International Journal of Scientific Research in Science, Engineering and Technology
Print ISSN - 2395-1990
Online ISSN : 2394-4099
Available Online at :www.ijsrset.com
doi : https://doi.org/10.32628/IJSRSET251214

A Review on Marathi Braille

Madhav A. Kankhar, Dr. C Namrata Mahender
Department of Computer Science & IT, Dr. Babasaheb Ambedkar Marathwada University Chh. Sambhajinagar, Maharashtra, India

ARTICLEINFO

Article History:

Accepted : 18 Jan 2025
Published: 20 Jan 2025

Publication Issue :
Volume 12, Issue 1
January-February-2025

Page Number :
112-121

ABSTRACT

This paper investigates the complex process of translating Marathi text into Bharati Braille, emphasizing the critical importance of equitable information access for individuals with visual impairments. It provides an in-depth analysis of Bharati Braille's structure, encoding guidelines, and its adaptation to Indian languages, with a particular focus on Marathi's linguistic features and challenges. Through a comprehensive literature review, the study examines existing text-to-Braille conversion technologies, analyzing hardware and software solutions and their applicability to Marathi. Key challenges such as linguistic nuances, dialectical variations, and the preservation of semantic integrity during translation are explored in detail. The paper highlights technical barriers, including encoding complexities and readability issues, and stresses the need for innovative solutions to address these gaps. By offering actionable insights, this research supports the development of advanced text-to-Braille systems tailored to Marathi, fostering inclusivity and enhancing access to education and information for visually impaired individuals. This study aims to contribute to the broader goal of promoting social and educational inclusion, empowering individuals with visual impairments to participate fully in society.

Keywords— Visual impaired people, Braille Language, Bharati Braille, Marathi Braille System, Text Processing.

INTRODUCTION

There has been a significant change in how technology is affecting our lives in recent years. The digital revolution has altered the way we work, play, and educate ourselves. A seemingly endless supply of information is now available to us thanks to the World Wide Web; a variety of user-friendly software programs assist us in managing our daily office tasks, and digital communication is now a hot topic. Making technology accessible to everyone is vital to close the digital divide, which requires developing solutions for a variety of users who might not be the typical computer whiz child next door. They can be people with disabilities for whom the benefits of information technology have not yet materialized. In a culture that values information, everyone has the right to access and make use of the information. Therefore, it is essential to have a variety of tools that anyone may use to conveniently access information. Everyone is entitled to obtain and utilize the information. As a result, having a range of tools that anyone may utilize to easily access information is crucial. Over 44 million people are visually handicapped worldwide. People with physical disabilities, such as those who are blind or deaf, often struggle to interact or communicate with others. One-fifth of all blind children in the world—320,000 youngsters under the age of 16—live in India. The majority of the time, these kids needs their parents or other adults to take care of their everyday needs, including oral hygiene [1]. Recent technical advancements have been working to create many skilled approaches to improve the communication processes of the sight impaired. This demographic has an extremely high rate of illiteracy, much of which is related to the dearth of readily available reading material. Braille representations of various alphabets and symbols are always used for reading and writing by persons who are visually handicapped or blind. Text's importance in relation to Braille One of the main functions of conversion systems is to make printed material accessible to blind or visually impaired people.Considering that braille is a touch-based writing system, it enables people who have vision impairments to perform necessary tasks like reading, writing, and studying. For this group of people, these jobs would be extremely challenging, if not impossible, without such conversion mechanisms.

Text to Braille Conversion systems play a crucial role by transforming regular written text into Braille, thereby making it accessible to individuals with visual impairments. This not only enhances their ability to consume information but also plays a vital role in dismantling barriers to education and information faced by the blind and visually impaired community. Consequently, these systems contribute significantly to fostering inclusivity and equality.

