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Advanced Filter and Minutia Matching For Fingerprint Recognition

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Abstract: ***The Biometric used for authentication process of a person is Fingerprint which is more securable and unique for a person's to authenticate. A minutia matching is broadly used for fingerprint recognition and can be classified as ridge bifurcation and ridge ending. In this paper I projected Fingerprint Recognition using Minutia Matching Technique (FRMM). For Fingerprint thinning, the Thinning Filter is used to reduce the thickness from the binarized image, which scans the image at the boundary to preserves the quality of the image and extract the minutiae from the converted thinned image. The false matching ratio is better correlated to the existing algorithm.***

Keywords: Advanced Filter, preprocessing, minutia, fingerprint, FRMM.

1. Introduction

Biometric authentication systems can operate on behavioral and physiological biometric data to identify a person. The behavioral biometric parameters are human gait, signature, speech and keystroke, this kind of parameters can change depends with age and environment. However physiological characteristics such as fingerprint, face, palm print and iris remains are unchanged throughout the end of life for a human. The biometric system operates as verification mode or identification mode depending on the requirement of an application. The verification mode validates a person's identity by comparing captured biometric data with already saved template in database. The identification mode recognizes a person's identity by performing matches against multiple fingerprint biometric templates. Fingerprints are widely used in daily life for more than 100 years due to its feasibility, distinctiveness, permanence, accuracy, reliability, and acceptability. Each and every fingerprint including all the fingers are unique, even identical twins have different fingerprints. Fingerprint is a pattern of ridges, furrows and minutiae, which are extracted using inked impression on a paper or sensors. A good quality fingerprint contains 25 to 80 minutiae depending on sensor resolution and finger placement on the sensor. The false minutiae are the false ridge breaks due to insufficient amount of ink and cross-connections due to over inking. It is difficult to extract reliably minutia from poor quality fingerprint impressions arising from very dry fingers and fingers mutilated by scars, scratches due to accidents, injuries. Minutia based fingerprint recognition consists of Thinning, Minutiae extraction, Minutiae matching and Computing matching score.

2. Motivation

The motivation behind the work is growing need to identify a person for security. This is one of the popular biometric methods used to identify and authenticate human being. The proposed fingerprint verification FRMM provides reliable and better efficiency and performance than the existing technique.

3. Contribution

In this paper I used Fingerprint Recognition using Minutia Matching Technique with the help of MATLAB codes. Minutiae are extracted from the thinned image for both template image and input image while the authentication process. Finally both the images are subjected to matching process and matching score is computed.

4. Related Research

L. Lam et al., [1] presented a method, thinning is the process of reducing thickness of each line of patterns to just a single pixel width. The requirements of a good algorithm with respect to a fingerprint are i) the thinned fingerprint image obtained should be of single pixel width with no discontinuities ii) Each ridge should be thinned to its central pixel iii) Noise and singular pixels should be eliminated iv) no further removal of pixels should be possible after completion of thinning process.

Ballan M [2] introduced Directional Fingerprint Processing using fingerprint smoothing, classification and identification based on the singular points (delta and core points) obtained from the directional histograms of a fingerprint. Fingerprints are classified into two main categories that are called Lasso and Wirbel. The process includes directional image formation, directional image block representation, singular point detection and decision. The method gives matching decision vectors with minimum errors, and method is simple and fast.

Haiping Lu et al., [3] 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. The proposed novel fingerprint image post-processing algorithm makes an efforts to reliably differentiate spurious minutiae from true ones by making use of ridge number information, referring to original gray-level image, designing and arranging various processing techniques properly, and also selecting various processing parameters carefully. The proposed post-processing algorithm is effective and efficient.

Prabhakar S, Jain. A.K. et al., [4] has developed filter-based representation technique for fingerprint identification. The technique exploits both local and global characteristics in a fingerprint to make identification. Each fingerprint image is filtered in a number of directions and a 640-dimensinal feature vector is extracted in the central region of the fingerprint. The feature vector is compact and requires only 640 bytes. The matching stage computes the Euclidian distance between the template finger code and the input finger code. The method gives good matching with high accuracy.

