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Fingerprint Recognition System

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Abstract—Fingerprint Identification System (FIS) is very commonly used in the bio-identification applications. This Project finds out the current techniques for fingerprint recognition. The performance depends upon the quality of images. Fingerprint verification is used for the purpose of criminal investigations, terrorist identification and security issues. This system consists of many stages like image preprocessing, feature extraction and feature match. For each stage, some methods are used. The program is coded by using the MATLAB. For this system some methods at coding and algorithm level, used to improve the performance of the recognition system. Fingerprint recognition system based on minutia based matching which is used in various fingerprint algorithms and techniques. The approach of this project involves how the minutia points are removed from the fingerprint images and after that perform the fingerprint matching between two fingerprint images. The significance of this work is to monitor the matching and similarity for two or more fingerprint images simultaneously.

***Keywords*— biometric; fingerprint image; minutiae points; euclidean distance; matching; similarity component;**

I. INTRODUCTION

A fingerprint is the combination of both ridges and furrows. Finger prints can be distinguished by using the minutiae; these are nothing but some abnormal points on the ridges. Minutiae consist of two main parts such as: termination and bifurcation. Termination is the point where your ridge ends and bifurcation is the point where ridge divides into branch again minutiae having both ridges and furrows. Valley is also a furrow.

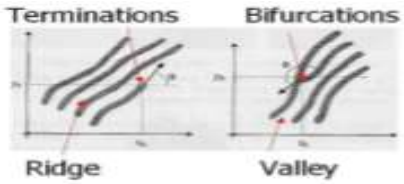


Fig.1 Minutiae

Fingerprint identification is very useful biometric technologies which have substantial amount of attention recently. A fingerprint is the combination of ridges and valleys on the surface of a finger. Each person has unique fingerprint. The uniqueness is found by the ridge characteristics and their relationship.

The fingerprint recognition problem having two methods: fingerprint verification and other is fingerprint identification. The fingerprint recognition is called as AFRS (Automatic Fingerprint Recognition System), which is program-based.

II. SYSTEM IMPLEMENTATION

A fingerprint recognition system consists of fingerprint acquiring device as a sensor, minutia extractor and minutia matcher.

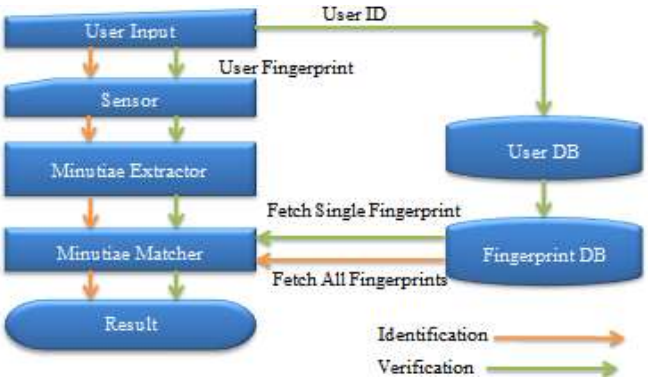


Fig.2Simplified Fingerprint Recognition System

Fingerprint verificationis the method where we compare a applicants fingerprint with already stored database fingerprint, where we are going to match both the fingerprints. This method is mainly used to verify a person's authenticity. Fingerprint verification is also called, person-to-person matching.

Fingerprint identificationis mostly used to specify any person's identity by his fingerprint. Identification is used for criminal fingerprint matching. This process is also called, one person-to-many person matching. Identification is used for solve crime and catch thieves.

III. SYSTEM LEVEL DESIGN

To implement a minutia extractor, a three-stage method is used by researchers. They are preprocessing, minutia extraction and post processing stage.

