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Braille Character Recognition System: Review

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Abstract

The Braille Recognition System is the process of capturing a Braille document image and turning its content into its equivalent natural language characters. The Braille Recognition System's cell transcription and Braille cell recognition are the two basic phases that follow one another. The Braille Recognition System is a technique for locating and recognizing a Braille document stored as an image, such as a jpeg, jpg, tiff, or gif image, and converting the text into a machine-readable format, such as a text file. BCR translates an image's pixel representation into its character representation. As workers at visually impaired schools and institutes, we profit from Braille recognition in a variety of ways. The Braille Recognition System contains many stages, including image acquisition, pre-processing of images, and character recognition. This review aims to examine the earlier studies on transcription and Braille cell recognition by other scholars and the comparative results and detection techniques among them. This review will look at previous work done by other researchers on Braille cell recognition and transcription, comparing previous works in this study, and will be useful and it illuminates for Braille Recognition System researchers, especially newcomers.

Keywords:
Braille Recognition System, Image Acquisition, Image Pre-Processing, Character Recognition and Neural Network.

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1. Introduction

Braille Recognition System is technology to capture and process images of braille characters into natural language characters. It is used to convert braille documents for people who cannot read them into text, and for preservation and reproduction of the documents [1].

In a recent evaluation, the World Health Organization (WHO) found that there are 9.31 billion people who are visually impaired and 43.3 million blind people in the world with these figures rising steadily. The high frequency of vision impairments causes serious difficulties in the daily lives of those who are affected. [1,2] Therefore, it is essential to improve the quality of life and make daily activities easier for those who are blind. Compared to those with normal vision, people with visual impairments frequently have more sensitive hearing enabling children to receive information about their environment by using auditory and touch feedback [3].

With the development of the Braille writing system by Louis Braille, which relies on touch has given those with visual impairments a way to read and communicate. Six concave and convex dots are used in the Braille system to represent letters and numbers in various combinations. However, reading fixed standard Braille might be difficult, and creating a Braille communication system based on finger touch would be more appropriate for the blind, Wearable electronic gadgets with tactile feedback have been created in recent years to help the blind use smart electronic devices, enhancing their ability to communicate, read, place, and navigate [3,4,5]

In the era of technological development, since a few decades ago, pattern recognition has grown to be a very fascinating subject for researchers. A complex and difficult aspect of image and pattern recognition is character recognition. In daily activities, language is a way of communication. It can be either in written or verbal form. It is used to express our views. For those who are blind, braille is a vital form of written communication. People with visual impairments are a valuable part of society and can contribute significantly to its success. Therefore, it has become necessary to give those people tools and platforms for communication with the outside world. The ability to access text-based information for those who are blind or visually impaired has shown considerable potential. With the use of flatbed scanners and software, optical braille recognition enables people with visual impairments to read large numbers of typewritten documents [6,7].

Scanning can be used to convert documents into digital form. Scanned image needs a lot of preprocessing including filtering, smoothing, slant removing and size normalization before recognition process. The method that is used to convert scanned paper document into identified and editable electronic form is called Character Recognition (CR) technique [8].

In last decades, significant advances have been made in machine recognition of shapes, pattern and characters. Computer systems that recognize characters from a scanned image or document and can process automatically is called Optical Character Recognition (OCR). An OCR system converts a document image into text format for easy editing, storage, transmission, searching, indexing and integrating into other application. [9, 10]

Both online and offline recognition of the characters is possible. Real-time character recognition is possible with online character recognition. Online systems can recognize characters more accurately than offline systems since they don't need to locate the character in the beginning like offline systems do. As technology has developed, tablets and other comparable devices now allow people to enter data by handwriting using paper to write handwritten text and a scanner to turn it into an image Off-line handwritten text recognition is the process of recognizing handwritten characters in an image [10, 11].

Braille language is a writing system that enables visually impaired people to read and write through touch using a series of raised dots to be read with their fingers. Traditionally, it is embossed in writing. After its inventor, Frenchman Louis Braille [12,13,14].