BRAILLE LANGUAGE

Blind and visually impaired people employ the Braille writing method, which is tactile. Traditionally, embossed paper is used to write on it. They can use a Braille writer or a computer that prints in Braille to type in Braille. They can use the original slate and stylus, or they can write it on a portable notepad. Louis Braille, a Frenchman who invented braille, is the name of the system. Who was blinded in an accident when he was a young child. In 1824, Braille developed his coding for the French letters. When he was just 15 years old as an improvement tonight writing. In 1829, he released his system, which was later updated to include musical notation. The second iteration, it was the first binary writing system developed in the modern era and first appeared in 1837. Even today its importance is there for visually impaired individuals which cannot be overstated. Here are some key points to include in a brief overview:

- Accessibility: Braille provides a means for visually impaired individuals to access written information independently. It allows them to read books, study educational materials, and navigate public spaces with signage in Braille.
- Education: Braille is crucial for the education of blind and visually impaired children. It enables them to learn language skills, mathematics, science, and other subjects just like their sighted peers. Without Braille, these individuals would face significant barriers to academic success.
- Literacy: Braille literacy is essential for functional independence. It empowers visually impaired individuals to write, take notes, label items, and communicate effectively through written text.

- Employment: Proficiency in Braille opens up employment opportunities for visually impaired individuals. It allows them to access job-related materials, write reports, and communicate with colleagues and clients.
- Cultural and Social Inclusion: People who are blind or visually challenged can still read books, newspapers, periodicals, and other cultural objects thanks to braille. It also facilitates social inclusion by allowing them to read correspondence, write letters, and participate in written communication.
- Technology Integration: Braille has evolved alongside technology, with innovations such as refreshable Braille displays and Braille-enabled devices making digital content accessible to blind and visually impaired individuals.

Panda, revolving, and refreshable display Braille devices are just a few of the several varieties that are on the market.

A. Refreshable Braille Display

One of the main socioeconomic causes of disability, blindness has an effect on the lives of those who are visually impaired as well as their family. The conventional Braille code is one of the key techniques that blind people use to access printed information. This is the rationale for recent technological efforts to create refreshable Braille equipment. These are made up of several physical dots that dynamically alter their arrangement in order to replicate various Braille letter sequences. These methods, albeit promising, have a number of limitations, most of which have to do with price, power consumption, portability, and design complexity [2].

B. Rotatable Braille Display

With a substantially smaller number of actuators, a revolving braille generator may produce refreshable braille characters indefinitely long. At the wheel's circumference are cells using pins to show each cell's dots. A 6-dot braille cell has just three actuators, whereas an 8-dot braille cell has four actuators, are used to move these pins. On the top of the wheel, the braille language is visible as "treads on a tire." The pins are placed outside of the reading window. Two layers of three tracks make up the internal pin retaining mechanism of the wheel which holds braille pins in the appropriate locations. The reader can read an endless line of text by placing their finger on the uncovered region of the wheel, referred to as the "reading area." while the disc revolves constantly with the rotation angle being controlled by software. This appears to the reader as an unchanging text line that is in motion. The development of rotating refreshable braille screens is being led by NIST [3].

C. Panda Braille Display

Students at VIT University in India created Panda Braille, a technique that creates a braille cell's perception of dots via electrocutaneous (EC) stimulations. The electrodes were subjected to an impulse waveform with an optimum intensity that represented a braille cell's individual dots. The circuit was complete and current began to flow when the electrodes made contact with the finger. The current was sufficient to create the appearance of braille dots without posing a risk to the user. The device also had a motion sensor so that the user could adjust the rate and location of the braille characters that were displayed in real time. Compared to other technologies, this one reduces the cost of the gadget by 50 times by doing away with the need for intricate mechanical systems [4].

D. Braille Code

Traditional Braille is composed of a 6-dot pattern called a "cell," which has three rows and two columns. Unfortunately, it can only represent a maximum of 64 different symbols (including the "space" sign) in each braille cell. Braille cells are the individual units used to create Braille symbols, as illustrated in Fig. 1. Each cell contains six dots arranged in two vertical columns of three dots each. Dots are numbered from one to six to specify their positions. By employing various combinations of these six dots, 63 different symbols can be formed, as shown in Fig 1. A single Braille cell can represent a letter, a number, a punctuation mark, or sometimes an entire word.

