Volume 4, Issue 4, April 2014 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Survey on Fingerprint Enhancement Techniques

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Abstract—The purpose of this research paper is to define a critical step in studying the statistics of fingerprint minutiae to reliably extract minutiae from the fingerprint images. It is necessary to employ the image enhancement techniques prior to minutiae extraction to obtain a more reliable estimate of the minutiae locations. Thus, fingerprint Image enhancement is to make the image clearer for easy further operations. Since, fingerprint images obtained from the sensors are not assured with the perfect quality, thus various enhancement methods, for increasing contrast between the ridges and furrows and for connecting the false broken points of ridges due to insufficient level of the ink and are very useful for keeping a higher accuracy to fingerprint recognition.

Keywords— Automatic Fingerprint Identification System (AFIS), Fingerprint Image Enhancement (FIM), Histogram Equalization (HE), Fourier Transform (FT), Automatic Fingerprint Recognition System (AFRS)

I. INTRODUCTION

The most and widely used bio-identification system is fingerprint recognition system popular because of the fact that fingerprints of human are unique and persistent. The fingerprints of even identical twins are different [3]. Fingerprints have been used for over century and are the most widely used form of biometric identification. The fingerprint of individual is unique and remains unchanged over lifetime [1]. A fingerprint is formed from impression of the pattern of ridges on a finger. A fingerprint can be seen as smoothly varying pattern formed by alternating crest (ridges) and troughs (valleys) on the surface of the finger as shown in Fig. 1. The ridges are the dark lines and valleys are the light lines in the fingerprint image pattern [3]. A ridge is defined as the single curved segment, and valley is a region between the two adjacent ridges [1]. Fingerprint identification is commonly employed in forensic science to support criminal investigation, and in biometric system such as civilians and the commercial identification devices. The issue of how many minutiae points should be used for matching a fingerprint is unresolved.

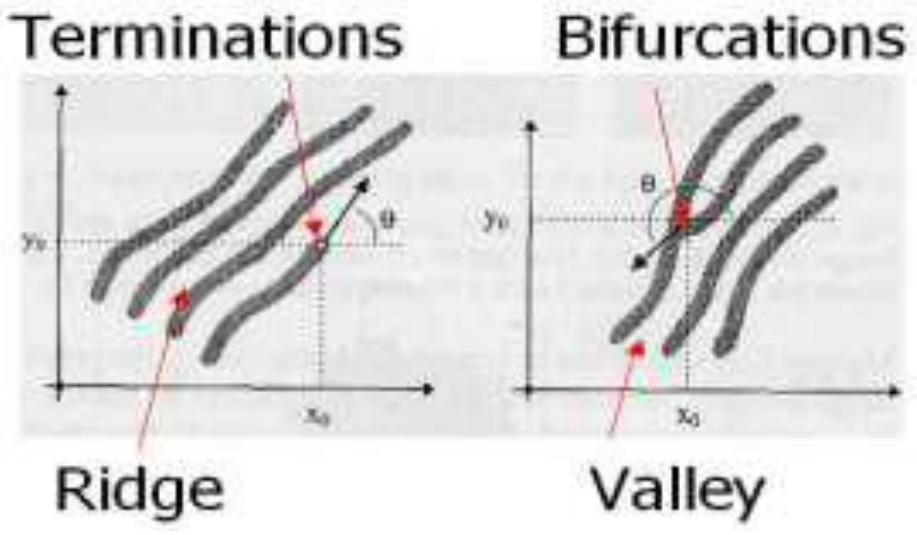

Figure 1. Example of a ridge ending and a bifurcation [1].

Most of the automatic fingerprint identification systems (AFIS) are based on the minutiae matching. Minutiae or Galton‘s characteristic are the local discontinuities in fingerprint pattern and the American National Standards Institute has proposed a minutiae classification based on four classes : terminations, bifurcations, trifurcations (or crossover) and undetermined.

The various types of minutiae are shown in Fig. 2. Prior to the feature extraction and the matching clarity of ridges and valleys of the fingerprint image should be improve to make them more suitable for the minutiae extraction algorithm and the local features such as minutiae can be extracted easily for the matching purpose[3].