Mohamed et al., [5] presented fingerprint classification system using Fuzzy Neural Network. The fingerprint features such as singular points, positions and direction of core and delta obtained from a binarized fingerprint image. The method is producing good classification results.

Jinwei Gu, et al., [6] 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.

V. Vijaya Kumari and N. Suriyanarayanan [7] proposed a method for performance measure of local operators in fingerprint by detecting the edges of fingerprint images using five local operators namely Sobel, Roberts, Prewitt, Canny and LoG. The edge detected image is further segmented to extract individual segments from the image.

Raju Sonavane, and B.S. Sawant [8] presented a method by introducing a special domain fingerprint enhancement method which decomposes the fingerprint image into a set of filtered images then orientation field is estimated. A quality mask distinguishes the recoverable and unrecoverable corrupted regions in the input image are generated. Using the estimated orientation field, the input fingerprint image is adaptively enhanced in the recoverable regions.

Robert Hastings [9] developed a method for enhancing the ridge pattern by using a process of oriented diffusion by adaptation of anisotropic diffusion to smooth the image in the direction parallel to the ridge flow. The image intensity varies smoothly as one traverse along the ridges or valleys by removing most of the small irregularities and breaks but with the identity of the individual ridges and valleys preserved.

M. R. Girgisa et al., [10] proposed a method to describe a fingerprint matching based on lines extraction and graph matching principles by adopting a hybrid scheme which consists of a genetic algorithm phase and a local search phase. Experimental results demonstrate the robustness of algorithm.

Ching-Tang Hsieh and Chia-Shing – Hu [11] has developed anoid method for Fingerprint recognition. Ridge bifurcations are used as minutiae and ridge bifurcation algorithm with excluding the noise–like points are proposed. Experimental results show the humanoid fingerprint recognition is robust, reliable and rapid.

Lie Wei [12] proposed a method for rapid singularities searching algorithm which uses delta field Poincare index and a rapid classification algorithm to classify the fingerprint in to 5 classes. The detection algorithm searches the direction field which has the larger direction changes to get the singularities. Singularities detection is used to increase the accuracy.

Hartwig Fronthaler, et al., [13] Proposed fingerprint enhancement to improve the matching performance and computational efficiency by using an image scale pyramid and directional filtering in the spatial domain.

Mana Tarjoman and Shaghayegh Zarei [14] introduced structural approach to fingerprint classifications by using the directional image of fingerprint instead of singularities. Directional image includes dominant direction of ridge lines.

Luping Ji, and Zhang Yi [15] proposed a method for estimating four direction orientation field by considering four steps, i) preprocessing fingerprint image, ii) determining the primary ridge of fingerprint block using neuron pulse coupled neural network, iii) estimating block direction by projective distance variance of a ridge, instead of a full block, iv) correcting the estimated orientation field.

G. Sambasiva Rao et al., [16] proposed fingerprint identification technique using a gray level watershed method to find out the ridges present on a fingerprint image by directly scanned fingerprints or inked impression.

Eric P. Kukula, et al., [17] purposed a method to investigate the effect of five different force levels on fingerprint matching performance, image quality scores, and minutiae count between optical and capacitance fingerprint sensors. Three images were collected from the right index fingers of 75 participants for each sensing technology. Descriptive statistics, analysis of variance, and Kruskal-Wallis nonparametric tests were conducted to assess significant differences in minutiae counts and image quality scores based on the force level. The results reveal a significant difference in image quality score based on the force level and each sensor technology, yet there is no significant difference in minutiae count based on the force levels of the capacitance sensor. The image quality score, shown to be effected by force and sensor type, is one of many factors that influence the system matching performance, yet the removal of low quality images does not improve the system performance at each force level.

Alessandra Lumini, and Loris Nanni [18] developed a method for minutiae based fingerprint and its approach to the problem as two - class pattern recognition. The obtained feature vector by minutiae matching is classified into genuine or imposter by Support Vector Machine resulting remarkable performance improvement.

Xifeng Tong et al., [19] proposed a method to overcome non linear distortion using Local Relative Error Descriptor (LRLED).The algorithm consists of three steps i) a pair wise alignment method to achieve fingerprint alignment ii) a matched minutiae pair set is obtained with a threshold to reduce non-matches finally iii) the LRLED – based similarity measure. LRLED is good at distinguishing between corresponding and non corresponding minutiae-pairs and works well for fingerprint minutiae matching.

