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Biometrics- Fingerprint Recognition

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ABSTRACT

Human fingerprints are rich in details called minutiae, which can be used as identification marks for fingerprint verification. The goal of this project is to develop a complete system for fingerprint verification through extracting and matching minutiae. To achieve good minutiae extraction in fingerprints with varying quality, preprocessing in form of image enhancement and binarization is first applied on fingerprints before they are evaluated. Many methods have been combined to build a minutia extractor and a minutia matcher. Minutia-marking with false minutiae removal methods are used in the work. An alignment-based elastic matching algorithm has been developed for minutia matching. This algorithm is capable of finding the correspondences between input minutia pattern and the stored template minutia pattern without resorting to exhaustive search. Performance of the developed system is then evaluated on a database with fingerprints from different people

1. INTRODUCTION

In the world of computer security, biometrics refers to authentication techniques that rely on measurable physiological and individual characteristics that can be automatically verified. In other words, we all have unique personal attributes that can be used for distinctive identification purposes, including a fingerprint.Fingerprint recognition is one of the best known and most widely used biometric technologies. Fingerprint recognition technology extracts features from impressions made by the distinct ridges on the fingertips. The fingerprints can be either flat or rolled. A flat print captures only an impression of the central area between the fingertip and the first knuckle; a rolled print captures ridges on both sides of the finger.Among all biometric traits, fingerprints have one of the highest levels of reliability. A fingerprint refers to the flow of ridge patterns in the tip of the finger. The ridge flow exhibits anomalies in local regions of the fingertip and it is the position and orientation of these anomalies that are used to represent and match fingerprints.

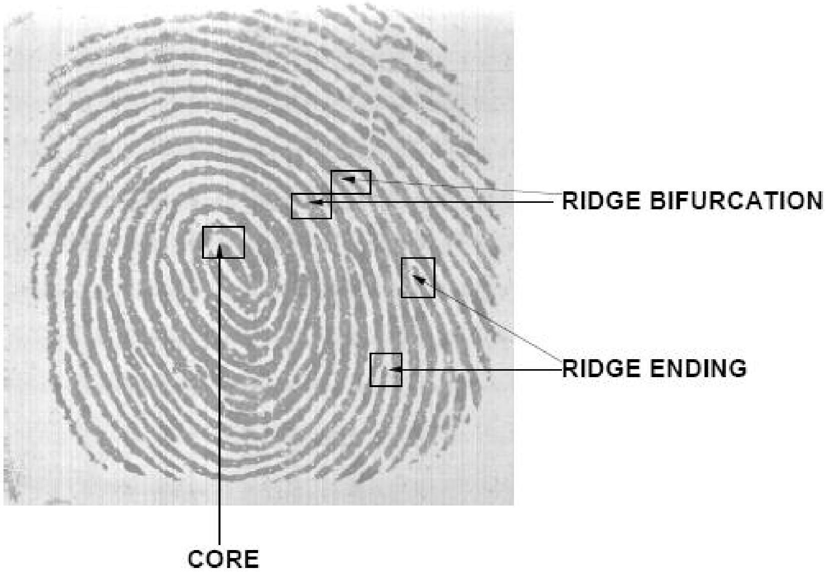

Figure 1. The Components of a Fingertip

2. FINGERPRINT

2.1 Fingerprint Image Enhancement

Fingerprint Image enhancement is used to make the image clearer for easy further operations. Since the fingerprint images acquired from scanner or any other media are not assured with perfect quality, those enhancement methods, for increasing the contrast between ridges and valleys and for connecting the false broken points of ridges due to insufficient amount of ink, are very useful for keep a higher accuracy to fingerprint recognition.

Figure 2. Image Enhancement

2.2 Histogram Equalization

Histogram equalization is to expand the pixel value distribution of an image so as to increase the perceptional information. The original histogram of a fingerprint image and the histogram after the histogram equalization is shown in Figure 3.

