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FINGER PRINT IDENTIFICATION USING REAL MINUTIAE EXTRACTION METHOD

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***Abstract*: Fingerprint is a biometric that provides secure process to authenticate a person due to its permanent feature and uniqueness that stay behind throughout human life. It has been in used for more than 100 years as a result of its achievability, reliability, accuracy, and acceptability. Although there exist many algorithms for fingerprint authentication, there is still a need to close the gap of accurateness. Among the algorithm of fingerprint methods are minutiae matching and pattern matching method. A minutiae matching is widely used for fingerprint recognition and can be classified as ridge ending and ridge bifurcation. In this paper the minutiae extraction method was improved by combining it with image enhancement that includes noise reduction, smoothing, contrast stretching, histogram equalization, Fourier transform and edge enhancement. For the image preprocessing steps, we have used histogram equalization followed by Fast Fourier Transform to do the image enhancement and then image binerization is done by locally adaptive threshold method. This method presented a satisfactorily performance.**

***Keywords:* Minutiae extraction, minutiae matching, fingerprint, biometrics, fingerprint enhancement.**

1. INTRODUCTION

Fingerprint recognition or fingerprint authentication refers to the automated method of verifying a match between two human fingerprints. Fingerprints are one of many forms of biometrics used to identify an individual and verify their identity. Because of their uniqueness and consistency over time, fingerprints have been used for over a century, more recently becoming automated (i.e. a biometric) due to advancement in computing capabilities. Fingerprint identification is popular because of the inherent ease in acquisition. For a long time, researchers had come up with many approached identify and verify a fingerprint. Although the position, type of minutiae, ridges and many other parameters are used, the results are still not satisfied in recognizing fingerprint. However, all fingerprint recognition verification or identification, are eventually based on a well-defined representation of a fingerprint. The underlying principle of well-defined representation of a fingerprint and matching remains the same. The verification would be straightforward if the representation of fingerprints remains the uniqueness and kept simple [1].

2. FINGER IDENTIFICATION SYSTEM

An identification system can be defined as the one which helps in identifying the individual from many people available. It generally involves matching available biometrics feature like fingerprint with the fingerprints which are already enrolled in the database.

A fingerprint identification system constitutes of fingerprint acquiring device, image preprocesses and minutia extractor and minutia matcher [2].

During the fingerprint image preprocessing stage, Histogram Equalization and Fourier Transform were deployed to perform image enhancement. And then the fingerprint image is binarized using the locally adaptive threshold method. The image segmentation task is fulfilled by a three-step approach: block direction estimation, segmentation by direction intensity and Region of Interest extraction by Morphological operations [3]. Most techniques used in the preprocessing stage are developed by other researchers but they were structured as a new combination in this work through various tests.

The minutia matcher chooses any two minutiae as a reference minutia pair and then matches their associated

ridges first. If the ridges match well, two fingerprint images are aligned and matching is conducted for all remaining minutiae.

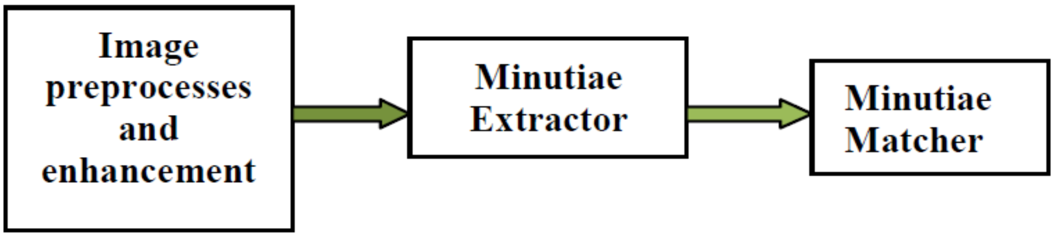

FIG 1 Basic Fingerprint Identification System

3. METHODOLOGY

3.1 FINGERPRINT IMAGE ENHANCEMENT

Fingerprint image enhancement is to prepare the image to be better to ease further operations. Since the fingerprint images acquired from camera or other sensors are not guaranteed with great quality, thus image enhancement need to be carried out.

