

Using Rotation Method for Removal of Misalignment of Scanned Braille Pattern

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Abstract— This paper presents a new algorithm to remove misalignment of scanned braille pattern using image processing. It is known that because of scanner imperfections, error occurs in scanned braille pattern document. In this paper indexing method has been used for fixing the corner pixel value of tilted braille pattern. The proposed work employs basic triangular property. Thereby we have calculated the angle by which the corner dots have been thrown out of alignment on a respective side. Since a variety of different braille patterns are available, some being regular and exactly symmetrical, sorting method is used for symmetrical and unsymmetrical braille pattern. This simulation has been carried out in MATLAB (R 2010a) and yields almost perfect results with acceptable errors and removes misalignment of braille pattern.

Keyword- Braille, Indexing, Median Filtering, Sorting, Image Processing.

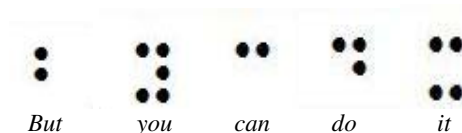
I. INTRODUCTION

The Braille system was developed by one of the blind student, named Louis Braille. He adopted and simplified the system of tactical dots and set the foundations of braille writing [1]. It can also be simply read by the naked eyes. Today, it is the best known writing convention for blind people, in which symbols are represented by arrangements of dots recognizable by touch. Braille is a code and can be used to express braille character in any language, Hindi or English [2]. The various Braille symbols (representing different alphabets) are formed within a predefined space called Braille cells. Braille cells can be considered as a rectangular matrix, of 3 rows and 2 columns [3X2]. Each column consists of 3 dots and every position of dot represents a specific braille symbol as shown below.



By placing the dots at various positions, different symbols can be obtained. A total of sixty-four (2^6) possible subsets can be obtained, including the arrangement in which no dot is there. A particular combination may be described by naming the positions where dots are raised, the positions being universally numbered 1 to 3 from top to bottom in the left column and 4 to 6 from top to bottom in the right column[3]. For example, dots 1-2-3 describe a cell with three raised dots, at the top, middle and bottom in the left column, this represents the letter *l* in English and corresponding binary vector is [111000]. A single cell pattern can be used to represent an alphabet, number, punctuation mark, or even a whole word. When one braille cell corresponds to 1 language character, it is referred to as Grade 1 braille. However in Grade 2 braille system, individual cell or a combination of cells forms a variety of contractions or whole words.

The sentence in grade 2, takes six cells space. This because the letters *b* and *y* are used to represent whole words, *but* and *you* respectively. The sentence *but you can do it* in grade 2 system, looks like this:



Braille system is of great importance for reading and writing for blind people. It can also be used for different other applications like transmitting data for military purposes. The most common problem faced by the blind people and various libraries are copying of braille documents. The braille document can be scanned at one end and at the other end the encoded documents could either be translated to ASCII or printed with a braille printer. Furthermore, By converting them to their electronic representation, braille documents can be made benefit from the progress made in the handling of

printed documents [3]-[7]. The rise in demand and the new inroads in technology have led to the development of E-Braille. Braille can be understood as a digital library in which various documents related to braille system can be kept and maintained. While scanning document, human made errors such as: Misalignment may occur. This results in deformation of various braille cells, altering the semantics of the Braille document and making it irrelevant. Our research proposes a simple and cost effective system for transmitting the data and minimizing the error, which occur during manual scanning of the braille document.

II. PROCEDURE OF PROPOSED WORK

Complete processing is done in two steps: *Basic steps (pre processing)* [2] and *Removal of misalignment*.

