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Adaptive Fingerprint Image Enhancement Based On Cascading Filtering

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Abstract— *Automated Fingerprint Identification Systems (AFIS) have recently become one of the best-known and most widely used biometric technologies, which consists of various stages such as Image acquisition, enhancement, feature extraction and matching. The enhancement process is conducted to improve the quality of the fingerprint image and make it more legible and convenient for the further feature extraction process. In this paper, we propose an adaptive methodology for fingerprint image enhancement, where multiple techniques are adopted in conjunction, namely, Histogram Equalization, Fast Fourier Transformation and Image Binarization. The experiments are all performed using OpenCV library and the obtained results reveal the potential of the proposed methods.*

Keywords— Fingerprint, histogram equalization, Fast Fourier Transformation.

1. INTRODUCTION

Biometrics are the measurement and statistical analysis of people's physical and behavioral characteristics. This technology is mainly used for identification and access control, or for identifying individuals.

Fingerprint recognition 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. Fingerprint identification is popular because of the ease of acquisition, established use and acceptance when compared to other biometrics, and the fact that there are numerous (ten) sources of this biometric on each individual.

A fingerprint is the pattern of ridges and valleys on the surface of the fingertip.

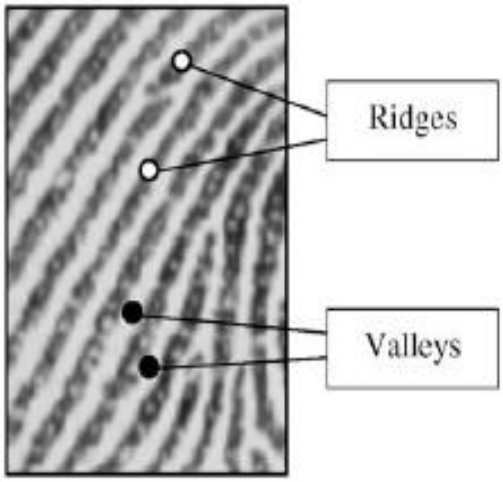

Fig (1.1): Ridges and valleys on a fingerprint image

The ridges are the dark lines of the fingerprint and the valleys are the white lines that exist between the ridges.
The ridges form called minutia points,
-Ridge endings (where a ridge end) and
-Ridge bifurcations (where a ridge splits in two).

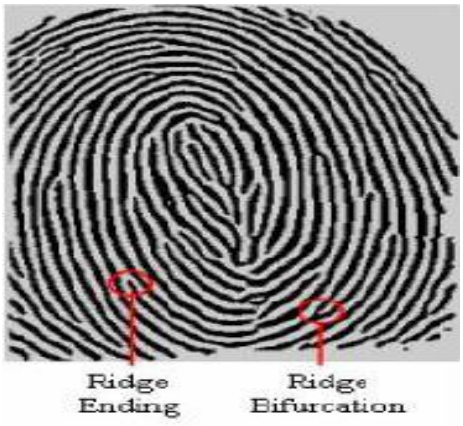

Fig (1.2): Two important minutiae features

The fingerprint recognition system includes two sub-domains:

(i) Fingerprint verification
(ii) Fingerprint identification.

-Fingerprint verification is used to verify a person's identity by comparing the captured biometric characteristic with his previously captured (enrolled) biometric reference template pre-stored in the system. It performs a one-to-one comparison to emphasize whether the claim of identity of the individual is true. The submitted claim of identity is either rejecting or is accepted by the verification system.

-Fingerprint identification is used to identify an individual by searching the entire enrollment template database for a match. It performs one-to-many comparisons to determine if the individual exists in the database if so, returns the identifier of the enrollment reference that matched.