Standard Braille is a method for producing printed materials with raised dots that resemble a Braille cell on thick sheets of paper. Six dots make up a cell, which is composed of two dots placed horizontally (a row) and three dots placed vertically (a column). Six dots can be arranged in this fashion to create 64 different patterns. A cell is a set of dots that has a minimum of one raised dot and a maximum of six raised dots. **Fig. 1** depicts the Braille cell's layout [13,15,16].

In a printed Braille sheet, there are typically up to 25 rows of text, each with 40 cells. A typical Braille page measures around 11 inches by 11 inches in size. The Braille cell's size is established as well, though regional variations may exist. A Braille dot's size has been determined by the tactile resolution of the user's fingertips. Each character's horizontal and vertical spacing as well as the separation between word cells are known. The height of a Braille dot is approximately 0.02 inches (0.5 mm), while the distance between dot centers in a Braille cell is roughly 0.1 inches (2.5 mm). There are roughly 0.15 inches (3.75 mm) of blank space horizontally and 0.2 inches (5.0 mm) of blank space vertically between dots on neighboring cells. As illustrated in **Fig. 2**, a typical Braille sheet measures 11 inches by 11.5 inches and normally has 25 lines with a maximum of 40 to 43 Braille cells per line [17,18,19].

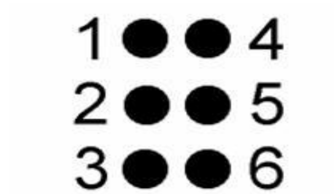

Fig. 1. A Braille Cell.

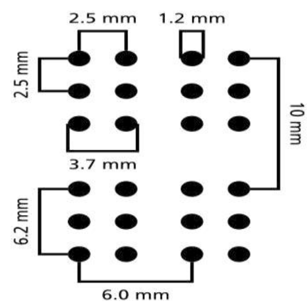

Fig. 2. A Braille Cell Dimension.

The Braille paper's size can also be used to depict words or sentences in cells rather than just single characters. Therefore, there are three levels of the Braille language: Grade 1: A word is made up of a combination of Braille cells, and each Braille cell in this grade corresponds to a single language character. Grade 2 is similar to grade 1 but uses some contractions and abbreviations. The third grade of Braille is the most challenging since it combines complex phrases and sentences. Grade 1 for English language is shown in **Fig. 3** [20 21,22].

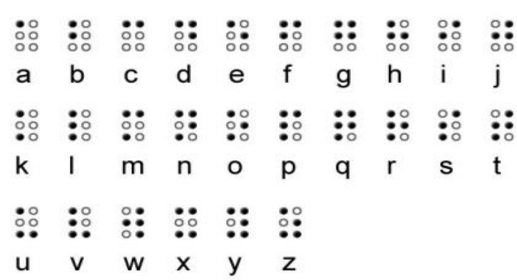

Fig. 3. Character for English Language

2. Challenges

The nature of braille documents is largely to blame for the difficulties in processing braille text. Braille is typically printed on paper that is a single color, without any ink to provide contrast between the raised characters and the paper's backdrop. A scan or photograph of the page, however, can show the page's flaws. Many documents are double-sided because they are inter-point printed. As a result, the braille of one side's depressions and the other's projecting braille appear to be layered [23].

3. Background Braille Recognition System

The Braille Recognition System is a technique for finding and identifying Braille documents that have been stored as images, such as jpeg, jpg, tiff, or gif files, and then converting the text into a machine-readable form, like a text file. The Braille Recognition System transforms an image's pixel representation into its corresponding character representation. Numerous advantages of Braille recognition make our job at institutions and schools for the blind and visually impaired easier on a daily basis. It is clear from the literature review research and comments that accurate pre-processing is necessary for retrieving information from braille paper [24, 25].

Fig. 4 shows the general process for Braille Recognition System. It includes many stages: Image Acquisition, Image pre-processing, character recognition.