3.1.1 ENHANCED BY USING HISTOGRAM EQUALIZATION

The fingerprint images were first enhanced by using Histogram Equalization. Histogram is a process that attempts to spread out the gray levels in an image so that they are evenly distributed across their range [4]. It basically reassigns the brightness value of each pixel based on the image histogram. Histogram is a technique to produce more visually pleasing result across a wider range of images to produce as flat as possible histogram of the image.

FIG 2 Histogram Enhancement (left: original image, right: enhanced image)

3.1.2 ENHANCEMENT THROUGH FOURIER TRANSFORM

In this enhancement, the image is divided into small processing blocks of 32by 32 pixels and then we perform the Fourier Transform on each block according to:

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

$for\ u = 0,1,2, \ldots ,31$, and

$for\ v = 0,1,2, \ldots ,31$.

In order to enhance each block by its dominant frequencies, each block after FFT will be multiplied with its magnitude a set of times. Where magnitude can be given as:

$abs\big(F(u,v)\big) = |F(u,v)|$

and the enhanced block will be based on:

$$g(x,y) = F^{-1}\{F(u,v) \times |F(u,v)|^k\}$$

$where\ F^{-1}\{F(u,v)\}\ is\ given\ by$

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

$for\ x = 0,1,2, \ldots ,31$, and

$for\ y = 0,1,2, \ldots ,31$.

The k in the formulae is a constant which is determined experimentally, here we will choose the k value = 0.45 by some experiments over fingerprints. Suppose, if we have a higher 'k' then the appearance of the ridges will be improved and it will fill up the small holes in ridges but, if have a very higher 'k', then it can result into false joining of ridges. Hence, termination minutiae might become bifurcation minutiae.

FIGURE 3 represents the image after FFT enhancement where FIGURE 4 is the image after histogram equalization

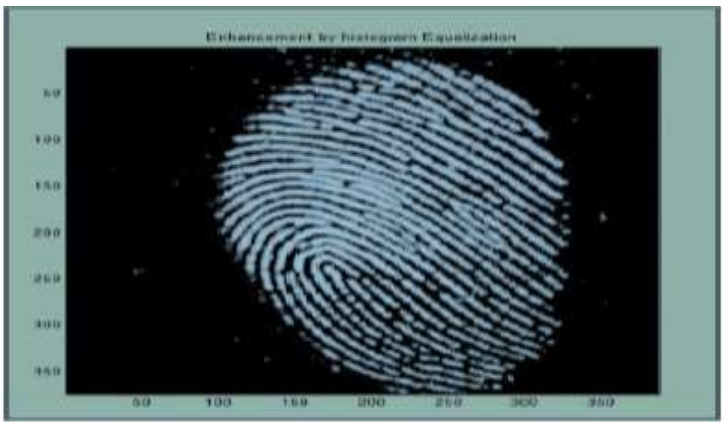

FIG 3 Histogram equalized image

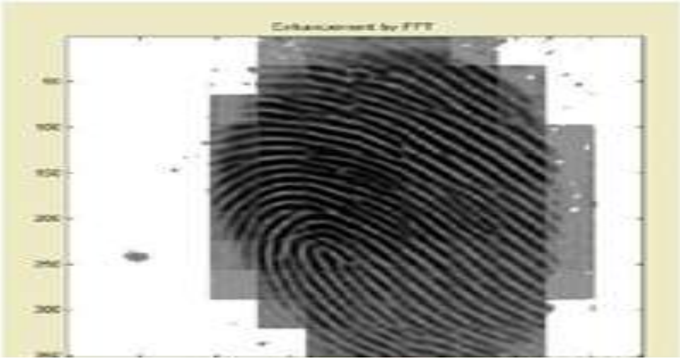

FIG 4 Image after FFT operation

3.2 FINGERPRINT IMAGE BINARIZATION

Fingerprint image binarizationis done to transform a 8-bit gray image to a 1-bit binarized image where 0-value holds for ridges and 1-value for furrows [5]. And after the binerization operation ridges are highlighted with black color and furrows are highlighted with white color.