Bhupesh Gour et al., [20] have developed a method for extraction of minutiae from fingerprint images using midpoint ridge contour representation. The first step is segmentation to separate foreground from background of fingerprint image. A 64 x 64 region is extracted from fingerprint image. The grayscale intensities in 64 x 64 regions are normalized to a constant mean and variance to remove the effects of sensor noise and grayscale variations due to finger pressure differences. After the normalization the contrast of the ridges are enhanced by filtering 64 x 64 normalized windows by appropriately tuned Gabor filter. Processed fingerprint image is then scanned from top to bottom and left to right and transitions from white (background) to black (foreground) are detected. The length vector is calculated in all the eight directions of contour. Each contour element represents a pixel on the contour, contains fields for the x, y coordinates of the pixel. The proposed method takes less and do not detect any false minutiae.

Sharath Pankanti et al., [21] proposed Scale Invariant Feature Transformation (SIFT) to represent and match the fingerprint. By extracting characteristic SIFT feature points in scale space and perform matching based on the texture information around the feature points. The combination of SIFT and conventional minutiae based system achieves significantly better performance than either of the individual schemes.

Manvjeet Kaur et al., [22] 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.

5. Proposed Method

Figure 1 gives the block diagram for Schematic Structure of FRMM which is used to match the test fingerprint minutia score with the template minutia score of fingerprint image which are saved in the database using Minutia Matching Technique. Fingerprint Image: The input of scanned fingerprint image is the gray scale image of a person, which has values of intensity ranging from 0 to 255. In an image, the ridges seem as thick lines while the valleys are the light areas between the each ridge. Here using of pre-processing unit can achieve three important processes which is binarization, filter and thinning are used to calculate the matching score from the captured input of fingerprint image, and save to the database as readymade template for future verification. Minutiae points are the locations where a ridge are becomes discontinuous one. A ridge can either come to an end, which is called as termination or it can split into two ridges, which is called as bifurcation. The two types of minutiae technique is terminations and bifurcations are of more important for further processes compared to other features of a fingerprint image. The Schematic Structure of FRMM is shown in Figure1.

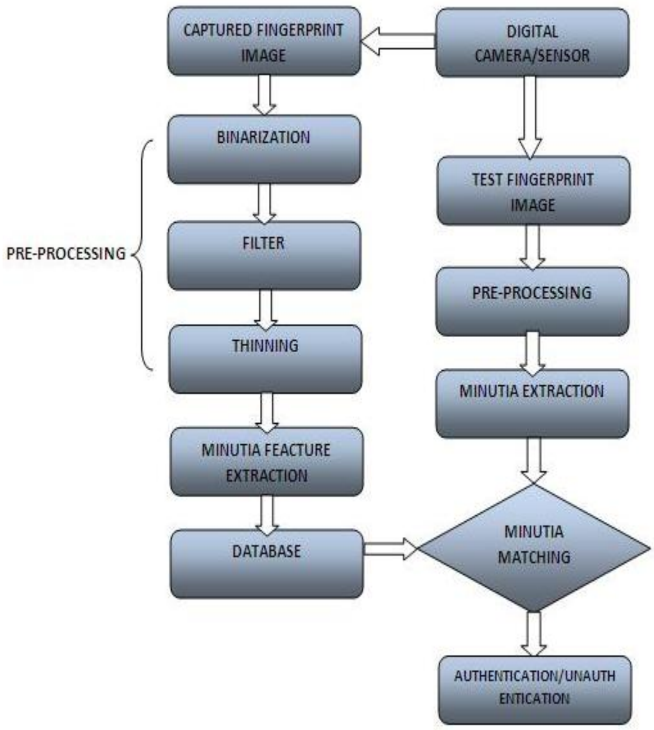

Figure 1: Schematic Structure of FRMM.

3.1 Binarization

The pre-processing of FRMM uses Binarization to convert gray scale image into binary image by fixing the threshold range. The pixel ranges above and below the threshold are set to ‘0’ and ‘1’ appropriately. An original input image and the image after Binarization process are shown in the Figure 2.