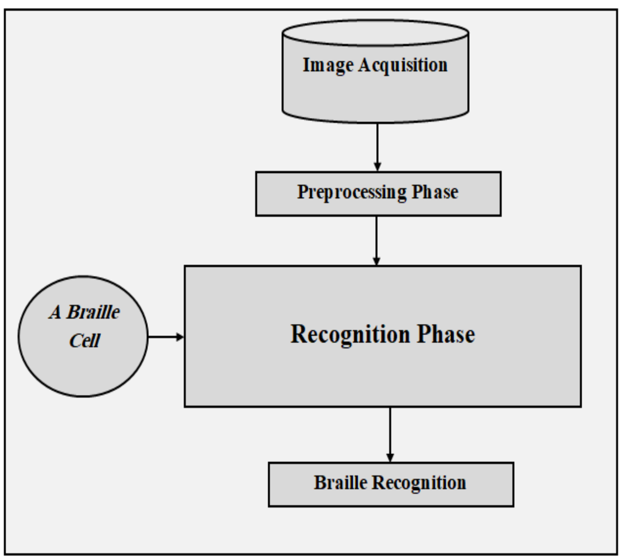

Fig. 4. Braille Recognition System Method.

3.1 Image Acquisition

A critical phase of the Braille Recognition System is the acquisition procedure. Numerous tools, such as portable devices, mobile phones, cameras, scanners, or specialized equipment might be used to complete this stage. The scanner is the acquisition method of choice for the majority of studies because it can address issues with cameras, such as complicated camera setup, limited resolution, illumination issues, and Braille dot misalignment. In terms of Braille dot alignment and resolution, using a scanner produces better results. On single- or double-sided Braille sheets, it is simple to locate Braille dots because the scanner is connected to a single common light source. [25 26 27]

3.2 Image Pre-Processing

The obtained Braille images still require some improvements in order to move on to the next level of the Braille Recognition System processing. The application of a series of picture pre-processing techniques can be used to attain these improvements. Researchers in the past have concentrated on employing a variety of image processing methods to improve the acquired Braille image, such as transforming the RGB (Red, Green, and Blue) colored image to a grayscale image using Equation 1: [29 30 31]

$$\text{Grayscale} = 0.299\text{R} + 0.587\text{G} + 0.114\text{B}$$

Where:
R: Red channel
G: Green channel
Blue: Blue channel

Then convert greyscale image to a binary image (black and white) via select threshold value from the original image, then convert each pixel to white or black depending on the threshold value, if it is greater than or less than threshold by using Equation 2. [30, 32]

$$\text{output pixel} = \begin{cases} white\ if\ its\ grey\ level > T \\ Black\ if\ its\ grey\ level \leq T \end{cases}$$

Where:
T: Threshold

Then the Braille image was acquired, and it gained in a rotated with different angles. The goal of this step is to rotate of Braille image to the normal location. Either the acquisition machine or a human being made a mistake when acquiring the Braille page led to this issue. To achieve that, first, compute the correct angle by using the Hough transform method, then by using the bilinear interpolation method with the correct angle to rotate the Braille image to a normal location. **Fig. 5** shows the Braille image before and after the rotation operation. [10 33 34].

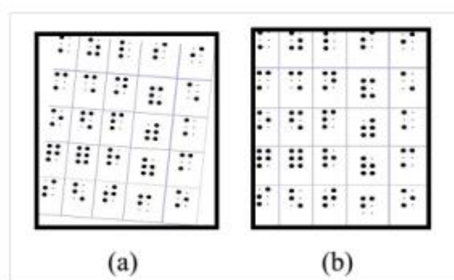

Fig. 5. Skew Scanned Braille Image.

While Braille cell dots are aligned in vertical and horizontal fashion the diagonal, horizontal or vertical lines can be computed by the projections. Compute the vertical projection by using the Equation 3, which is the total number of pixels in each row of the image, while the horizontal projection can computed by using the Equation 4, which is the total number of pixels in each columns of the image [28 29 35].

$$P\_hor = \sum_{i=0}^{C} \sum_{j=0}^{R} O(i,j)$$

$$P_{\_ver} = \sum_{i=0}^{R} \sum_{j=0}^{C} O(i,j)$$

Where:
C: Image Width
R: Image Height
P_{hor}: Horizontal projection Array
P_{ver}: Vertical projection Array
$O(i,j)$: Pixels Value

Character recognition is next to each character's location which receives a horizontally and vertically projected Braille image. According to **Fig. 6**, each character has four locations that represent its lower and upper bounds: (Xup, Xlow, Yup, and Ylow), and implemented recognition algorithm to be converted to a text file.

