ ⠍ ⠽ ⠍ ⠞ ⠎ ⠥ ⠍ ⠙ ⠗ ⠍ ⠛ ⠷ ⠥ ⠍ ⠙ ⠛

CONCLUSION

The aim of this paper was to create a standard database that would be technically helpful for creating an optical braille recognition system and for assessing the system's performance. Multiple languages like Marathi and Telugu and a character recognition system have been addressed. The generated database satisfies the requirements since it provides a wide range of databases for developing a useful optical braille recognition system. The approach we propose converts multilingual text into Braille script. It achieves the desired outcome while eliminating any mapping

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issues. We put our technique to the test utilizing information from online newspapers and websites that print Kannada. The goal of this initiative is to inspire academics to compile a database that contains information in all native languages.

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