Figure 2: (a) Original Fingerprint (b) Binarized image.

After this process we can get bright and dark result, for easiest way of removing the noise and unwanted thinks from the input data. Binarized image are very clear for the further process.

3.2 Thinning Filter

The binarized image is thinned using Advance Thinning Filter to reduce the thickness of all ridge lines to a single pixel width to extract minutiae points effectively. Through this can get better and accurate thinned fingerprint image. Thinning does not change the location and orientation of minutiae points compared to original fingerprint which ensures accurate estimation of minutiae points. Here all noise is eliminated and now the image is ready for assigning a score. Thinning process preserves beyond the pixels by placing white pixels at the boundary of the minutia image, as a result of first five and last five rows, first five and last five columns are allocate a value of one. Expansion and erosion are used to thin the ridges. A thinning image of fingerprint is from the binarized fingerprint image shown in Figure 3.

Figure 3: (a) Binarized (b) after thinning

3.3 Minutia Extraction

The fingerprint minutiae location and the angles are derived after minutiae extraction process. The discontinuations which lie at the outer boundaries are not considered as minutiae score points, and crossing values is used to locate the minutiae points in fingerprint image. Crossing Value is defined as half of the sum of differences between intensity values of two adjacent pixels. If crossing value is 1, 2 and 3 or greater than 3 then minutiae points are classified as discontinuation, Normal ridge and Bifurcation respectively, is shown in figure 4.

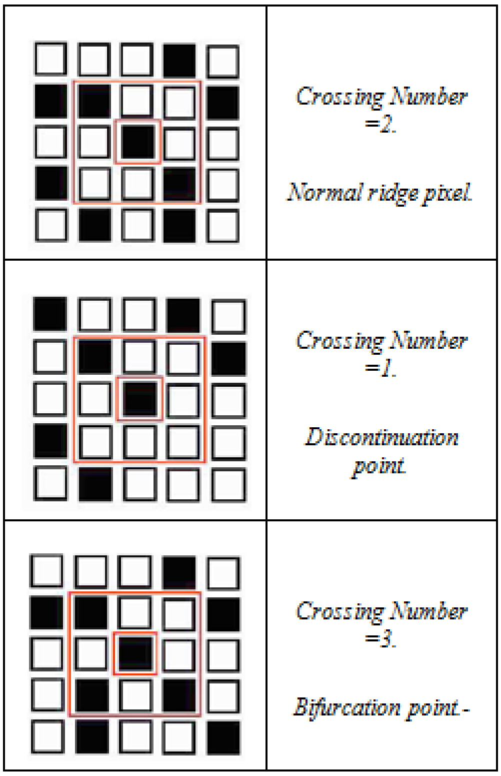

Figure 4: Crossing Number and Type of Minutiae.

To calculate the bifurcation angle, we use the advantage of the fact that termination and bifurcation are dual in nature. The termination in an image corresponds to the bifurcation in its negative image from now by applying the same set of rules to the negative fingerprint image, we get the bifurcation angles. Figure 5 shows the original image and the extracted minutiae points. Square shape shows the position of termination and diamond shape shows the position of bifurcation as in figure 5 (b).

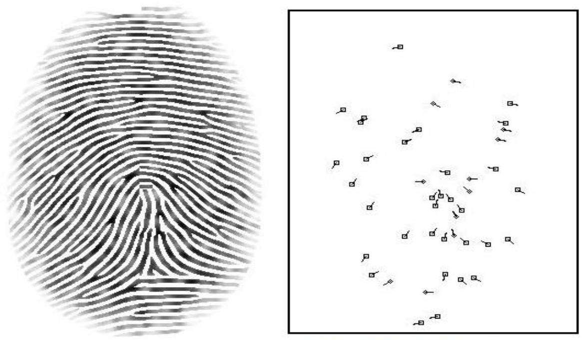

Figure 5: (a) Gray-scale Fingerprint (b) Minutiae points.

3.4 Minutia Matching

Minutia matching is final process of authentication module. Here the input fingerprint image was binarized , filtered, and minutia extracted. Then the image is ready to match with the already saved template image in database weather same or not. This is the most important and final process. The Figure 6 shown below.

