Fingerprint Matching using Ridge-End and Bifurcation Points

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ABSTRACT
The advent of Digital Fingerprint processing system motivates to review new concepts of fingerprint matching algorithm. One of the important, fingerprint matching is minutiae-based. Minutiae-based techniques are work on substructure pair. These substructure pairs are basically, ridge ending and bifurcation points. All the biometric techniques have received the most attention for person identification. This research paper establishes correspondence between two fingerprints based on ridge ending and bifurcation points. The fingerprint matching accomplished. The prototype of algorithm performs two operations: first, to calculate available points in image; and second, to find out location of those points. And the fingerprint matching is accomplished by comparing the point's data of two fingerprint impressions. The purpose of this research paper was to implement fingerprint recognition algorithm using minutiae matching with the help of an image processing with programming tool MATLAB.

General Terms
Fingerprint matching, Binarization, thinning, minutiae points detection.

Keywords
Ridges-ending minutiae points, bifurcation minutiae points.

1. INTRODUCTION
The word "Biometrics" comes from the Greek language and is derived from the words 'bio' means life and 'metric' means to be measure, so biometrics is a field of science and technology used to be measure life characteristics. Biometrics System uses physical (like fingerprint and retina) and behavioral (like voice and handwriting) parameters for person identification. Biometric data are unique for each individual person, even two identical twins. Basically we can use physical parameters than behavioral because behavioral parameters are changed with age and environment whereas physical parameters never changed during whole life. Fingerprint matching techniques are divided into three main types:

- Correlation based matching,
- Minutiae based matching, and
- Pattern based matching.

Minutiae based matching is the most popular and most widely used technique for fingerprint matching. This technique refers the analysis of some unique point's exhibit on fingerprint called minutiae points. The detection and representation of these points are also known as minutiae set. There are two basic minutiae points are majorly used for matching in minutiae based technique, that is Ridge-end, which means the end of the ridges and Bifurcation points, which means one single ridge divided into two ridges [1].

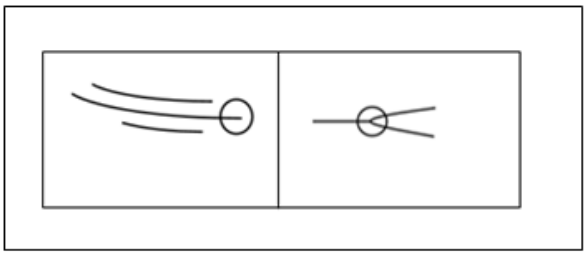

Figure 1: (a) Ridges-end point (b) Bifurcation point

2. Fingerprint Recognition
Fingerprint recognition system can be used to analyze two fingerprint images one is original image and another one is template image stored in the database. Fingerprint recognition is mainly divided in two sub-parts: one is verification system and other is identification system. Fingerprint verification is used to verify the authenticity of one person with one to one matching of the database, while fingerprint identification is used to specify the person identification with one to n matching, fingerprint verification is rapid execution method than fingerprint identification. Fingerprint identification is especially serviceable for criminal investigation cases [2].

MATLAB software provides the best image processing toolbox. Digital fingerprint images can analyze easily using MATLAB. In this paper we present the result of implementation of algorithm on MATLAB.

The complete algorithm is as follows:

Input: Introduce fingerprint Image.

Output: Matching score or total number of both ridges-end and bifurcation points.

Step1: Acquisition of fingerprint image.

Step2: Convert image into binary form.