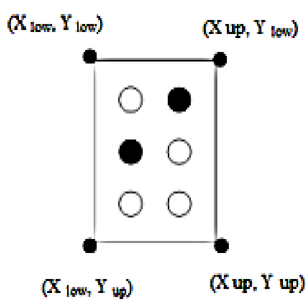

Fig. 6. Charter Area

4. Related Work

Liu YH, Wang JJ, Wang HZ, Liu S, Wu YC, Hu SG, et al., (2023) As part of this project, this paper created poly methyl siloxane (PDMS)- To build an electronic skin (E-skin) for the use of Braille recognition, flexible pressure sensors were used. For the purpose of gathering Braille data, the E-skin simulates the human touch-sensing capability. Using a neural network built on memorizers, braille recognition is accomplished. The binary neural network approach used in this work has just two bias layers and three fully connected layers. The computational burden and, hence, the system cost are significantly reduced by such a neural network design. This work; it is possible to create a wearable, inexpensive Braille Recognition System as well as a Braille learning assistance system. [36]

Waleed M., (2023) in this study, an artificial neural network is created to recognize the Braille representation system's image of a number from 0 to 9. Networks that will be used to recognize the scanned English number in the Braille representation system will be trained and evaluated. To mimic the environment of the actual world, some of the numbers have some sort of noise. [37]

Kavitha M, Meenakshi V, Pushpavalli M, Amudha S, Bharathi S, Pavithra P., (2023) This paper's main objective is to provide a thorough solution to the different communication problems that visually impaired persons encounter on a daily basis. Particularly in the crucial area of touch via mobile phones, technology is continuously changing. The tactile display surface is the sole aspect of the message application that the blind can see. However, because blind people are unable to read the text well, the system's quality is poor. Blind persons can currently only read through Braille technology. This Braille system is used; People who are blind can read messages and respond to them thanks to the proposed solution. The mobile messaging program can be used by blind people in the same way as other users. The reply message is transmitted one at a time by pressing each key on the keyboard when responding back. The user can send information via the GSM module by using the keypad options. [38]

Vaidyaraman J, Thyagarajan AK, Shruthi S, Ravi V., (2023) This study implements a circuit representation of a BAM neural network in order to build a device that can convert Braille to Latin. The hardware BAM that has been constructed models brain synapses using a memory crossbar array and a neuron circuit made up of an I-to-V converter, voltage comparator, D flip-flop, and inverter. Even with the addition of noise, the BAM network's performance remains stable. [39]

Baciero A, Gomez P, Duñabeitia JA, Perea M., (2023) This study investigates if letter similarity effects affect braille reading. Braille is a writing system in which the sensory information is processed in qualitatively different ways than in visual reading, according to the justification: Due to braille's standardization, the shape of the word's letters is extremely steady; however, the sensing of characters is erratic and mostly serial. In order to contrast the braille modality with the visual modality, this article expected that the letter similarity effect would be significant with misspelled frequent words. The responses to tactually identical faux words were less accurate than those to tactually dissimilar pseudo words, according to Bayesian linear mixed-effects models; a similar tendency was visible in the response times (RTs). [40]

Lee D, Cho J., (2022) This study suggests a braille-convertible object recognition, object extraction, outline creation, and living aid system that can be used both inside and outside. The wearer can utilize a braille pad to identify an object's shape and the smart glasses will lead them in actual photographs. Additionally, we created a database of 100 objects based on a study to choose those that visually impaired individuals regularly use in daily life when building the system. In order to evaluate the system's performance, accuracy and usefulness evaluations were undertaken. The first entailed comparing the tactile image produced using braille data to the anticipated tactile image, while the second used photographs of actual scenes to verify the object extraction accuracy and conversion rate. [41]