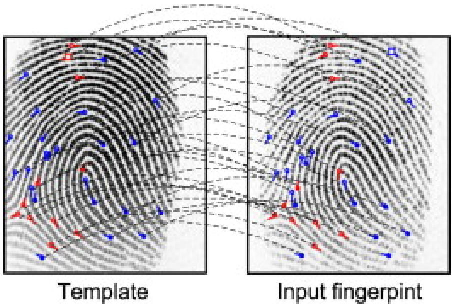

Figure 6: Matching process of Minutia.

6. Algorithm

Problem overview: Given the test Fingerprint Image the intention is,

1. Pre-processing the test Fingerprint image.
2. Extract the minutiae points and set score.
3. Matching test Fingerprint with the database.

Here table1 provide the algorithm of FRMM for fingerprint verification process, in which input test fingerprint image is compared with saved template fingerprint image in database, for recognition.

Table 1: Algorithm of FRMM

Input: Convert the Gray-scale from input Fingerprint image.
Output: Verified fingerprint image with matching.

- Fingerprint is binarized.
- Thinning on binarized image.
- Minutiae points are extracted. Based on position and Orientation.
- Matching of test fingerprint with Database.
- Finally the Matching score of both images is computed, if the matching score is 1, images are matched and if it is 0 then image are mismatched.

7. Performance Analysis and Results

In this part the performance analysis, we considered some example fingerprint database images which having different patterns and positions .such as fingerprint whorl, arch, left loop and right loop, as shown in the Figure 7.

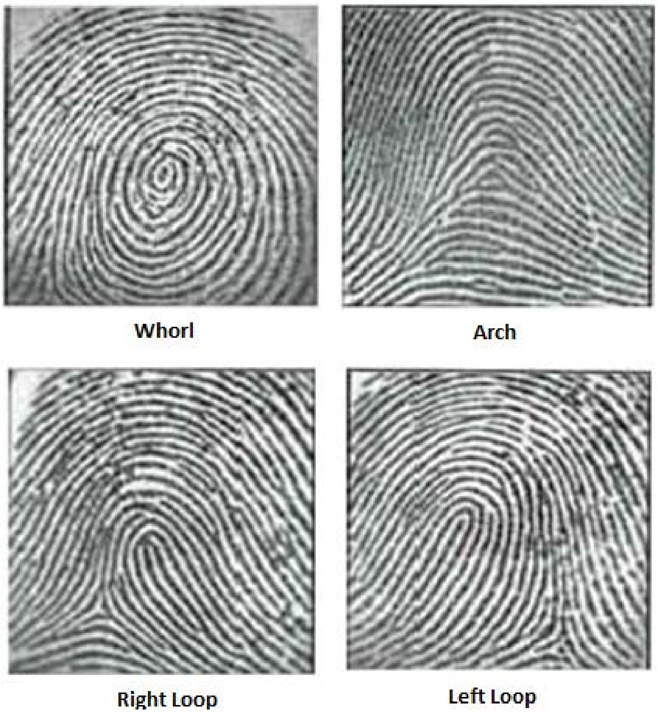

Figure 7: Different types of fingerprint images.

	FRFNN	*FRMM*
FNMR	0.00	0.00
FMR	0.23	0.26

Table 2: Comparisons of False matching Ratio

Table 2 provides the better analogizing of FNMR and FMR that is False Non Matching Ratio and False Matching Ratios for existing method of Fingerprint Recognition Fuzzy Neural Network (FRFNN) and proposed method of Fingerprint Recognition using Minutia Matching Technique (FRMM). It is contemplated that the False Non Matching Ratio for both the methods is zero and False Matching Ratio for existing method is 0.23 so considering for the proposed method FRMM is 0.026.

8. Conclusion

In this paper, I presented Fingerprint matching using FRMM. The pre-processing the original fingerprint involves image binarization, ridge thinning, and displace the noise. Fingerprint Recognition using Minutia Matching Technique is used for matching the minutia score points. The proposed method FRMM gives better False Matching Ratios (FMR) values in comparison to the existing method.

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