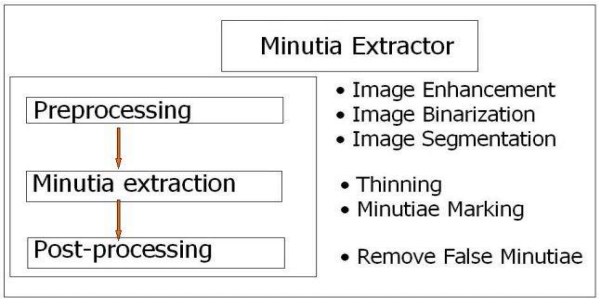


Fig. 3 Minutia Extractor

Pre-Processing

A. Image Enhancement

Fingerprint image enhancement is used to make image quality more clear for better use. The image enhancement is also used to reduce the noise and to enhance the definition of ridges against valleys. Here we used two methods for image enhancement stage those are:

I. Histogram Equalization:-

Histogram equalization is mainly used to increase the pixel value of an image. By using this method we can improve the contrast of an image. The original histogram of a fingerprint image shows bimodal after histogram and having the range from 0 to 255 and also the visualization effect is goes on increasing.

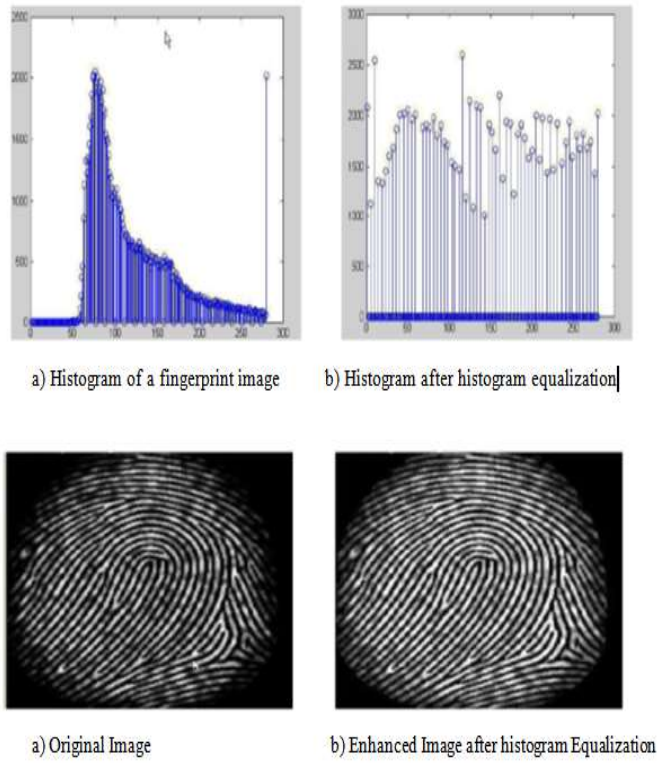


Fig. 4 Image Enhancement by Histogram Equalization

II. Fourier Transform

Here first of all we divide the image into different small processing blocks those are of 32 by 32 pixels then use the Fourier transform according to formula:

$$F(u,v) = \sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y) \times \exp\{-j2\pi \times (\frac{ux}{M} + \frac{vy}{N})\}$$

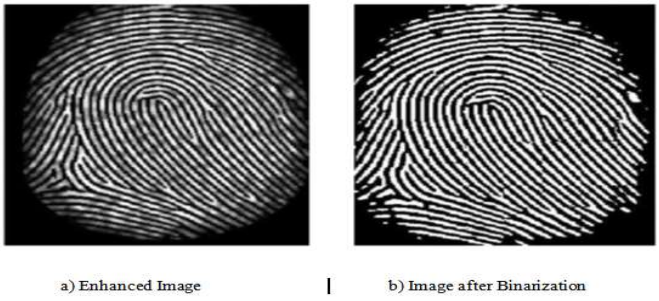
For u = 0, 1, 2……..31
and v = 0, 1, 2,…….31

a)Original Image b) Fingerprint Enhanced by FFT

Fig. 5 Image Enhancementby FFT

B. Image Binarization

It means translating gray scale images into binary images. Fingerprint Image binarization transforms the 8-bit Gray fingerprint image to a 1- bit binary image. Where 0 assignedfor ridges and 1 assigned for furrows. After these operations, the ridges in the fingerprint will be highlighted with black color while furrows will be color with white.



a) Enhanced Image b) Image after Binarization

Fig. 6 Image Binarization

C. Image Segmentation

Partitioning a digital image in to multiple segments that is a set of pixels. Typically image segmentation is used to show the objects and boundaries like the lines and curves present in an images. Generally **Region of Interest (ROI)** is very much useful for recognizing each fingerprint image. The image area without effective ridges and furrows holds background information. So the effective ridges and furrows deleted first. Then the remaining effective area is sketched. Because the minutia present in that region are too much confusing with other duplicate minutia which occurred when the ridges are out of the sensor.