A. Pre-Processing steps::Basic steps

- I. Scanning of Braille pattern
- II. Conversion of RGB image to binary image
- III. Complementing the binary image
- IV. Removal of impulsive noise
- V. Resizing of binary image

1. Scanning of Braille pattern

Utmost care is taken while scanning braille pattern. It is insured that unwanted noise is not introduced at the time of scanning. Documented braille pattern is scanned as shown in fig B.1



Fig.B.1

The study has scanned both manually written braille as well as computer printed braille. Experimentation has seen that due to scanner imperfection scanned pattern is misaligned by 0-10 degree which are removed by required techniques, will be

discussed in coming section named -removal of misalignment using rotation processing.

2. Conversion of RGB image to binary image

RGB image is converted into binary image. RGB image has different pixel values and binary image has only two type of pixels, "0" (black) and "1" (white). As RGB image contains different pixel values, on dealing with different values, processing would become more complicated. Binary image requires far less memory space. To make processing easier RGB image is converted in binary form.

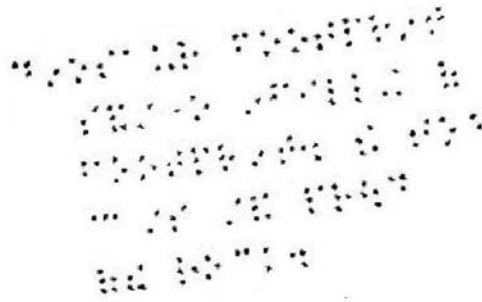


Fig.B.2

But as shown in figure these black dots are not that much clear in the sense of edges. In order to remove this problem binary image is complemented as discussed in the coming 4th subsection.

3. Removal of impulsive noise

In binary image some impulsive noise is present, unwanted dots might be considered as a part of character pattern. This impulsive noise some time called as salt and pepper noise is removed by median filtering.

4. Complementing the binary image

To get the clear edges, processed image is complemented as shown in figure B.3

Complementing the image implies that 'off pixel' are replaced by 'on pixel' and vice versa. By this method shape of dots becomes much clear. It is now easier to locate the corner dots which are (corner dots) used in further processing.

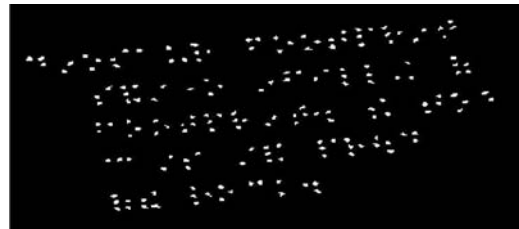


Fig.B.3

5. Resizing of binary image

Resizing is done in order to reduce memory storage requirement and the computation involved for further processing [2]. Outer part of misaligned braille pattern has no information so it is not required. To remove this redundant part proposed work employs 4 indices. The image matrix is scanned from top to bottom till the required portion containing the first white dot is reached. During scanning, all white pixels present in the first row are summed. If sum is less than the decided threshold, the next row is scanned in the same way till we encounter a row having a number of pixel values more than threshold. At this stage, scanning will stop and the location of index 1 is determined and stored in the memory. In the same way, the image is scanned from bottom to top to get index 2. The other two indexes, namely 3 and 4 are determined through column wise scanning from left to right and right to left respectively.

By this all unwanted part is removed as shown in figure B.4 Up to this method, pre-processing of braille pattern is done. In the section B removal of error in terms of angle (which is occurred during scanning of braille pattern) is explained in detail.



Fig.B.4

B. Removal of Misalignment of Braille Pattern using Rotation Processing-

- I. Indexing of misaligned scanned braille pattern.
- II. Calculation of angle with respect to respective side made by corner pixel values
- III. Sorting these four different angles and get the minimum angle.
- IV. Rotating the braille pattern using minimum sorted angle.
- V. Removal of unwanted edges of rotated image.

1. Indexing tilted Braille pattern:

During scanning of any braille pattern, there would be a fair chance that braille pattern has some error because of scanner imperfection. Proposed work has shown that because of scanner imperfection there would be around 0 degree to 10 degree error during scanning as shown in fig B.5

Proposed study is using indexing method. In this method first of all to fix upper right corner pixel we scanned the image from right to left starting from first row and then second, third and so on. So by this method upper right corner pixel value is known. Similarly other three remaining corner pixel would be fixed. As shown in Fig B.6 four arrows indicates four corner dots.