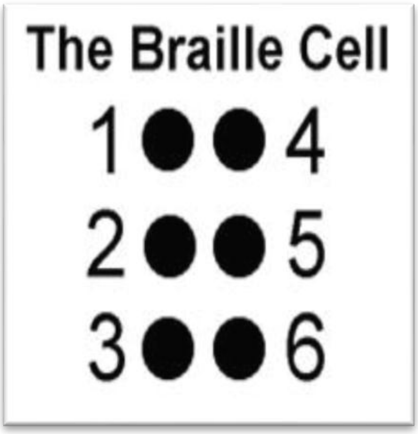

Fig. 1 Braille cell

The coding of symbols is indicated through the presence or absence of raised dots. Each dot is approximately 0.02 inches (0.5 mm) in height, with no space between the centers of adjacent dots within a row or column. The width of a single Braille cell is about 0.1 inches (2.5 mm). The spacing between dots is roughly 0.2 inches (5.0 mm) vertically and 0.15 inches (4 mm) horizontally. A standard Braille page measures 11 by 11.5 inches and typically contains 25 symbols per page. Lines on the page can accommodate between 40 and 43 Braille cells.

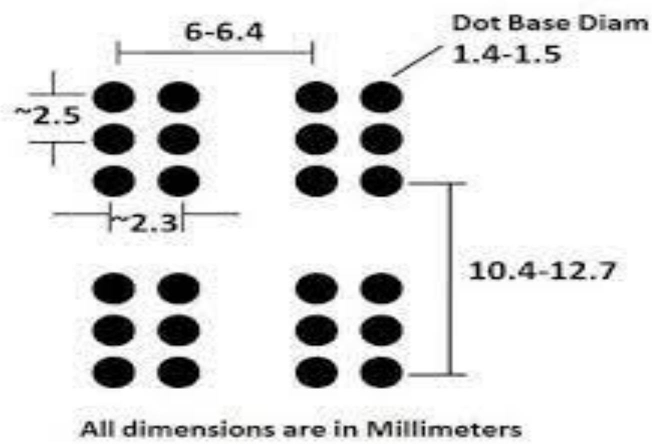

Fig. 2 Dimension of Braille Cell

Braille comes in many forms, Grade 1 being one of them. It uses 26 letters from the conventional alphabet plus punctuation. Only those who are just beginning to learn Braille utilize it. In second grade, students learn about contractions, punctuation, and the 26 common alphabetic letters. The contractions are employed to save space because a Braille page cannot have as much text as a regular printed page. Grade 2 Braille is used on most Braille products, such as books, menus, menu boards, and public signs. They are mostly utilized in private correspondence, journals, and notes; they are also occasionally employed in third-grade literature classes. Because entire words are condensed into a small number of letters, it mimics shorthand [5].

BHARATI BRAILLE

India writes the Indian languages in Braille using Bharti Braille, a kind of Braille script. It adds extra letters to the standard Braille script to represent the unique characters and sounds found in Indian languages. The literary script, which is based on the Braille standard script, adds extra letters to represent the unique sounds and characters found in Indian languages. This includes unique characters for the retroflex sounds found in many Indian languages, as well as characters for the characteristic conjunct consonants found in many Indian languages [6]. The 47 fundamental characters in the Devanagari script, which has 14 vowels and 33 consonants, make up the fourth most extensively, used writing system in the world. The Devanagari script is used to write the languages of Hindi and Marathi. In Hindi and Marathi, there is one borrowed vowel from English, two loan vowels from Sanskrit, and twelve pure vowels in the Devanagari alphabet. There are 34 consonants in all, 5 conjuncts, 7 borrowed consonants, and 2 traditional markings in the Devanagari script. Additionally, each consonant has 14 variations due to the incorporation of 14 vowels [7]. Many Indian languages use the Devanagari script as their primary writing system. Devanagari is used to write languages like Marathi, Bhojpuri, Konkani, Sanskrit, Pali, Sindhi, Kashmiri, Nepali, Bodo, Angika, Maithili, Romani, and Hindi, among others. 194 languages, both locally and globally, use the Devanagari script.

