Scientific Journal Impact Factor (SJIF) : 3.518
International Journal of Modern Trends in Engineering and Research
ISSN (ONLINE) : 2349 - 9745 ISSN (PRINT) : 2393 - 8161

BRAILLE CHARACTER RECOGNITION USING MODIFY MULTI-CONNECT ARCHITECTURE (MMCA).

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Abstract—In this paper, a single side English document is recognized using Modify Multi-Connect Architecture (MMCA).The work is consisting of two stages: The preprocessing stage and the recognition stage. The output of the recognition stage is converted to voice signal.The implemented algorithm achieved average accuracy for correct letters was 98.26%, average accuracy for correct words was 95.11% and average processing time around 11 sec per page.
Key words—Braille,Optical character recognition, Associative Memory.

I. INTRODUCTION

Louis braille invented braille system in 1821, this system used before plainly handicapped persons to read and write through touch.represents natural text in braille as a pattern consisting of dots raised coordinated in cells. each cell is Consisting of six dots in 3 x 2 arrangement appears an alphabet or numeral by eminent at one or more dot locations [10], as shown in Figure1.These dots coordinated in three rows and two columns. The six positions of dots are coordinated to give no more 64 various braille characters. These punctuate are written using a specialized machine [2].Braille Character Recognition (BCR) is a technique to determine and recognize Braille document stored in an image, such as a jpeg, jpg, tiff or a gif image, and transform the text into a coded machine form such as text file [5].

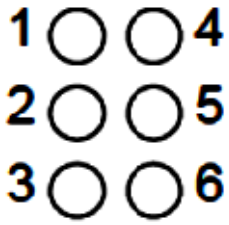


Figure 1. The six dots of a Braille cell

Each arrangement of dots is known as a cell and will consist of least one raised dot and a maximum of six, on a Braille sheet, as shown in Figure2.the dots are created by embossing using a special printer or even a manual machine that simultaneously embosses the dots. Today, we also have braille printers which may be connected to computers on standard printed interfaces. these are generally known as Braille Embossers.

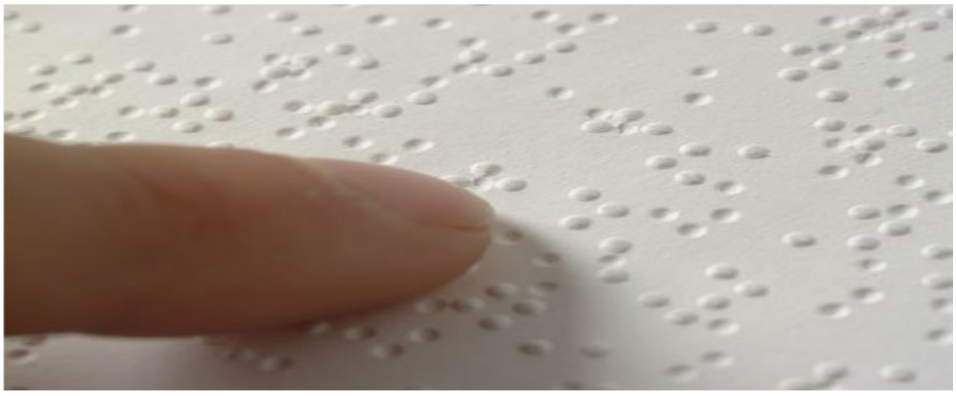


Figure 2.Braille sheet [6].

The alphabet Braille is divided into two types grade1 Braille and grade2 Braille, Grade1 Braille is the most basic representations of letters, numbers and punctuation, [5,4]. It is a direct substitution of normal print letters for letters from the Braille alphabet which can be read by all Braille users, and it is the first stage of learning to read Braille.Grade 2 Braille, now because Braille books are so much larger than print ones, numerous contractions have been introduced to make them take up less space and faster to read. Contracted Braille is known as Grade 2, and is by far the most widely used. It makes use of approximately more than 300 contractions (in addition to the representations mentioned above.) A contraction is used to shorten the length of a word. Contractions for example, the word for representing one character in Grade2. The word question represent only two letters in grade2 make it much faster and easier for everyone to enjoy a Braille book, While the Grade1 of the number of letters in Braille word be equal to the number of letters of any language to the same word Here are some examples in ***Table (1)***.