Minutiae Extraction

D. Ridge Thinning

Image thinning is used to reduce the darkness of all ridge lines. Thinning process does not convert the original location. Ridge thinning is used to destruct the extra pixel of ridges until just one Pixel broad.

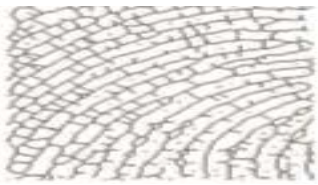
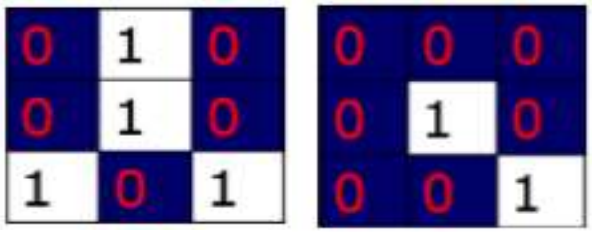


Fig. 7 Thinned Image

E. Minutiae marking

Minutiae markings are done by using 3 x3 pixel windows as follows. In the minutia marking the Crossing Number (CN) is used.



For a 3x3 window:
If the central pixel has only **1** one-value to its neighbor, then the central pixel is a ridge ending
If the central pixel has exactly **3** one-value to its neighbor, then the central pixel is a ridge branch
i.e. if Cn(P) = = 1 it's a ridge end and
if Cn(P) = = 3 it's a ridge bifurcation

Post processing

F. False Minutia Removal

In this stage different types of false minutia are generated due to the insufficient amount of ink or excess amount of ink. These types of false minutia are not totally eliminated so, we have to remove all types of false minutia. First calculate the inter ridge distance (D) which is the average distance between two neighboring ridges.

$$\text{Inter ridge distance} = \frac{sum\ of\ pixel\ with\ value\ 1}{row\ \boldsymbol{length}}$$

Finally an averaged value over all rows gives D.

G. Match stage

The minutia matching is done by keeping a bounding box around each of the template minutia. If the minutia which is to be matched is within that rectangle box and the direction discrepancy between them is so small, then the two minutiae's are taken as a pair of matched minutia. Each of the minutiae in that template image either has one corresponding minutia or has no matched. The final match ratio for two fingerprints is given by

$$\text{Match Score} = \frac{number\ of\ total\ matched\ \boldsymbol{minutiae}\ pair}{number\ of\ minutiae\ of\ \boldsymbol{template}\ fingerprint}$$

Match Score> Threshold value (Match Found)

Performance evaluation index

False Rejection Rate (FRR):

Sometimes the biometric security system may incorrectly reject an access attempt by an authorized user. To measure these types of incidents FAR is basically used. FRR is the ratio between the number of false rejections and the number of identification attempts.

(%) FRR= (FR/N)*100
FR=number of incidents of false rejections
N= number of sample

False Acceptance Rate (FAR):

Sometimes the biometric security system may incorrectly accept an access attempt of an unauthorized user. To measure these types of incidents FAR is basically used. A system's FAR basically states the ratio between the number of false acceptances and the number of identification attempts.