Fig. 3 Vowels in Devanagari script

MARATHI BRAILLE

Braille is a writing method that is tactile and can be adapted to various languages, including Marathi. The Braille system for Marathi uses a set of Braille characters to represent the Marathi script, allowing blind and visually impaired individuals to read and write in Marathi. In Braille, the standard Braille cell consists of six dots arranged in two columns of three dots each, resulting in 64 possible combinations (2^6). However, there are Braille systems that use 8-dot Braille cells to represent characters, providing additional options for representing complex scripts like Marathi. In Marathi Braille, each Braille cell consists of six dots arranged in two columns of three dots each. The combination of raised and lowered dots in these cells represents individual letters, numerals, and punctuation marks in the Marathi alphabet.

Here are the Braille representations of the Marathi alphabet (consonants and vowels) in a simplified form:

Consonants:

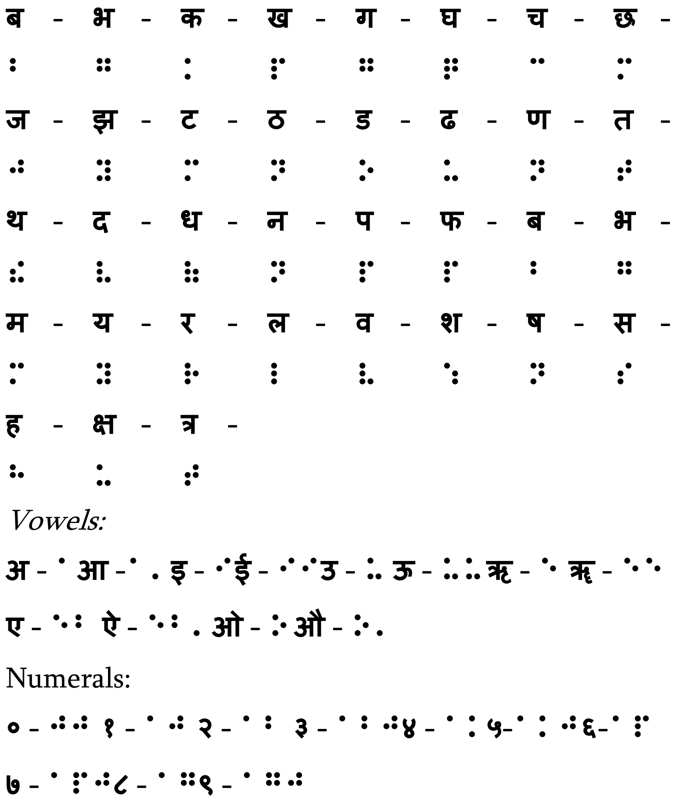

Table no.1 Marathi Characters & Numbers

RELATED WORK

Here is a summary of research conducted on the translation of various script types into Braille:

The challenge of transforming the task of formatting word-processed texts into Braille documents has been taken on by P. Blenkorn et al. [8]. The issue has been discussed in relation to word processor users' desire to create Braille documents. The word processor and translator will work together seamlessly. It is simple to use because MS Word's menu item facilitates translation. They have converted Text to Braille using a C-written DLL. The Braille Out technology converts a wide range of documents into dependable contracted Braille. The speed is tolerable, and the layout is good.

