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A New False Minutia Removal Based Fingerprint Identification Technique

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Abstract: Fingerprints marks are the most extensively used biometric feature for Human identification and verification in the field of biometrics till today. There are two main types of features that are used for fingerprint identification that are ridge and furrow pattern. The location and orientation of each minutiae is unique which is acquired and used for further references. This paper presents the implementation and defining of a minutiae based approach to identify fingerprints and serves as a review of the different steps involved in the development of minutiae based Automatic Fingerprint Identification System (AFIS). The technique described in this paper is based on a new case of removal of the false minutia extracted from the fingerprint image which is binarized and thinned as a part of pre-processing.

Keywords: Fingerprint, Enhancement, Fake Minutia, Minutiae Extraction, Minutiae Matching

I. INTRODUCTION

With the advancement of time, information communication technology has developed the need for secure personal authentication methods. Earlier, ID cards and username passwords were widely used and were most popular in personal authentication techniques. However, these methods have several drawbacks which makes it outdated now. The major disadvantage is that the HID cards could be stolen or forged, and in the case of passwords, they could become known to others by trial and error or other methods[2].

Fingerprints have been in use for biometric recognition since long because of their high acceptability, immutability and individuality. Immutability refers to the persistence of the fingerprints over time whereas individuality is related to the uniqueness of ridge details across individuals. Fingerprint authentication is one of the most important biometric technologies [4]. A fingerprint is the pattern of ridges and valleys (furrows) on the surface of the finger.

This paper focuses on fingerprints, which can provide personal authentication at high accuracies and low cost in a small-scale project. Firstly, Fingerprint image is obtained from sensor. And this image is enhanced because enhancement algorithm can improve the clarity of the ridge structures of input fingerprint images, then the enhancement image is binarized by fixing the threshold value. The binarization image is thinned using morphological operations. Then the output image is segmented for minutiae extraction. After minutiae extraction, false minutiae are removed by using Euclidean distance. After preprocessing, the existing data collection and template data collection are matched by using two steps (registration and verification).

II. RELATED WORKS

Robert Hastings, et at., [7] proposed a method for fingerprint verification which includes both minutiae and model based orientation field is used. It gives robust discriminatory information other than minutiae points. Fingerprint matching is done by combining the decisions of the matchers based on the orientation field and minutiae.

Manvjeet Kaur et al., [5] have introduced combined methods to build a minutia extractor and a minutia matcher. Segmentation with Morphological operations used to improve thinning, false minutiae removal, minutia marking. Mehnaz Tabassum et al., [12] proposed an effective and efficient algorithm for minutiae extraction to improve the overall performance of an automatic fingerprint identification system because it is very important to preserve true minutiae while removing spurious minutiae in post-processing[9].

The matching stage computes the Euclidean distance between the template finger code and the input finger code. The method gives good matching with high accuracy.

III. DESIGN OF THE TECHNIQUE

A. Steps of the Fingerprint Recoginition System

1. Fingerprint Acquisition
2. Enhancement
3. Binarization
4. Thinning
5. Segmentation
6. Minutiae Extraction
7. False Minutia Removal
8. Minutiae Matching
9. Application
10. Results

B. Complete Working Diagram of Fingerprint Recoginition System

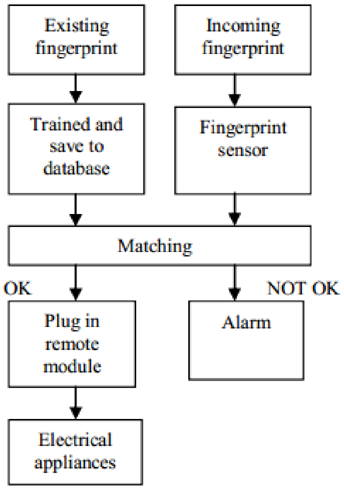

Fig. 1. Complete Working Diagram of Fingerprint Recognition System

IV. FINGERPRINT IMAGE PROCESSING

Following are the various steps during image preprocessing stage.

A. Acquisition

A MATLAB method is utilized to call the procedure to load the fingerprint from the desired images from the database [3]. The images are required for the further pre-processing steps of the fingerprint image minutiae extraction.