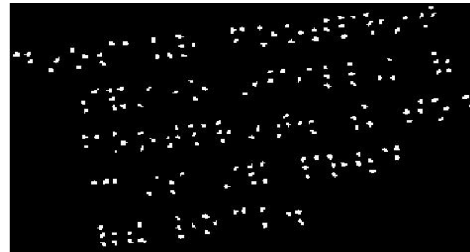


Fig.B.5

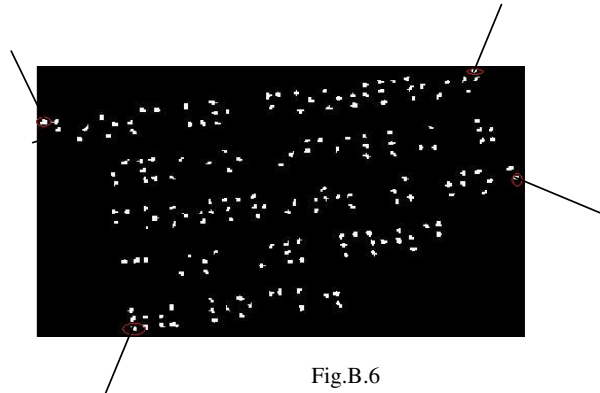
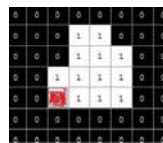
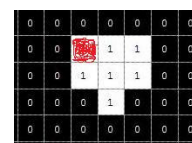


Fig.B.6

These four arrows are shown in fig B.6, shaded pixels value are scanned by indexing method as shown in fig B.7



Upper-left dot



Upper-right dot

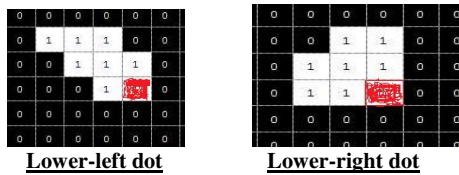


Fig.B.7

Using these four pixels value, proposed work employs calculation of angle in the next subsection using triangular property with respect to respective side as base and difference of columns as perpendicular.

1. Calculation of angle:

After getting values of four corner pixel values, we have calculated angle with respect to respective side made by 2 adjacent dots (pixels) as shown in fig B.8 Proposed model has taken base of the triangle as difference between the vertical distance and foot of perpendicular as difference between column values. Lets say col1 and row1 indicates **upper-right pixel** and col2, row2 indicates **lower-right pixel**, similarly col3 and row3 indicates **lower-left pixel** and col4, row4 indicates **upper-left pixel**.

Case-1: Braille pattern is anticlockwise misaligned

1. Angle θ_1 is calculated as: base value of shown triangle is row2-row1 and foot of perpendicular is col2-col1.
2. Angle θ_2 is calculated as: base value of shown triangle is row4-row1 and foot of perpendicular is col1-col4.
3. Angle θ_3 is calculated as: base value of shown triangle is row3-row4 and foot of perpendicular is col3-col4.
4. And similarly angle θ_4 is calculated as: base value is row3-row2 and foot of perpendicular is col2-col3.

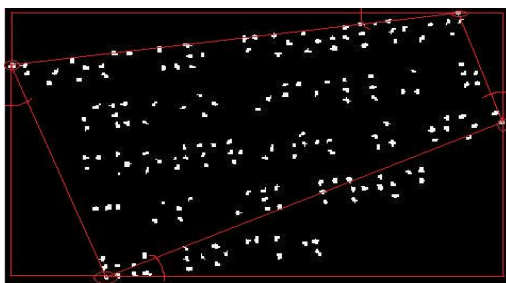


Fig.B.8

Case- 2: Braille pattern is clockwise misaligned

1. Angle θ_1 is written as (90 degree – calculated angle θ_1).
2. Angle θ_2 is written as (90 degree – calculated angle θ_2).
3. Angle θ_3 is written as (90 degree – calculated angle θ_3).
4. Angle θ_4 is written as (90 degree – calculated angle θ_4).