Table(1): Example of Grade 1 and Grade 2 Simplification [5, 7, 4 and 6].

The word	**Grade 1**	**Grade 2**
For		
Question		

II. RELATED WORKS

This section provide a survey of the literature related toBraille character recognition,That were developed to improve Braille character recognition.

Shreekanth. T, V.Udayashankara in 2014 [11] This paper presents an efficient and a new algorithmic approach for the recognition of double sided embossed Braille document, with simple Braille dot analysis, based on the variation in the gray level values of the Braille image due to the protrusions and depressions created on the original Braille document.The work in this paper has two main tasks, first is to recognize the printed Braille dots and second is to differentiate them as recto and verso dots. This involves few processes such as, thresholding, centroid detection, mask design, placement of designed mask on the centroid detected dots and differentiating recto dots from verso dots. Dots from the interpoint Braille document can be separated into recto and verso dots with a single scan and with the average processing time of 5.6 seconds. The experiments carried out on the developed database and obtained an excellent recognition rate of 99%.

AbdulMalik Al-Salman, YosefAlOhali, Mohammed AlKanhal, and Abdullah AlRajihin 2014 [1] The proposed system has used some new techniques to recognize Braille cells using a standard scanner. The system has been tested with a wide variety of A4 scanned Braille documents, both single and double sided, written in the Arabic language andscanned with different scanners. Overall, on singlesided and double-sided documents 99% of the dots are correctly recognized.

Mohammed Y. Hassan, Ahmed G. Mohammed in 2011 [7] in this paper use the feed forward artificial neural networkwas designed and tested to convert English characters into grade1 literary Braille code, taking into account the nonlinearity of the conversion because of Braille rules. The network was designed with minimum structure including a number of layers, and a number of neurons in each layer. Noisy input patterns were introduced to the network including the addition of a noise of std0.2 to all characters, which resulted in one or two characters to be detected wrong for each time running the program. A pattern of characters without and with noise were tested using the designed N.N and the results were satisfying.

zainb. Authman, Zamen F. Jebr in 2013 [13] in this paper we have explained the development of an automatic system for recognizing printed Braille cells. It has been divided in different modules for each part of the image processing. For achieving this system, local and adaptive thresholding has been used, and shrinking mechanism is added to the system for make Braille cells shape's more regular to relent the next task of (OBR) system. This process has an efficiency and it take only 17 sec. to recognize green Braille sheets and 21 sec. in recognize yellow Braille sheets.

S.Padmavathi, Manojna K.S.S, Sphoorthy Reddy .S and Meenakshy .D in 2013 [12] this paper proposes a method to convert a scanned Braille document to text which can be read out to many through the computer. The Braille documents are preprocessed to enhance the dots and reduce the noise. The Braille cells are segmented and the dots from each cell is extracted and converted in to a number sequence.These are mapped to the appropriate alphabets of the language. The converted text is spoken out through a speech synthesizer. The paper also provides a mechanism to type the Braille characters through the number pad of the keyboard. The typed Braille character is mapped to the alphabet and spoken out. The Braille cell has a standard representation but the mapping differs for each language. In this paper mapping of English, Hindi and Tamil are considered Accuracy of text conversion 97.8% -100%.

III. MODIFY MULTI-CONNECT ARCHITECTURE ASSOCIATIVE MEMORY [3, 8, 9]

Associative memoryis a data collectively stored in the form of a memory or weight matrix, which is used to generate output that corresponds to a given input, can be either auto-associative or hetero-associative memory. A Hopfield neural network is one of the most commonly used neural network models for auto-association and optimization tasks, it has several limitations. For example, it is well known that Hopfield neural networks has limited stored patterns, local minimum problems, limited noise ratio, retrieve the reverse value of pattern, and shifting and scaling problems.