Lim Roque DR, Marcelo Mateo JT, Linsangan NB, Juanatas RA, Villamor I., (2022) This essay describes the research and development of a Braille-to-Speech system created specifically to help Braille readers read Grade 1 or standard-sized unconstructed documents. The braille text is photographed using a DSLR camera, which is integrated inside the prototype together with an RPi3 microcontroller for image processing and braille pattern decoding. The acquisition of images, picture pre-processing, horizontal segmentation, OBR, and TTS were all automated using Python scripts. Ten different braille texts were created to be tested in order to determine how effective the system design was. [42]

Yamin RB, Kusuma H, Tasripan., (2022) This study creates a braille duplicator system, which is a function added to a braille printer. It functions by converting braille into text on a smartphone, delivering the result wirelessly to an accessory device mounted on the braille printer's interface. Consequently, a braille document can be copied without the original text. [43]

Kausar T, Manzoor S, Kausar A, Lu Y, Wasif M, Ashraf MA., (2021) in innovative method for automatic Braille character recognition is presented in this study. There are two primary phases to how the strategy operates. Several image preprocessing techniques are used in the initial stage to accomplish image alignment and enhancement. Character recognition is carried out in the second step using a suggested lightweight convolution neural network (CNN). For the accurate recognition of visual characters, CNN shows promise. In order to recognize Braille characters, this paper adopted many recently proposed cutting-edge CNN networks. also suggested a method that involved swapping out a few of the original CNN's modules for an inverted residual block (IRB) module with lower processing requirements in order to lighten the networks and enhance their recognition performance. The design and output performance of the CNN model are what make this work novel. [44]

Ovodov IG., (2021) The suggested approach can handle perspective distortions and Braille page deformations when it is shown on an image. The system works well at identifying braille texts that were taken indoors with a smartphone camera. Curved pages and perspective-distorted images are supported. Comparing the proposed algorithm to existing approaches reveals good performance and accuracy. Additionally, a new dataset of 240 images of Braille texts annotated for each Braille letter was created as a result of this effort. The dataset and the suggested algorithm are both accessible on GitHub. [45]

Li C, Yan W., (2021) This study uses ResNet to develop a character-based braille translator; ResNet is available in three different implementations for braille classifiers: ResNet-18, ResNet-34, and ResNet-50. This study also employs an innovative technique known as Adaptive Bezier-Curve Network (ABCNet) to create a word-based braille detector. It uses a technique called Scene Text Recognition (STR) to find text in scenes that are found in nature. [46]

Hsu B-M., (2020) This study uses a convolutional neural network (CNN) model and a ratio character segmentation algorithm (RCSA) to provide a novel method for turning braille images into English text. [47]

Shokat S, Riaz R, Rizvi SS, Abbasi AM, Abbasi AA, Kwon SJ., (2020) In this study, a position-free touchscreen-based Braille input method is created and put into use for those who are blind or visually impaired. It seeks to put as little strain as possible on the user by just requiring them to tap the dots that are required for a certain character. The user has entered Grade 1 English Braille (a–z) data using a newly created application. A total of 1258 photos from the collection were gathered. Deep learning techniques were employed for the classification, with 70%–30% of the total data used for training and validation. On a dataset gathered from visually challenged people using Deep Learning (DL) techniques, the proposed strategy was carefully assessed. [48]

Li R, Liu H, Wang X, Xu J, Qian Y., (2020) In order to directly detect and recognize Braille characters throughout the entire original Braille images, this research suggests an ideal semantic segmentation architecture called BraUNet. In order to obtain more low-level features, BraUNet extends the UNet network's existing auxiliary learning technique by connecting feature maps over longer distances between the encoder and decoder. Multiple-class Braille character segmentation and Braille foreground extraction can be used as an auxiliary learning approach, This can enhance the Braille segmentation performance and feature learning ability. The final individual Braille character regions are then obtained from the semantic segmentation results using morphological post-processing. Results from experiments demonstrate that the suggested framework is reliable, efficient, and quick for segmenting and recognizing Braille characters on both challenging double-sided Braille picture datasets and handwritten Braille image datasets. [49]

Gonçalves D, Santos G, Campos M, Amory A, Manssour I. (2020) This study examines the state-of-the-art in deep neural network-based Braille letter detection. Additionally, provides a fresh public dataset containing 2818 Braille character images that have been categorized and sorted into alphabetical order, as well as a comparison of several recent detection techniques. As a result, using a reduced physical environment, the suggested Braille letters detection approach could help teach programming to blind pupils. Another contribution is the suggestion of using EVA (Ethylene Vinyl Acetate) pieces with pins to imitate Braille characters in this setting. [50]