It is observed that among these angles the required angle by which image should be rotated would be that angle which gives aligned braille pattern.

From this work we have seen that there are two possible cases regarding Braille pattern:

1. Symmetrical Braille pattern (in the sense of complete rows/column)
 2. Unsymmetrical Braille pattern (in the sense of incomplete rows/column)
2. Sorting among angles:

This study has taken unsymmetrical braille pattern as well as symmetrical braille. The above fig B.8 is an example of unsymmetrical pattern. It is known that if braille pattern is symmetrical then all of the four angles calculated above will be same, i.e. anyone of them will give desired result.

But if braille pattern is unsymmetrical then the minimum angle amongst these four angles will lead to perfect result. This ‘minimum’ criterion is well checked and implemented on various scanned braille patterns.



Fig.B.9

In fig B.9 angle θ_2 would be the required angle. Apart from that angle θ_4 gives maximum value of angle among four angles. Values of angle θ_1 and angle θ_3 are less than angle θ_4 and more than angle θ_2 .

3. Rotating Braille pattern:

The study has proposed that minimum angle θ_2 gives almost perfect result. Rotating above braille pattern by angle θ_2 , misalignment of Braille pattern has been removed. Rotated image is shown in figure B.10

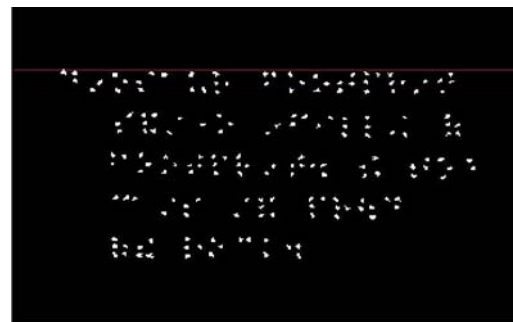


Fig.B.10

In figure B.10 horizontal red line shows almost ~ 0 degree alignment, hence experimentation yields required result.

As by seen the fig.B.10 rotated image has some unwanted part which does not contain any information. So in order to dot that resigning has to be done, which we have discussed in pre-processing section.

4. Removal of unwanted edges of rotated image/Resizing

To resize the braille image process used in 5th subsection of section I is repeated to remove unwanted edges of required image. Obtained image is shown as fig B.11

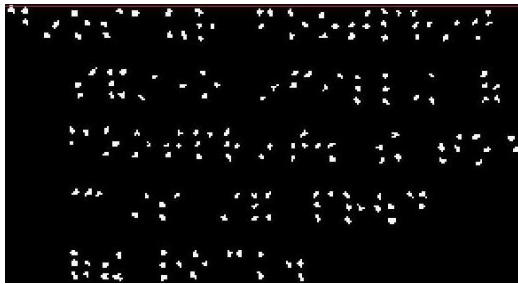


Fig B.11

Up to this step pre processing and removal of misalignment is done. By using these techniques a misaligned braille pattern (in terms of angle error) is rotated to make the pattern aligned.

III. LIMITATIONS

Proposed work is implemented for those braille patterns in which error in terms of angle ranges from ~ 3 degree to ~ 10 degree (approx). ~ 0 degree to ~ 3 degree is not very serious. It can be ignored because ~ 0 to ~ 3 degree would not change the braille pattern that much.

IV. CONCLUSION

The proposed work is fully tested on different braille patterns with variation of angle (as angle causes error), it gives almost perfect result. Using these techniques, error in terms of scanner imperfection is removed almost perfectly.

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