Although, MCA has been overcome these limitations, to improve its efficiency by decreasing the network size and weight size.In additional to increase the ability for noise robust as well as speed up its learning and convergence process. A modified associative memory based on the MCA, namely the Modify Multi Connect Architecture (MMCA), is proposed. The modifications include the network architecture as well as in its learning and convergence processes.

This improving was done by proposed algorithms for learning process and convergence process. Thus for both, the pattern (pattern: It means a sequence of 1's and -1's) will bedivided into a number of parts with size two, to be considered as a vector v (each two element of the pattern will be one vector). Each one of these vectors needs to create its learning weight matrix during learning process or need to find the convergence pattern during the convergence process see Figure 4.

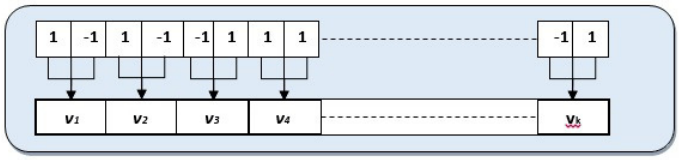


Figure 4. The data (pattern) divided into a number of vectors with size two, which it need to create its learning weight matrix.

Because of this process, MMCA can deal with any pattern size and the associative memory capacity became unlimited, and it could remember even the correlation patterns. Additionally, because the size of the vectors is two, there are no more than four possible vectors see Table 2, this means there are no more than two weight matrices W will be built during learning process depending on the fact that each pair of orthogonal vectors has the same weight. These matrices are symmetric, without zero diagonal and with size 2*2.

Table 2.Illustrated the four possibilities of the bipolar vector with length two.

-1	-1
-1	1
1	-1
1	1

The architecture of MMCA is illustrated in Figure 5. It shows each path represents one learning weight matrix (1< m <2), thus, all the vectors in the pattern will be replacing with a number, which represents the number of the path in the net, by this number, we can call the path again.

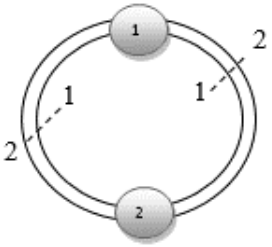


Figure 5.The architecture of MMCA associative memory.

IV.THE PROPOSED BCR MODULE

The general flowchart of*BCR*module as shown in Figure 6.Where the captured by a scanner is then processed by the system and the assessment results are storing in the text file. The details of each phase discussed in next subsection.