(%) FAR= (FA/N)*100
FA= number of incidents of false acceptance
N=total number of samples

Distance based classifier also used in the given system for recognition. Relative distances are compared with the stored Feature Vectors. Euclidean distance metric is measured by equation below. It is used to compute the similarity or match value for a given pair of features. Zero distance have a perfect match, and mismatch as the distance increases.

$$D_{(x,y)}^{Eucli} = \sqrt{\sum_{i=0}^{N} (x_i, y_i)^2}$$

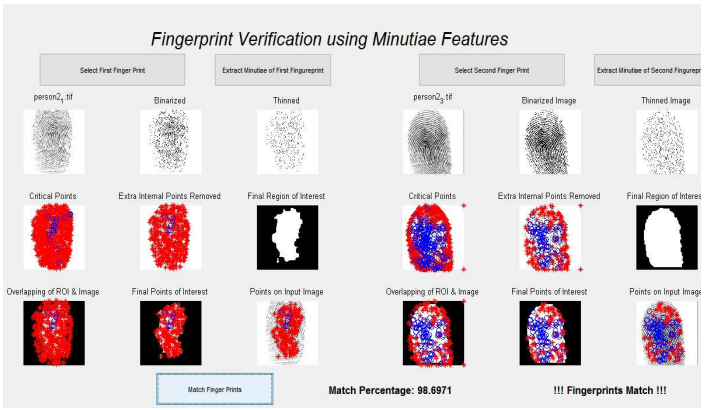
IV. Result and Observations

Two images are analyzed to find out the behavior of a fingerprint recognition system: one method is FRR (false rejection rate) and the other method is FAR (false acceptance rate). In the image database, each sample is matched with the other samples of the same finger and then the sample determines the False Rejection Rate. If the matching *g* against *h* is true, the symmetric one (i.e., *h* against *g*) is not performed to avoid correlation. All the scores for such matches are combined into a series of Correct Score.

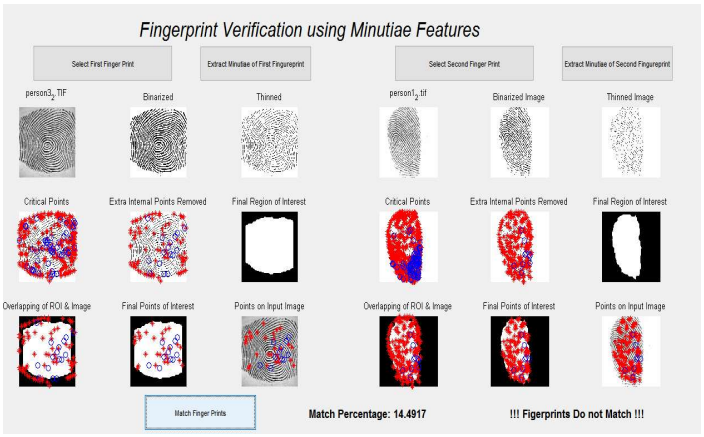
Also the first sample of each finger in the database is matched with the first sample of the remaining fingers todetermine the False Acceptance Rate. If the matching *g* against *h* is accurate, the symmetric one (i.e., *h* against *g*) is not performed to avoid correlation. All the scores from such matches are combined into a series of Incorrect Score.

A fingerprint database from the FVC2000 (Fingerprint Verification Competition 2000) is used to test the experiment performance. This program tests all the images for the database.

Case 1: Fingerprint Match



Case 2: Fingerprint Do Not Match



V. CONCLUSION

A new approach on minutiae based fingerprint matching and similarity checking technique is developed. The minutiae points are fully occupied in the fingerprint image. Towards the matching, this algorithm checks each minutiae point for each image and it is tested with query image. The finger print identification is one of the very few technique employed in forensic science to aid criminal investigations in daily life, providing access control in financial security, visa related services and so on. This project has combined many methods to combine a minutia extractor and a minutia matcher. The combination of multiple methods is derived from a proper investigation into research paper. Also it having the changes like segmentation for the purpose of Morphological operations, minutiae identification for the use of triple branch counting, minutia unification carried out by dividing a branch into three parts, and matching in the x-y coordinate system having a two-step transformation which is used in this project, Also a program coding with MATLAB software going through it is helpful to analyze the process of fingerprint recognition and determines the key issues of fingerprint recognition.

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