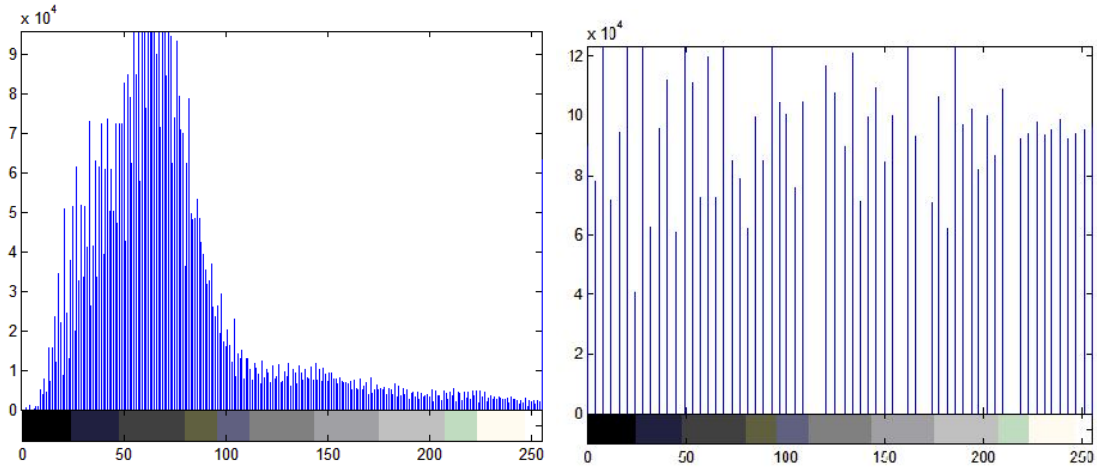

Figure 3. Before and After Histogram Equalization

2.3Fingerprint Enhancement by Fourier Transform

The data used in the program can be changed by the user to any value as per the requirements and realize the performance for different aircrafts at different flights conditions. By default it is set for Boeing 747 with an initial mach number 0.9.

We divide the image into small processing blocks (32 by 32 pixels) and perform the Fourier transform according to:

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

for u = 0, 1, 2, ..., 31 and v = 0, 1, 2, ..., 31.

In order to enhance a specific block by its dominant frequencies, we multiply the FFT of the block by its magnitude a set of times. Where the magnitude of the original FFT = abs(F(u, v)) = |F(u, v)|

2.4 Fingerprint Image Binarization

Binarization transforms the image from a 256-level image to a 2-level image that gives the same information. Typically, an object pixel is given a value of “1” while a background pixel is given a value of “0.” Finally, a binary image is created by coloring each pixel white or black, depending on a pixel's label (black for 0, white for 1).

2.5 Block direction estimation &ROI extraction

Estimates the block direction for each block of the fingerprint image with WxW in size (W is 16 pixels by default). For ROI Extraction two Morphological operations called 'OPEN' and 'CLOSE' are adopted. The 'OPEN' operation can expand images and remove peaks introduced by background noise. The 'CLOSE' operation can shrink images and eliminate small cavities.