Li R, Liu H, Wang X, Qian Y., (2019) The unique two-stage learning framework TS-OBR for double-sided Braille image identification is proposed in this research. In the first stage, a Haar cascaded classifier using the sliding window technique is used to accurately and quickly identify Braille recto dots. Then, to correct the initial skewed Braille images, a course to fine de-skewing method is suggested. [51]

Perera TDSH, Wanniarachchi WKIL., (2018) In this study, an OBT system that recognizes Sinhala Braille characters in single-sided Braille documents and translates them into Sinhala is proposed. The Grade 1 English Braille characters, digits, capital letters, and some Grade 2 English Braille sentences can also be recognized by this system. The proposed system was made using image processing methods in the MATLAB environment. [52]

Assefa, T.H. (2018) In this study, a Braille system that enables an interaction between a blind person and a computer is designed using an artificial neural network (ANN). The implementation of Braille pattern recognition makes use of the Multilayer Perceptron (MLP), which has four layers and nineteen neural networks. The Braille pattern is fed into the MLP, and by using a program created in MATLAB, the patterns are trained. With the help of the established technology, a blind person can type letters, numbers, and other commands into a computer. [53]

Li R, Liu H, Wan X, Qian Y., (2018) This study creates an extensive Double-Sided Braille Image dataset (DSBI) including annotated Braille cells, recto dots, and verso dots. An additional annotation approach is suggested to swiftly annotate Braille pictures, which utilizes initial automatic Braille dot identification and updates annotation findings using a practical human-computer interaction technique. In one Braille image, this labeling approach can, on average, boost label efficiency by six times. The fundamental and central phase in Braille image identification is Braille dot detection. The performance of recto dots identification is benchmarked in this research along with the evaluation of other Braille dots detection techniques using our dataset, DSBI. Additionally have published our dataset of Braille images on the GitHub website. [54]

Choudhury AA, Saha R, Hasan Shoumo SZ, Rafsun Tulon S, Uddin J, Rahman MK.., (2018) In order to solve this problem, it is suggested in this study to develop dynamic braille, which would use a camera to recognize objects in real-time, transform the identified images into text, and then translate the text into braille. This model can correctly detect about 9000 items. This is a creative way to combine braille functionality with object detection techniques used in image processing, and hopefully utilizing this, some issues related to blindness can be partially resolved. [55]

Murthy VV, Hanumanthappa M., (2018) The main mission of the paper is to understand and apply a proportional learning of diverse preprocessing techniques on the Braille image and identify the best method to improve quality of Braille image. [56]

Smelyakov K, Chupryna A, Yeremenko D, Sakhon A, Polezhai V., (2018) These techniques enable high speeds and great levels of recognition accuracy. The system may dynamically adapt to elements like input pattern quality and differences. In this study, an artificial neural network is created to recognize Cyrillic alphabet letters in the Braille representation system. A network will be tested and trained to recognize Braille characters that have been scanned in Cyrillic. To mimic the surroundings of the actual world, some of the letters have some sort of noise applied to them. [57]

Seid Ali H., (2017) In order to identify the recto, verso, and overlapping dots on double-sided Amharic Braille papers, a system is proposed in this study. Additionally, utilize the direction field tensor to preprocess the dots and separate them from the background. To determine whether a dot is a recto or verso dot, utilize the gradient field. Braille dot properties (centroid and area) are used to distinguish between overlapping dots. The dots are separated into recto and verso pages after being identified. Then, create algorithms for translating Braille codes into print text and encoding Braille cells to represent dots, respectively. The recto page is mirrored about a vertical symmetric line with the intention of employing the identical Braille cell encoding and Braille code translation technique. The idea of reflection is also used in this paper to automatically reverse incorrectly scanned Braille documents. [58]