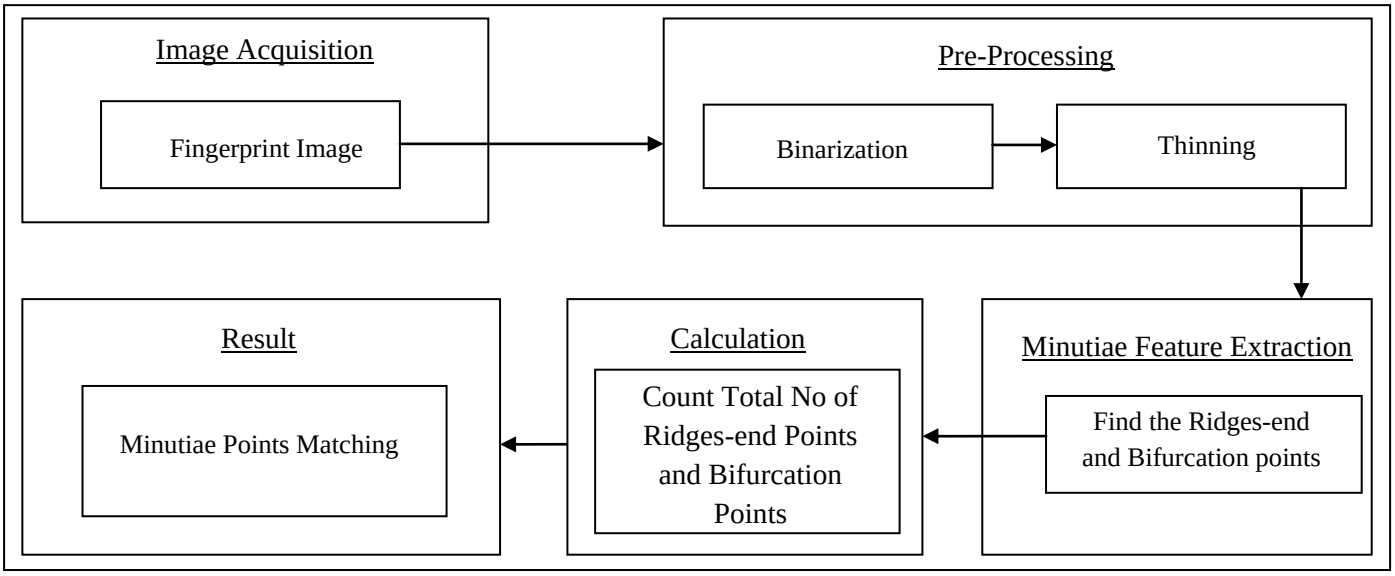

Figure 2: Block Diagram of Algorithm

Step3: Apply thinning process on the binary image.

Step4: Find total numbers of ridges-end points and bifurcation points.

Step5: Match both minutiae points for fingerprint verification; if total numbers of minutiae points of two fingerprint images are same, it is prove that both fingerprint are same or matched else both fingerprint images are not same and related to two distinguish peoples.

3. Pre-Processing

3.1 Binarization

Binarization is the process of alter a gray scale image to a black and white image (or binary image). In MATLAB, a value of one represents that the pixel is white and value of zero represents that the pixel is black. This modification of gray scale image to binary image is executed by using threshold process to the image. When a threshold process is applied to an image, each pixel values are analyzed to the input threshold. Those pixel values which are smaller than the threshold value is place to zero and those pixel value which are greater than the threshold value is place to one. At the end of this process each pixel values within the image are either zero or one, and the image has been modifying to binary form. After this conversion the ridges in the fingerprint are highlighted with black color while valleys are highlighted with white color. Binarization can be done in MATLAB using inbuilt function "im2bw". Example, b=im2bw ('Input Image'); [3]

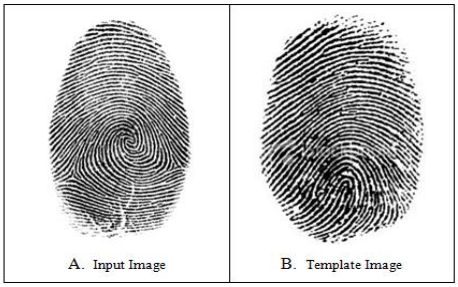

Figure 3: Fingerprint Images

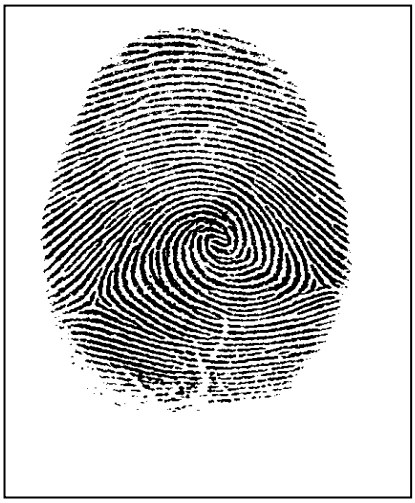

Figure 4: Input Image after binarization

3.2 Thinning

After binarization, next leading pre-processing technique used for matching process is thinning. Image thinning is the process of decrease the thickness of all ridges lines into single pixel width. Thinning process does not convert the original x, y location and angle of direction of the minutiae points of the image, which assure the true calculation of minutiae points. It is also known as Block Filtering. Ridges thinning are used to destruct the extra pixel of ridges till the ridges are just one pixel broad [3].This is done using MATLAB's inbuilt morphological thinning function named as "bwmorph". Example, bwmorph ("Binary image",'thin', Inf); Bwmorph shows morphological operations on binary image.