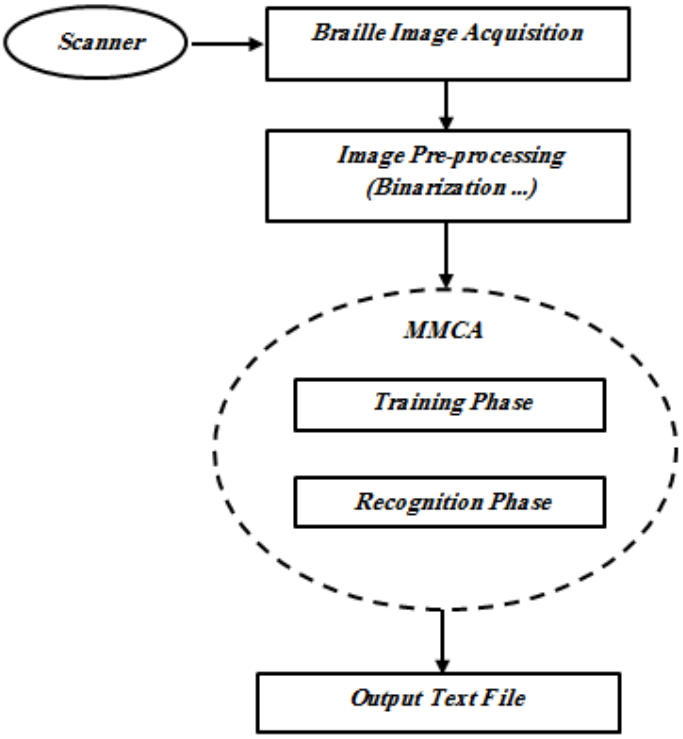


Figure 6: Flowchart of BCR

4.1 Image Acquisition

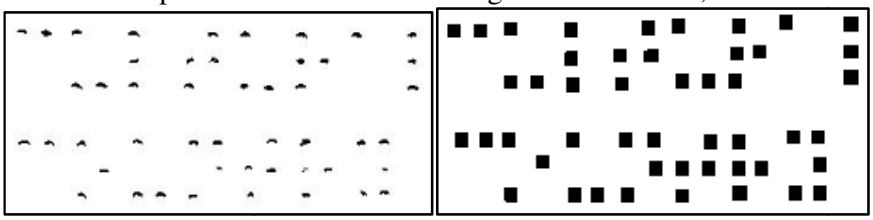
The role of scanner is just to scan the Braille sheet. Therefore,the Braille sheet scanned by using Brather Scan MFC-J470DW scanner with horizontal and vertical resolution 200 dpi, Image data are transferred from scanner to computer and stored in memory of the computer with JPG image format.

4.2 Preprocessing

The pre-processing phase consists in a set of operations that make the scanned image more suitable for the further phases:

1. The first operation performed to the image is the conversion to gray scale;
2. then the image converted into black and white format using the thresholding method

3. Next using dilation to expand the dots in braille image and to be clear, as shown in Figure 7.



(a) (b)

*Figure 7. (a)*complemented image, (b) An image after dilation

4.character Area AllocationIn this step Braille sheet is projected horizontally and vertically to located area for each character. Each character comprises four positions (X_{up}, X_{low}, Y_{up}, Y_{low}) which are lower and upper bounds of the character as shown in Figure 8.

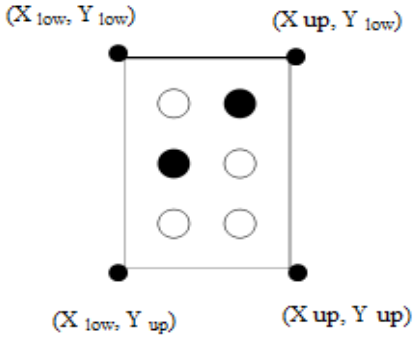


Figure 8: charter zone represented by the quadruple (X_{up}, X_{low}, Y_{up}, Y_{low}).

4.3 Character Recognition using MMCA

The proposed Braille approach will use set of character as a training image during learn phase is implemented for each character and save it in a lookup table in MMCA associative memory to be remembered during recognition process.

Where recognition phase implemented for the braille image after detecting each character for it, the convergence phase of the MMCA using the lookup table that is built during the training Phase.Figure9.illustrates the training and recognition phase steps to implement of MMCA method**.**