Sarah Hikmat Khaled , Assist. Prof. Safana H. Abbas, (2017) this study suggests a Braille Recognition System module that can convert a single-sided Braille document into English text and voice. The preprocessing stage and the recognition stage make up the majority of the module. Different thresholds and mask sizes were evaluated in the first stage, after which the preprocessed image was employed in the recognition stage. The English document was obtained using the Modify Multi-Connect Architecture (MMCA) and Modify Bidirectional Associative Memory (MBAM) algorithms. [59]

Venugopal-Wairagade GA, (2016) The approach described in the paper interprets the raised dots on a Braille page and transforms them into their corresponding English characters. It was discovered that the program can achieve more than 80% accuracy in optimal lighting and Braille document alignment with respect to the smartphone. Users who do not understand Braille may use the program in the educational field to assist blind or visually impaired students with their coursework and exams. [60]

Subur, Joko, et al. (2015)The purpose of this project is to convert braille characters into alpha-numeric text and develop a method for recognizing them. The braille characters on the paper sheet are converted into braille images using a webcam camera. In picture preprocessing, procedures like cropping, grayscale conversion, thresholding, erosion, and dilation are employed. The braille characters are then recognized using techniques based on artificial neural networks. [61]

Mousa A, Hiary H, Alomari RS, Alnemer LM, Abdullah K (2013) in this study, a comprehensive character recognition method for single-side Braille documents is proposed. Additionally, a thorough analysis of Braille Recognition Systems and related research initiatives is included in this work. The size of the scanned image is completely adaptable to the suggested Braille recognition method. Additionally enhance each phase, from the taking of the picture to the final stage of recognizing the Braille cells. The suggested system has a stage for picture capture, a stage for noise removal from the images, a stage for modified image segmentation, a stage for feature extraction, and a stage for character recognition. [62]

Yousefi M, Famouri M, Nasihatkon B, Azimifar Z, Fieguth P., (2012) In order to estimate the scaling, spacing, and skewness parameters for a certain Braille document, a statistical method is proposed in which the detected dots in the Braille text are modeled using a parameterized probability density function. Skewness, scaling, and line spacing are calculated as a result of utilizing expectation maximization to solve a maximum likelihood (ML) issue. Each line of the Braille document is extracted using those parameters, and the vertical projection of the Braille dots is used to split each of the three rows of individual lines. Finally, a scale-independent automatic document gridding method based on a hidden Markov model is suggested for dot localization and character detection. [63]

Prof. Dr. Mohammed Y. Hassan, A., G. Mohammed, A. (2011) The ability of the neural networks to translate scanned English-language text pages, books, or lectures into Grade I Braille will be examined in this study so that blind individuals may deal with it. A minimally structured artificial neural network is created and tested to translate English characters into grade I literary Braille coding. It will be expected that English characters will be impacted by the noise of the mean-variance between 0 and 0.4. A data file that can be delivered to a Braille printer or a Braille display can be used to hold the output of the N.N. [64]

Matsuda Y, Sakuma I, Jimbo Y, Kobayashi E, Arafune T, Isomura T. (2010) in this paper Using tiny piezoelectric accelerometers worn by the receiver, this study created a Finger Braille identification system. Additionally performed a measuring experiment to develop algorithms for the identification of the positions and dotted fingers. The findings demonstrated that dotted finger recognition was 92.9% accurate and that the recognition method was unaffected by the strength, location, and recipient of the dots. The identification system was 81.9% accurate in recognizing dotted locations, and it was able to do so if the recipient's hand created a natural longitudinal arch on the surface. [65]

Al-Shamma SD, Fathi S., (2010) The system for designing and putting into practice Arabic Braille Recognition System with speech and text conversion is presented in this study. The implemented algorithm is based on a comparison between the database created for each Braille cell and the extraction of the Braille dot positions in each cell. The Braille scanned page has through a number of digital images processing steps, including binary conversion, edge detection, hole filling, and picture filtering before dot extraction. Additionally, each Braille cell's individual decimal code was generated as part of the research for this publication. This code served as the foundation for word reconstruction using the associated speech and text conversion databases. [66]