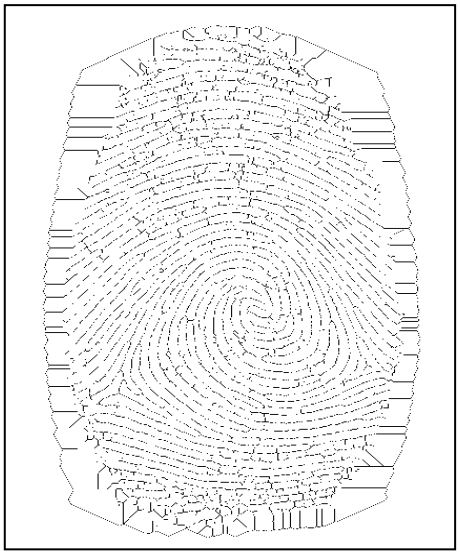

Figure 5: Input image after thinning

4. Minutiae Point Detection

Preprocessing steps are crucial for further minutiae extraction. The Minutiae Extraction is done by:

4.1 Points Searching

The proposed algorithm detects the Minutiae Points on the basis of:

(a) Ridges are disconnected at arbitrary point: Ridge-end Point.
(b) Ridges are associated with bifurcations: Bifurcation Point.

4.2 Substructure Creation

The classification of ridge-end or bifurcation points is done in MATLAB by creating matrix. If the central pixel is one, has only one neighbor pixel that is ridge-end point. Whereas, if the central pixel is one, has two neighbor pixel that is bifurcation point.

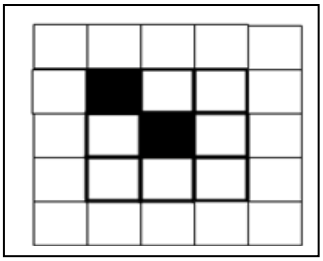

Figure 6: Ridges-end minutiae point

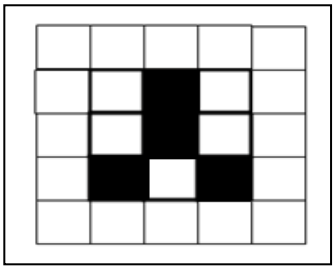

Figure 7: Bifurcation minutiae points

5. Minutiae Matching

5.1 Image Acquisition

Iimage.jpg = Input Image acquisition from reader.

Timage.jpg = Template Image retrieve from database.

5.2 Computation of Points

This step is a very important part of fingerprint matching. After the detection of minutiae points, matching algorithm require to calculate total number of available points in the fingerprint image separately. To perform this computation two counter variables are used to count both ridge-end and bifurcation points.

Table 1 Minutiae Point Calculation

Sr. No	Images	Ridges Points	Bifurcation Points
1.	Iimage.jpg	545	2858
2.	Timage.jpg	161	860

5.3 Location Detection of Points

Each minutiae point in the fingerprint image has a specific location. This location information of particular point is significant to store for further matching of fingerprints. The location of every point in the digital image is given by pixel position, so that it can be taken and stored separately for both ridge-end and bifurcation points.

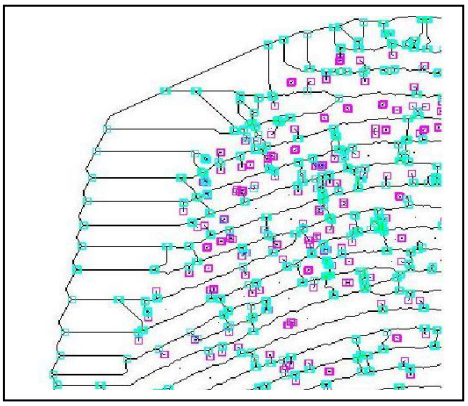

Figure 8: Minutiae point extracted in input image

5.4 Amount and Location Matching

In the previous steps, all the required information about points is computed and stored. Now, this is the matching step, here the algorithm compares the computed values with the stored values. This algorithm first, compares the combination of both amounts of ridge-end and bifurcation points with stored data. If the match occurs, the algorithm then compares the location of ridge points with stored location data. And finally, if all the location matches, the message will be displayed on the screen as ‘Fingerprint does match..!’ instead the message will be displayed as ‘Fingerprint does not match..!’

6. Conclusion

Image pre-processing is the most evaluative step for accurate minutiae detection and fingerprint matching. Accurate estimation of overall steps of the algorithm is very important for reliable result. In this research paper, minutiae based fingerprint matching technique is studied in detail and implemented in MATLAB. This research paper shows analyzer can recognize the fingerprint image by minutiae point calculation as well as location evaluation of minutiae points.

7. REFERENCES

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