The author P. Blenkorn [9] has extensively examined the challenge associated with converting Braille characters into printed text, especially in relation to the Standard English Braille Characters framework. To address this problem, the investigator has presented a Finite State System and a corresponding matching method. Additionally, the author has delved into the realm of contracted English Braille and has emphasized the conversion of letter signs. The paper includes a comprehensive table employed by the author for text generation. Furthermore, the decision table concept has been utilized to articulate all the rules governing the algorithm. Using a list of common English Braille terms and Braille files produced by Torch Trust for the Blind, the system's efficacy has been evaluated. M. Singh et al. [10] addressed the difficulty of translating Hindi and English text into Braille characters in their study. The authors successfully created a comprehensive database containing English and Hindi characters alongside their Braille equivalents. Their approach involved reading a character string, separating words based on blank spaces, breaking down each word into individual letters, and accessing a lookup table to match input string characters with corresponding lookup table characters. When a match occurred, the corresponding Braille characters were printed. This process was repeated until all characters in the input string matched the characters in the lookup table. The authors rigorously tested their system using samples from Newspapers in Hindi and English were converted to Grade I Braille with an astounding 100% accuracy for English text and 99% accuracy for Hindi text. One group that has taken on this task of transcribing English characters into Braille is M. Y. Hassan and colleagues [11]. The English characters are recognized using a neural network. The utility is designed using Matlab programming. A scanned page image is separated into 400 elemental columns, each of which represents a 20 by 20 grid for a character. The relevant Braille character is generated using the network's output in accordance with the Braille instructions. The Braille characters that are generated are stored as a 2*6 matrix for every character. NN is built and trained with a back-propagation training technique to identify 63 characters. NN conversion is a quick and precise process. The task of translating English material into Braille has been taken on by Dr. B. L. Shivakumar and associates [12]. They adopted a Client/Server Architecture by using a one-to-one matching technique with Visual Basic 6.0 as the front-end tool and MS Access 2002 as the back-end tool. The database contains every format for a braille cell., follows a systematic process: reading input values until the enter key is pressed, separating words based on blank spaces, breaking down words into individual letters, By utilizing pre-established guidelines and parameters to access the Braille database. For every input character, the software methodically looks through all 64 (26) possible combinations of Braille matching values.

In instances where a match is not found, the system generates an appropriate error message. For a predetermined set of characters that are kept in the database, this method yields very accurate results. X. Zhang et al. [13] took on the problem of employing FPGAs to translate text into Braille. In contrast to the majority of commercial methods, their translation system executes the translation process in hardware rather than relying on software. To expedite the translation process, they leveraged an FPGA with substantial programmable resources. Additionally, In order to improve the translation speed, they made changes to an algorithm that P. Blenkhorn had first presented. The final system outperforms Blenkhorn's original approach in terms of throughput. According to their work [14], H. R. Shivakumar and associates have developed an intuitive interface that can quickly and efficiently convert printed Tamil books. Catering specifically to individuals with visual impairments. This innovative tool, OS compatibility: Linux, Windows, and Mac; built in Java using Eclipse SWT. Notably, the project is established as an open-source initiative, emphasizing accessibility and inclusivity in its design and implementation.

A technique for automatically translating Dzongkha text to Braille forward has been presented by T. Dasgupta et al. [15]. Bhutan's national language is Dzongkha. The system's goal is to give blind persons affordable, effective access mechanisms. It also tackles the issue of the dearth of automatic Braille transliteration systems for the Dzongkha language. The current system may be set up to receive a Dzongkha text document as input and produce the equivalent Braille output depending on a set of transliteration rules. Structure for translating Braille from Indian language that can be optically recognized has been designed by O. Khan Durrani et al. [16]. The system will assist in turning a vast amount of data written in several Indian languages into a form that can be read tactilely. The system is mostly made up of OCR modules that are efficiently constructed to support scalability and portability. They have also discussed the value and necessity of the effort, as well as the characteristics of Indian scripts and Braille. They have also talked about the system-related work that has been done and the OCR work that has been done on Indian languages. The system design is then thoroughly detailed, and some conclusions and next development follow. The report also lists the requirements that must be met in order for the general public to profit from the developed technology.

Yoo and Baek [17] introduced a gadget designed to produce Braille documents specifically catering to the visually impaired. Their innovation involved integrating a Raspberry Pi camera into the system to capture documents and save them as image files within the device. Subsequently, the characters from these images were extracted and converted into Braille format. This Braille output was then processed, resulting in a device capable of generating Braille content. Noteworthy features of their proposed device included its portability and the feasibility of construction using 3D printing technology. Zhang et al. are not mentioned further in the provided text. In the study conducted by Park et al. [18], they introduced a novel approach aimed at automating the conversion process of scanned book images into digital Braille books. The key aspect of their method involved the utilization of character identification and image recognition techniques applied to the content within books. This intricate process ultimately facilitated the seamless translation of scanned images into textual information. The notable outcome of implementing their method was a substantial reduction in both time and cost associated with the production of Braille books. Essentially, their innovative approach streamlined and expedited the transformation of printed material into accessible digital Braille format, contributing to increased efficiency and affordability in the creation of materials for individuals with visual impairments.Top of Form In the study Al-Salman et al. [19] are credited with the creation of a Braille copier machine. This machine is designed to generate Braille documents in different languages. Notably, the functionality of the machine extends beyond simple copying; it also operates as a printing system. The technology behind its operation involves optical recognition and techniques derived from image processing. Essentially, the Braille copier machine developed by Al-Salman et al. serves a dual purpose, facilitating both the reproduction and printing of Braille documents through the incorporation of advanced optical and image processing methods.