Nadira, M., Kamariah, N.I., Jasni, M.Z., & Azami, A.B., (2007) The prototype of this system uses Template Matching as the algorithm to identify the characters within its own scopes; the characters to be tested are the letters of the alphabet (A–Z). Grey-scale images with the Times New Roman font type were utilized, along with bitmap image format and 240 x 240 image size. The alphabet was recognized by comparing the two images. The goal of this system prototype is to address the issue of character recognition, which previously made it challenging to identify characters without the aid of techniques. Template Matching is one approach that can be used to address this issue. The software program that was employed to create the system prototype was Matlab R2006a. This system prototype involved a few different steps. The steps begin with the acquisition process, continue with the filtering process, set a threshold for the image, group the alphabet's images, and finally identify the alphabet. After comparing the two character images, each of these procedures is crucial to obtaining the recognition result. [67]

Falcón N, Travieso CM, Alonso JB, Ferrer MA. (2005) This essay describes the creation of a system called Brail Lector that can speak from Braille writing. Using TTS software (Text-To-Speech), adaptable Braille grid, recovery dots, and dynamic thresholding, In addition to translating Braille scanned images into regular text, Brail Lector may also pronounce the translated text. [68]

Ng CM, Ng V, Lau Y. (2003) the purpose of this work is to propose a system that automatically identifies Braille pages and converts them into English or Chinese text for editing. Using Braille papers that are both single- and double-sided as the test. [69]

5. Summary and Discussion

The discussion of the Braille recognition methods used in this paper is shown in this section and will make comparison between the different Braille Recognition Systems, where results, detection techniques, and most of the techniques used to distinguish Braille Recognition Systems are using artificial neural networks, The results show that the majority of the techniques used in Braille Recognition Systems are using artificial intelligence and image processing techniques. These results show that the accuracy of the results using artificial intelligence is better than the results that use other techniques, as shown in the table 1.

6. Conclusion

The distance between blind and visually impaired persons and sighted people can be narrowed thanks to the Braille Recognition System; The Braille characters can be changed into the equivalent plain language characters by the system. Anyone who works with blind individuals who are unfamiliar with the Braille scripting language can benefit from it. This evaluation discovered that the majority of research efforts use the scanner as their acquisition approach; there is currently a dearth of research on employing regular cameras or mobile cameras. Additionally, the majority of scripting languages, including Arabic, have sufficient research. The researchers utilize their own database and a Braille image to gauge the performance of their algorithms because there is no benchmark to compare the suggested methods against. In additional, examine the earlier studies on transcription and Braille cell recognition by other scholars and comparative results and detection techniques among them.

The results show that the majority of the techniques used in Braille Recognition Systems are using artificial intelligence and image processing techniques. These results show that the accuracy of the results using artificial intelligence is better than the results using other techniques, as shown in **Table 1**.

Table 1. Comparison Braille Recognition System (results, and detection techniques)

Paper	Detection Techniques	Results
36	Binary Memristive Neural Network	91.25%
37	Artificial Neural Networks	85%
38	Artificial Neural Networks	N/A
39	Bidirectional Associative Memory Neural Network	100%
40	Pseudo Words Matrix	97.10%
41	Yolov3	90% and above
42	Assistive Technology	81.63% to 93.48%
43	Image Processing	99%
44	Deep Learning Strategy	98.3%
45	Neural Network	99.63%
46	Deep Learning	100%
47	Artificial Intelligence	98.73%
48	Deep Learning Scheme	92.21% to 100%
49	Auxiliary Learning Strategy	98.35%
50	Deep Neural Networks	94%
51	Learning Framework TS-OBR	99.99%
52	Image Processing Techniques	Over 99%
53	Artificial Neural Network	N/A
54	N/A	97.65%
55	YOLO Algorithm	87%
57	Neural Networks	N/A
58	N/A	99.30%
59	Neural Networks	98.26% and95.11%
60	N/A	80%
61	Artificial Neural Network	99%
62	Image Processing Techniques	94.39%
63	Image Processing Techniques	N/A
64	Artificial Neural Network	N/A
65	Piezoelectric Accelerometers	92.9%.
66	Artificial Neural Network	Over 99%
67	Template Matching	N/A
68	Image Processing Techniques	99.90%
69	Regular Feature Extraction	100% and 97%

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