Here, we will use a locally adaptive binerization method called as 'adaptive thresholding' to binarize the fingerprint image. In this method we transform the gray level to 0 if it is below threshold value and to 1 if it is above threshold value. The threshold value is the mean taken from the gray level of the current block (16*16) to which the pixel belongs. [FIG 5]

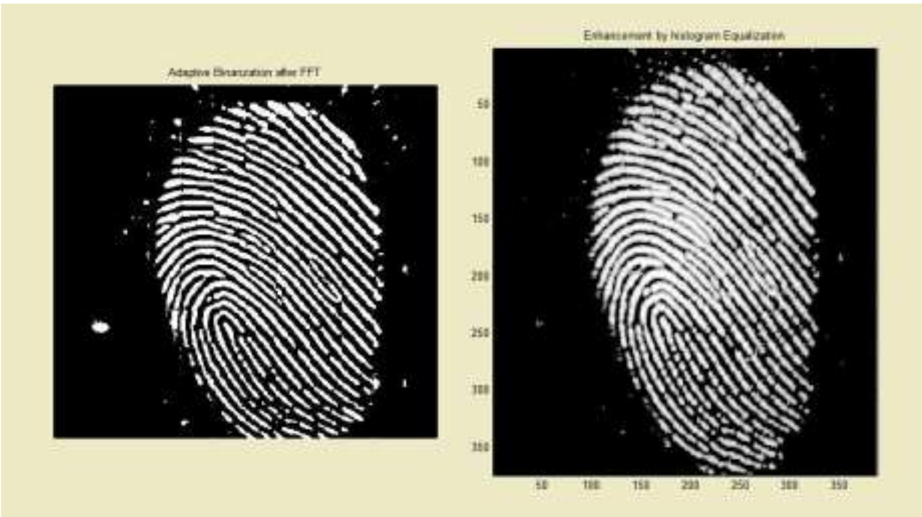

FIG 5 binarized image (left), histogram equalized image (right)

3.3 FINGERPRINT IMAGE SEGMENTATION

As for our aim only region of interest is the useful part which needs to be recognized for each and every fingerprint image. Here, the image area without effective furrows and ridges will be first discarded from the image since it has only background information [6]. Then we will sketch out the bound of the remaining effective area since bound region minutiae produces confusion with the spurious minutiae that are generated out of the sensor.

To get the ROI we use a two-step method. The first step constitutes 'block direction estimation' and 'direction variety check', whereas the second step is done using some morphological operations.

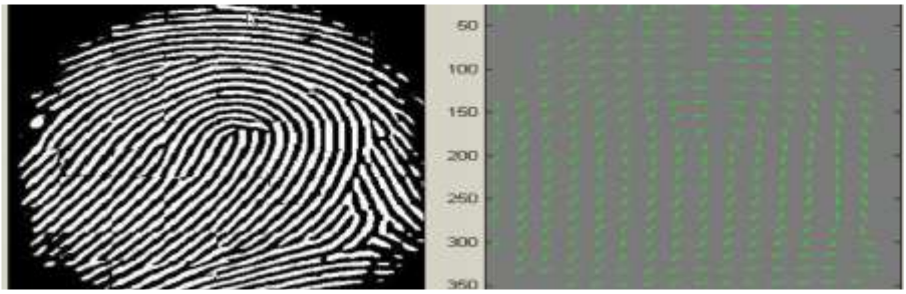

FIG 6 Direction Flow Estimate Binarized Image (Left), Direction Map (Right)

4. MINUTIAE EXTRACTION

4.1 FINGERPRINT RIDGE THINNING:

Thinning is the process of reducing binary objects or shapes to strokes whose width is one pixel wide [7]. Here in fingerprint recognition thinning is done to thin the ridges so that each is one pixel thick. In each scan of the fingerprint image, the algorithm removes the redundant pixels in small image window (3x3).In our algorithm, for thinning purposes we had invoked an inbuilt morphological operation in MATLAB.