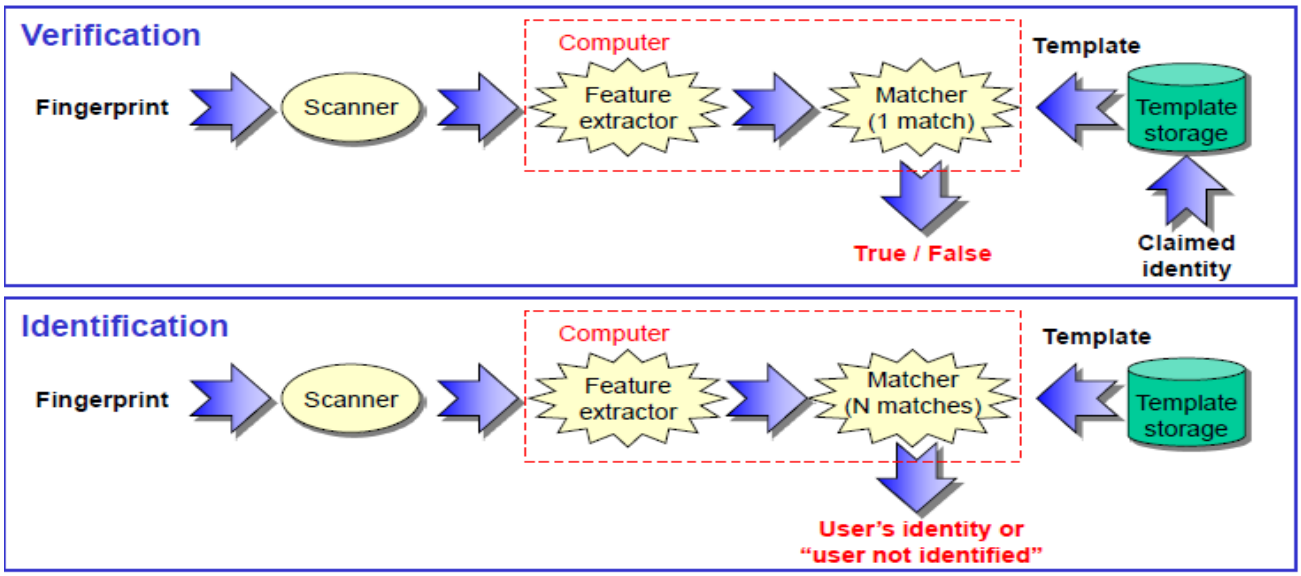

Fig (1.3): Fingerprint Recognition System

2. PROPOSED METHODOLOGY:

- The main steps are: Image Acquisition, Image enhancement, Binarization, Thinning.
- The system first acquires the image. Then do two image enhancement processes (i.e. DFT & Histogram equalization); the methodologies for these processes viewed as some blocks in Fig (1.4).

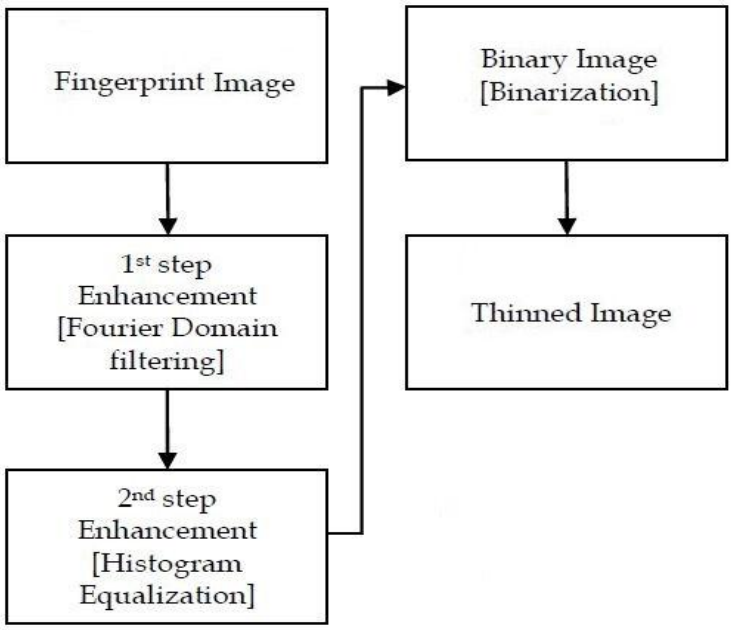

Fig (1.4): Image Enhancement Steps

2.1 Image Acquisition:

Different types of scanners, like, optical sensor, capacitive sensor or thermal sensor can be used for acquiescing fingerprint image. The images are poor quality and the enhancement step is essential.

2.2 Fingerprint Image Enhancement:

Image enhancement is done to upgrade the fingerprint image quality. It is used to increase the contrast between ridges and valleys and to link the some of the false broken points of ridges.
For image enhancement we use Histogram Equalization and Fourier Domain Filtering techniques.

- Discrete Fourier Transform (DFT): It is important because the image decomposes into its sine and cosine components.
- Histogram Equalization: It is a method that improves the contrast in an image, in order to stretch out the intensity range. This permits for areas of lower local contrast to gain a higher contrast without affecting the global contrast. After implementing DFT and histogram equalization fingerprint image quality has increased. By using two phase cascading enhancement process showing much better result.

(a) (b) (c)

Fig (2.1): (a) Original image, (b) Enhanced image by DFT, (c) Final Enhanced Image after Histogram Equalization.

3. BINARIZATION

We use binarization to convert gray scale image into binary image, In the binary image each pixel value is either 0 or 1 (255). This improves the contrast between the ridges and valleys in a fingerprint image, thus facilitating the extraction of minutiae.
We implement local thresholding method and in this method there is a threshold value, The pixel values above and below the threshold are set to '1' and '0' respectively.

(a) (b)

Fig (3.1): (a) Enhanced image, (b) Binary image

4. FINGERPRINT RIDGE THINNING

The binarized image is thinned to decrease the thickness of all ridge lines to one pixel width. This step will help to extract the minutiae points.

Thinning is based on the Zhang-Suen line thinning approach.

(a) (b)

Fig (4.1): (a) Binary image, (b) Thinned image

5. Conclusion

This paper has proposed an adaptive methodology for fingerprint image enhancement. Through using enhancement techniques such as Histogram Equalization, Fast Fourier Transformation and Image Binarization, the quality of the input fingerprint image has extremely increased, which facilitate the way to extract fingerprint features.

6. References

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