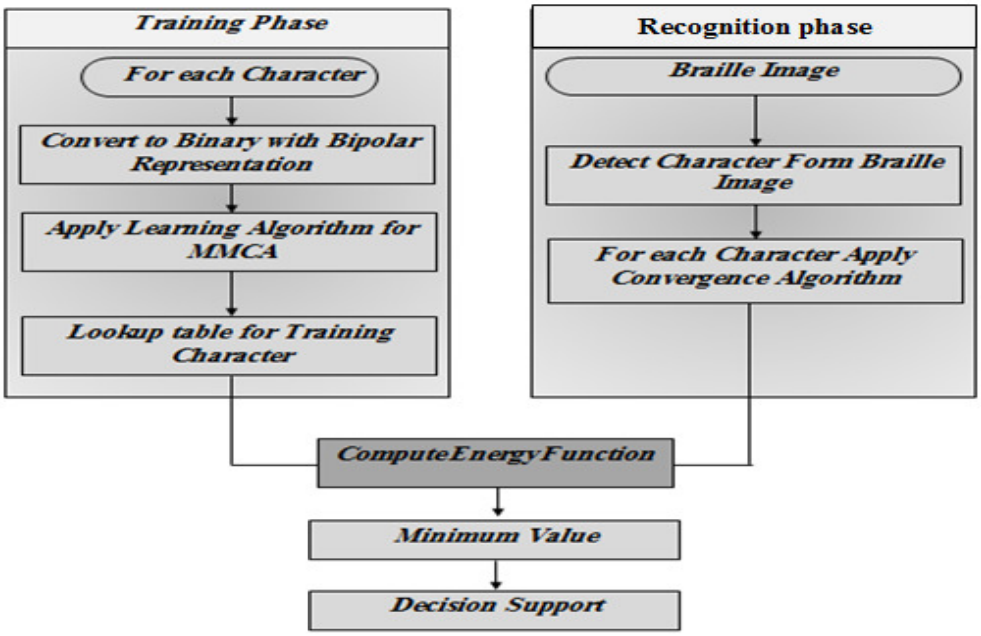


Figure 9: the training and recognition phase steps to implement of MMCA method.

V. RESULT

The implemented method has been tested with a variety of scanned Braille documents on single sided written using Standard English Braille.Thedataset is used in this research composed from 46 Braille documents. The average accuracy for correct letters was 98.26%, average accuracy for correct words was 95.11% and average processing time around 11 sec per page. The system is working for Grade 1 Braille English for purpose we have taken some of the documents printed in Braille for the translation by the system some of the translation of Braille to English text by using (MMCA) algorithm is shown in Figure 10.

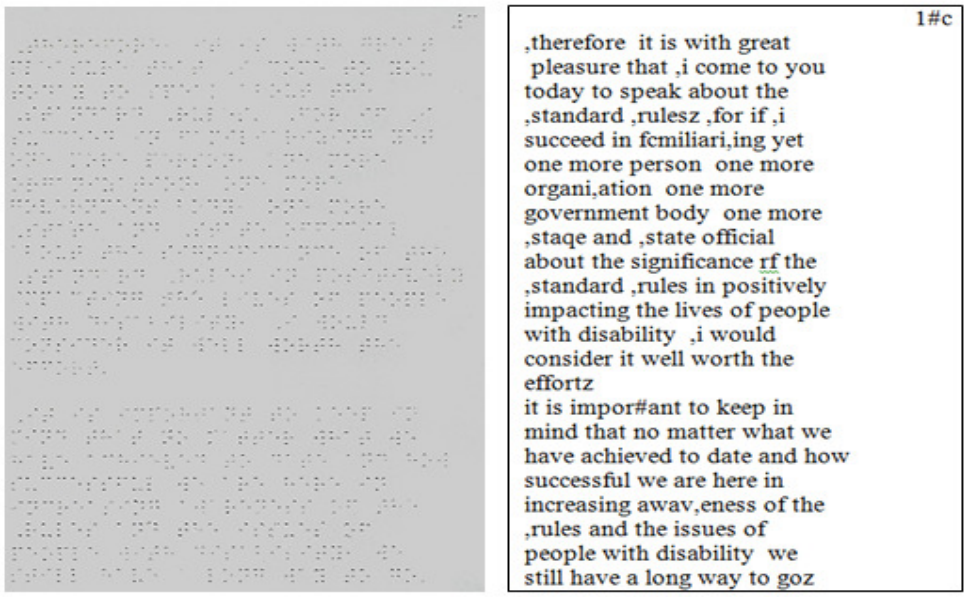


Figure10: translation of Braille to English text by using (MMCA).