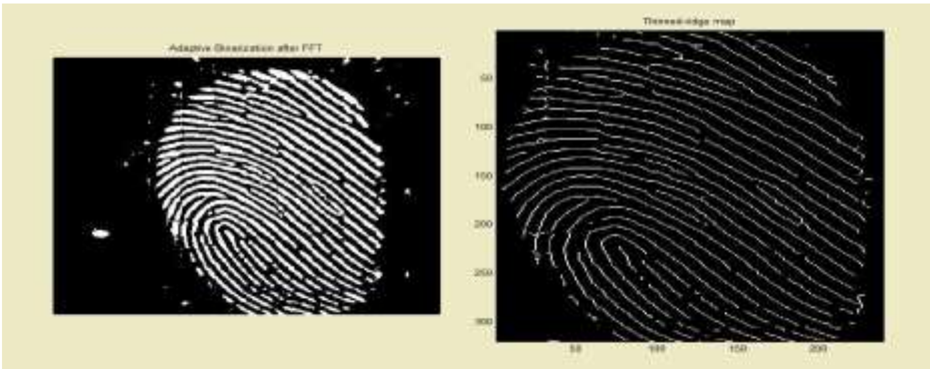

FIG 7 (a) Binarized Image (b) Thinned Ridge Image

4.2 MINUTIA MATCH

The minutia details of two fingerprints are obtained using the above procedures and they are matched using the minutia match algorithm [8]. Alignment based match algorithm is used in our project. It comprises of two stages:

i. Alignment Stage.
ii. Match Stage.

An iterative ridge alignment algorithm is first used to align one set of minutia with respect to another and then an elastic match algorithm is carried out to count the number of matching minutia pairs.

5. RESULT

This work used fingerprint database which includes fingerprint of 16 persons and each of them with 8 image fingerprint and matching score was obtained in order to compare same image and finally the recognition performance analyzed.

5.1 PERFORMANCE EVALUATION INDEX

To determine the performance of a fingerprint recognition system we used the following performance evaluation index:

5.1.1 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. A system's FRR basically states the ratio between the number of false rejections and the number of identification attempts.

Mathematically FRR may be expressed in the following manner:

$$(\%)\ FRR = (FR/N) * 100$$

FR=number of incidents of false rejections

N= number of samples

The FRR depends upon the quality of the image whether the quality is good or bad.

The database of fingerprint of 16 person have been taken to validate and verify the result. Table 1 showing the FRR and recognition rate of fingerprint matching.

TABLE 1

S. No.	Database Of Fingerprint Per Person	Recognition Match	FRR	% of Matching	% of FRR
1	8	7/8	1/8	87.5%	12.5%
2	8	7/8	1/8	87.5%	12.5%
3	8	8/8	0/8	100.0%	0.0%
4	8	7/8	1/8	87.5%	12.5%
5	8	7/8	1/8	87.5%	12.5%
6	8	7/8	1/8	87.5%	12.5%
7	8	8/8	0/8	100.0%	0.0%
8	8	7/8	1/8	87.5%	12.5%
9	8	7/8	1/8	87.5%	12.5%
10	8	8/8	0/8	100.0%	0.0%
11	8	6/8	2/8	75.0%	25.0%
12	8	8/8	0/8	100.0%	0.0%
13	8	6/8	2/8	75.0%	25.0%
14	8	7/8	1/8	87.5%	12.5%
15	8	7/8	1/8	87.5%	12.5%
16	8	7/8	1/8	87.5%	12.5%
	Weigh Average Percentage			**89.062%**	**10.937%**

6. CONCLUSION

This work focuses on image enhancement that include noise reduction, smoothing, contrast stretching, fourier transform and edge enhancement and from that presented a practical performance for minutiae extraction and recognition of the fingerprint images. The matching score of the minutiae was observed to increase at a lower enhancement threshold and by limiting the minimum number of minutiae extracted prior to recognition. These results validate that the collection of image enhancement technique can further improve the recognition rate and matching score by using minutiae extraction. It is believed that further research can be made in producing a better slight image rotation and filtration of unsuitable images that lacking criteria for fingerprint detection.

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