B. Binarization

Binarization is to convert gray scale image into binary image by fixing the threshold value. The pixel values above and below the threshold are set to 1 and 0 respectively [14]. Binarized image can be seen in Figure below.

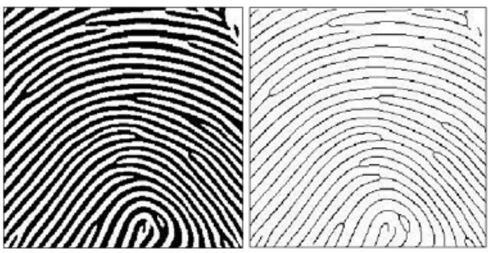

Fig. 2 Binarized Image (Left) and Thinned Image (Right)

C. Thinning

The binarized image is thinned to reduce the thickness of all ridge lines to a single pixel width no discontinuities [13]. Each ridge should be thinned to its centre pixel. Noise and singular points should be eliminated. No further removal of pixels should be possible after completion of thinning process[15].

D. Minutiae Exraction

Minutiae extraction is just a trivial task of extracting singular points in a thinned ridge map. The performance of currently available minutiae extraction algorithms depends heavily on the quality of input fingerprint images[8][10]. The minutiae location and the minutiae angles are derived after minutiae extraction. The terminations which lie at the outer boundaries are not considered as minutiae points, and Crossing Number is used to locate the minutiae points in fingerprint image Rutovitz's definition of crossing number for a pixel 'P' is defined as half the sum of the differences between pairs of adjacent pixels defining the 8-neighborhood of 'P'[1].

Mathematically,

$$C_n = \frac{1}{2}\sum_{i=1}^{8} |val(P_{i\,mod\,8}) - val(P_{i-1})|$$

Where P0 to P7 are the pixels belonging to an ordered sequence of pixels defining the 8-neighborhood of P and Val (P) is the pixel value[6].

E. False Minutia Removal

The preprocessing stage does not totally heal the fingerprint image. For example, false ridge breaks due to insufficient amount of ink and ridge cross-connections due to over inking are not totally eliminated [9] [11].

For this, the Predefined cases m1 to m7 are implemented along with new Broken Bifurcation Case.

Algorithm for Broken Bifurcation Case:

Step 1. Select the minutia points with selection window.
Step 2. Mark the ridge end points as RE1 and RE2
Step 3. Mark the bifurcation point BF1, BF2 and BF3
Step 4. Measure the inter-distance between (RE1, BF1) (RE1, BF2) (RE1, BF3)
Step 5. Measure the inter-distance between (RE2, BF1) (RE2, BF2) (RE2, BF3)
Step 6. Find the coordinates of nearest pair i.e. (RE1, BF1) to calculate the distance d.
Step 7. If d<D then remove RE1 and BF1 and increment false minutia count.
Step 8. Exit
Where D is the average inter-ridge width representing the average distance between two parallel neighboring ridges.

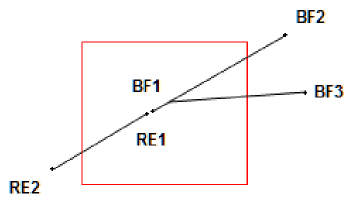

Fig. 3 Broken Bifurcation case (Proposed Case)

V. RESULTS

After the implementation of the new case the results are having improved results. A significant number of bifurcations and ridge ends gets detected even after the implementation of previous cases. The new case works after the detection of minutiae from the available fingerprint image. The combination of multiple methods comes from a wide investigation into the work.

Also Fingerprint Binarization, Fingerprint Thinning and Ridge End marking and finding the bifurcation help to preprocess the fingerprint templates for better results. Categorization and Classification of real versus spurious minutia has proved to be the efficient identification feature.

A program coded in MATLAB demonstrates all the fake minutia removal cases and the new case Broken Bifurcation too. Code is helpful in understanding the procedures of fingerprint feature extraction steps.

Overall, a new case Broken Bifurcation of spurious minutia identification is implemented. These techniques can then be used to facilitate the further study of the statistics of fingerprint.

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