CHALLENGES FOR TRANSLATION OF TEXT INTO BHARATI BRAILLE

Several problems can occur while converting text to Bharti Braille, including the following:

A. **Complicated Script Structure:** Translating text into Bharti Braille presents challenges due to the intricate composition of the Devanagari script, commonly employed in India. This script features a complex array of elements such as vowels, consonants, and various diacritical marks.

- **B. Linguistic Complexity**: Marathi script has a rich set of characters, including conjuncts and diacritics, which pose challenges in Braille representation. Ensuring accurate and comprehensive Braille equivalents for these characters requires detailed linguistic analysis and expertise. Complex grammatical structures, such as verb conjugations, tense markers, and compound words, need precise Braille symbols to maintain readability and grammatical correctness.
- **C. Lack of Standardization:** There are no clear standards for translating text to Bharti Braille, and different institutions and organizations may translate Devanagari script characters into Braille cells in different ways.
- **D. Incomplete or Faulty Transliteration Rules:** The resulting Braille text may be wrong or difficult to read if the rules for converting Devanagari script characters to Braille cells are insufficient or incorrect.
- **E. Technical Restrictions:** Text to Braille conversion systems could be limited by technical issues, like memory constraints, processor speed issues, or hardware or software compatibility issues, which could affect the translation process's accuracy and efficacy.
- **F. User Awareness and Training:** User The success of Text to Braille Conversion systems partly depends on user knowledge and training. Users need to be made aware of the limitations of the hardware or software and given instructions on how to use it correctly in order for a system to function well.

It is crucial to create comprehensive and precise transliteration standards, deploy dependable and effective hardware or software, and offer user education and awareness campaigns in order to address these problems [6].

CONCLUSION

This study highlights the critical role of translating Marathi text into Bharati Braille as a significant step toward fostering accessibility and inclusivity for visually impaired individuals. By addressing the linguistic complexities and cultural relevance of Marathi within the framework of Bharati Braille, the research bridges the gap between language diversity and assistive technology. The literature review underscores the advancements in text-to-Braille conversion tools while also identifying the persistent challenges that demand innovative and collaborative solutions. The findings emphasize that the continuous refinement of text conversion processes, informed by interdisciplinary collaboration, is vital to ensuring accuracy, cultural alignment, and usability. Furthermore, the development of robust algorithms and tools tailored to Indian languages like Marathi holds the potential to transform how accessibility is approached in multilingual societies.

In conclusion, this work not only contributes to the enhancement of Braille-based accessibility but also underscores the broader commitment to inclusivity in technology. Ongoing efforts to integrate linguistic diversity with technological innovation will play a pivotal role in empowering the visually impaired community and promoting equality in access to information and opportunities.

ACKNOWLEDGMENT

The Chhatrapati Shahu Maharaj Research Training & Human Development Institute (SARTHI), Pune, is acknowledged by the authors for their kind fellowship award, which enabled them to conduct this study. Additionally, the Maharashtra government's Rajiv Gandhi Science and Technology Commission number is RGSTC-11/2022=2023/368–70. Furthermore, sincere gratitude is given to the Computational and Psycholinguistic Research Lab Facility for their fantastic support. The Department of Computer Science & Information Technology at Dr.

Babasaheb Ambedkar Marathwada University, Chh. Sambhajinagar, Maharashtra, India, is also acknowledged by the writers for their resources and support.