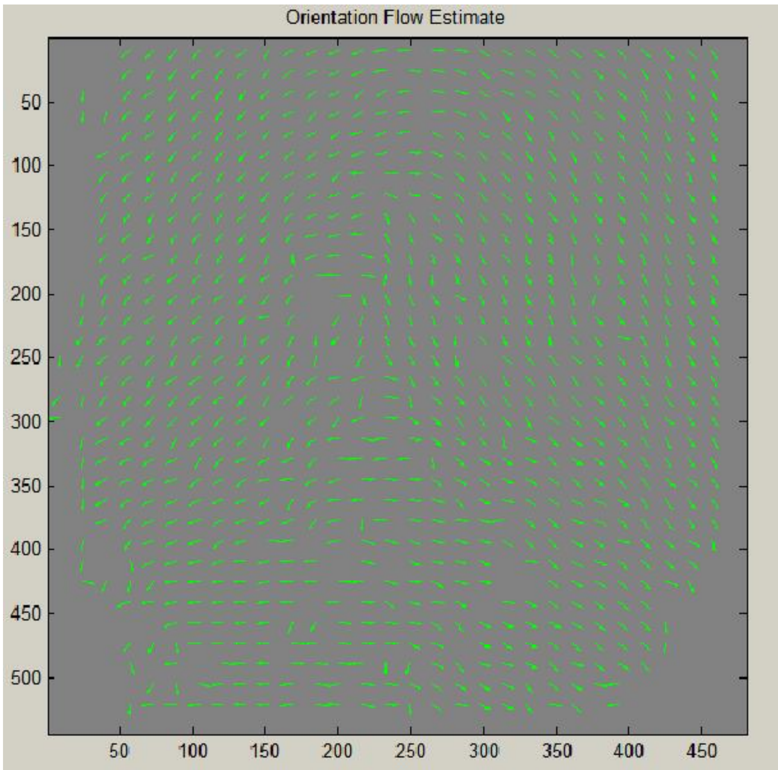

Figure 4. Direction Map

2.6Fingerprint Ridge Thinning

Ridge Thinning is to eliminate the redundant pixels of ridges till the ridges are just one pixel wide. An iterative, parallel thinning algorithm is used. In each scan of the full fingerprint image, the algorithm marks down redundant pixels in each small image window (3x3) and finally removes all those marked pixels after several scans. The thinned ridge map is then filtered by other Morphological operations to remove some H breaks, isolated points and spikes. In this step, any single points, whether they are single-point ridges or single-point breaks in a ridge are eliminated and considered processing noise.

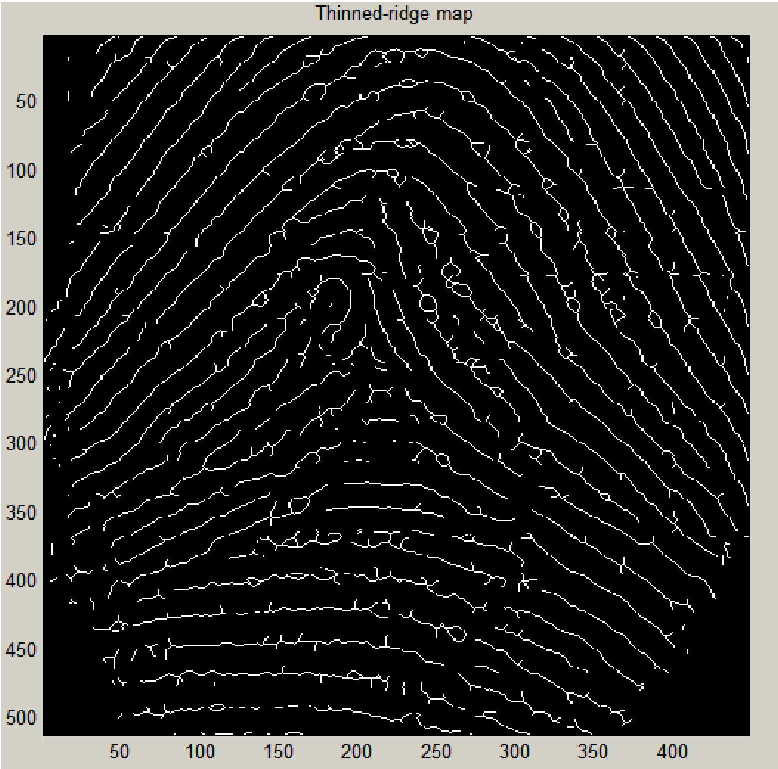

Figure 5. Image Thinning

2.7 Match Stage

The final match ratio for two fingerprints is the number of total matched pairs divided by the number of minutia of the template fingerprint. The score is 100*ratio and ranges from 0 to 100. If the score is larger than a pre-specified threshold (typically 80%), the two fingerprints are from the same finger.

3.CONCLUSIONS

The reliability of any automatic fingerprint system strongly relies on the precision obtained in the minutia extraction process. A number of factors damage the correct location of minutia. Among them, poor image quality is the one with most influence. The proposed alignment-based elastic matching algorithm is capable of finding the correspondences between minutiae without resorting to exhaustive research. There is a scope of further improvement in terms of efficiency and accuracy which can be achieved by improving the hardware to capture the image or by improving the image enhancement techniques. So that the input image to the thinning stage could be made better, this could improve the future stages and the final outcome

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