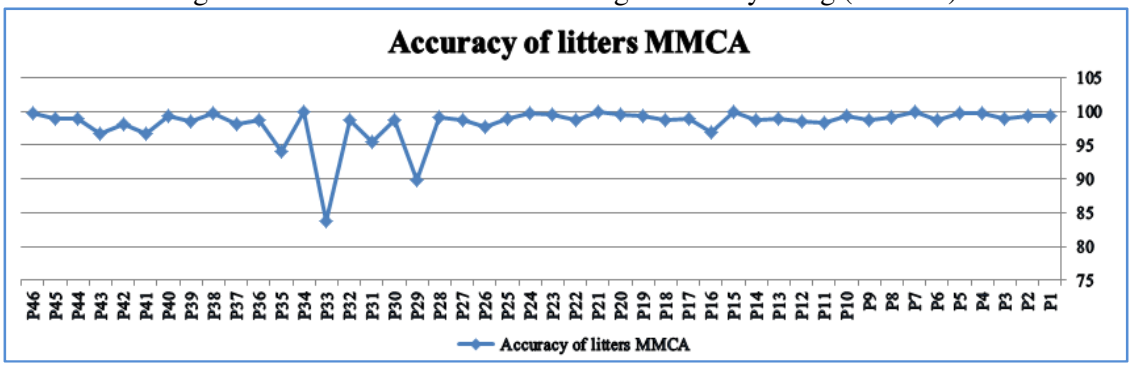


Figure 11: Accuracy of litters of each page .

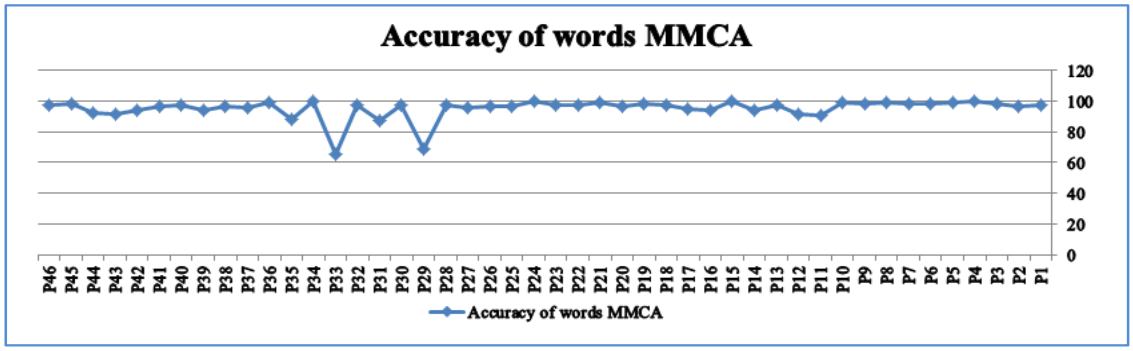


Figure 12: Accuracy of words of each page.

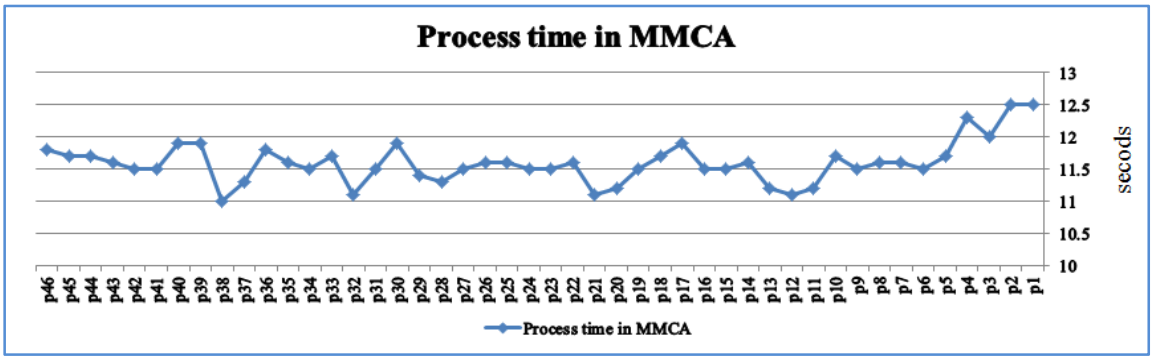


Figure 13: Process time of each page.

VII. CONCLUSION

Results Discussion and Analysis show that the proposed BCR average accuracy was 98.26%, for letter and 95.11% for word. This work focused on the development of an BCR for recognition single side English document via using a new technique (i.e. associative memory with modify multi-connect architecture) paving the way to the future works to develop more efficient BCR in speed and accuracy using associative memory (may be after modified it). This work includes two stages preprocessing stage and the recognition stage the output of the recognition stage is converted into an audio signal. The input forms used in the experiments were Braille sheets. The scanned copies are then used as input to the proposed BCR.

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