REFERENCES

[1]. Reddy, V. K., Chaurasia, K., Bhambal, A., Moon, N., & Reddy, E. K. (2013). A comparison of oral hygiene status and dental caries experience among institutionalized visually impaired and hearing impaired children of age between 7 and 17 years in central India. Journal of Indian society of pedodontics and preventive dentistry, 31(3), 141-145.

[2]. Bettelani, G. C., Averta, G., Catalano, M. G., Leporini, B., & Bianchi, M. (2020). Design and validation of the readable device: a single-cell electromagnetic refreshable braille display. IEEE transactions on haptics, 13(1), 239-245.

[3]. Roberts, J., Slattery, O., & Kardos, D. (2000, May). 49.2: Rotating-wheel braille display for continuous refreshable braille. In SID Symposium Digest of Technical Papers (Vol. 31, No. 1, pp. 1130-1133). Oxford, UK: Blackwell Publishing Ltd.

[4]. Nadeem, M., Aziz, N., Sajjad, U., Aziz, F., & Shaikh, H. (2016, August). A comparative analysis of Braille generation technologies. In 2016 International Conference on Advanced Robotics and Mechatronics (ICARM) (pp. 294-299). IEEE.

[5]. Kavalgeri, S. A., Chakraborthy, R. V., Naz, S. F., & Chaitanya, K. J. E-Braille: A Study Aid for Visual Impaired. International Journal of Research in Engineering, Science and Management Volume-2, Issue-2, February-2019 www.ijresm.com | ISSN (Online): 2581-5792

[6]. Joshi, N., & Katyayan, P. (2023, March). A Model for Translation of Text from Indian Languages to Bharti Braille Characters. In 2023 6th International Conference on Information Systems and Computer Networks (ISCON) (pp. 1-4). IEEE.

[7]. Rathod, P. H., Dhore, M. L., & Dhore, R. M. (2013). Hindi and Marathi to English machine transliteration using SVM. International Journal on Natural Language Computing, 2(4), 55-71.

[8]. Blenkhorn, P., & Evans, G. (2001). Automated braille production from word-processed documents. IEEE Transactions on Neural Systems and Rehabilitation Engineering, 9(1), 81-85.

[9]. Blenkhorn, P. (1995). A system for converting Braille into print. IEEE transactions on Rehabilitation Engineering, 3(2), 215-221.

[10]. Singh, M., & Bhatia, P. (2010). Automated conversion of English and Hindi text to Braille representation. International Journal of Computer Applications, 4(6), 25-29.

[11]. Hassan, M. Y., & Mohammed, A. G. (2011). Conversion of English characters into braille using neural network. Iraqi J. Comput. Commun. Control Syst. Eng, 11, 30-37.

[12]. Shivakumar, B. L., & Thipathi, M. R. (2013). English to Braille conversion tool using client server architecture model. International Journal of Advanced Research in Computer Science and Software Engineering, 3(8), 295-299.

[13]. Zhang, X., Ortega-Sanchez, C., & Murray, I. (2007). A system for fast text-to-Braille translation based on FPGAs. In 2007 3rd Southern Conference on Programmable Logic (pp. 125-130). IEEE.

[14]. HR, S. K., & Ramakrishnan, A. G. A tool that converted 200 Tamil books for use by blind students.

[15]. Dasgupta, T., Sinha, M., & Basu, A. (2012, December). Forward Transliteration of Dzongkha Text to Braille. In Proceedings of the

Second Workshop on Advances in Text Input Methods (pp. 97-106).
[16]. Durrani, O. K., & Shet, K. C. (2005). A New Architecture for Brailee Transcription from Optically Recognized Indian Languages.
[17]. Yoo, D. H., & Baek, S. W. (2022). Developing of Text Translation and Display Devices via Braille Module. Mathematical Statistician and Engineering Applications, 71(3), 537-547.
[18]. Park, T., Jung, J., & Cho, J. (2016). A method for automatically translating print books into electronic Braille books. Science China Information Sciences, 59, 1-14.
[19]. Al-Salman, A. M. S., El-Zaart, A., Al-Suhaibani, Y., Al-Hokail, K., & Gumaei, A. (2014). Designing braille copier based on image processing techniques. Int. J. Soft Comput. Eng. ISSN, 4(5), 62-69.