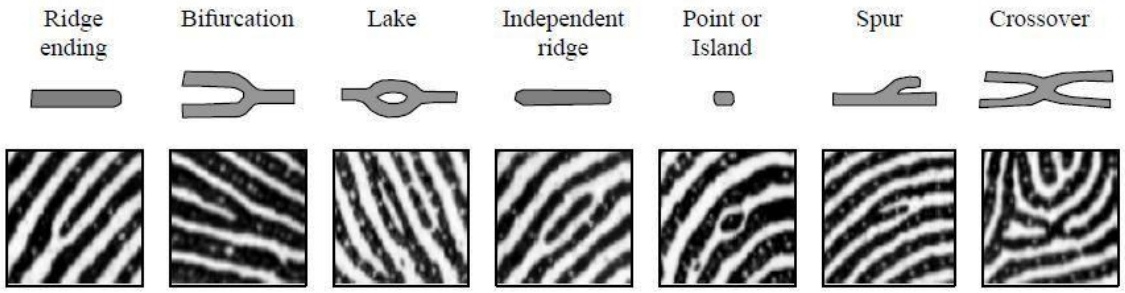

Figure 2. Various Types of Minutiae [3].

The finger print acquisition can be classified into two major techniques (i) Automatic Fingerprint Recognition System (AFRS) with the help of online sensors or other devices.(ii) Another technique on latent prints which are obtained by various medias such as ink, powder, paper etc, mostly they are by crime sections[4].

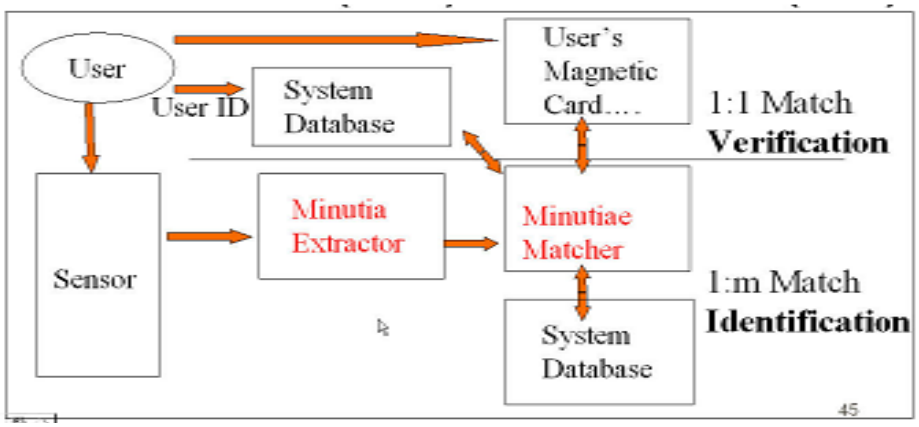

Figure-3: Automatic Finger Recognition System [4].

Fingerprint images are rarely of perfect quality and they may be degraded and corrupted with the elements of noise due to many factors including variations in skin and the impression conditions. This degradation can be result in the significant number of spurious minutiae being created and genuine minutiae being ignored. A critical step in studying the statistics of fingerprint minutiae is to reliably extract minutiae from the fingerprint images and it is necessary to employ the image enhancement techniques prior to minutiae extraction to obtain a more reliable estimate of minutiae locations [1].

FINGERPRINT IMAGE ENHANCEMENT

Fingerprint Image enhancement (FIM) is used to make the image clearer for easy further operations. Since fingerprint images acquired from sensors or the other medias are not assured with the perfect quality and those enhancement methods for increasing the contrast between ridges and furrows and for connecting false broken points of ridges due to insufficient amount of ink and are very useful for keep higher accuracy to fingerprint recognition [1].

Two Methods are: the first one is Histogram Equalization [3]; the next one is Fourier Transform [3].

1. HISTOGRAM EQUALIZATION (HE):

HE [4] attempts to improve the contrast of an input image by stretching the peaks of the histogram and compressing the troughs .Histogram equalization is to expand the pixel value distribution of an image so as to increase the perception information.

2. FOURIER TRANSFORM (FT):

In this, we divide image into small processing blocks (32 by 32 pixels) and perform Fourier transform.

II. RELATED STUDY

Benazir.K.K.al [1] presents a fast fingerprint enhancement methodology and new implementation of techniques for fingerprint image enhancement. Experimental results show incorporating enhancement algorithm improves the verification accuracy.

CarstenGottschlich [2] for the purpose of enhancing curved structures in noisy images, he introduce curved Gabor filters which locally adapt their shape to the flow of direction. These Gabor filters enable the choice of filter parameters which increase the smoothing power without creating artefacts in the enhanced image. These filters are applied to the curved

ridge and valley structure of low-quality fingerprint images. First, he combines two orientation end estimation methods in order to obtain a more robust estimation for the noisy images. Second, curved regions are constructed by following the respective local orientation and they are used for estimating the local ridge frequency. Lastly, curved Gabor filters are denied based on curved regions and they are applied for the enhancement of low-quality fingerprint images. The experimental results on FVC2004 databases show improvements of this approach in comparison to state-of-the-art enhancement methods.

VipanKakkar.al [3.]Proposed a enhancement method based on Gabor filtering in the wavelet domain. This filter is chosen because it has both frequency-selective and orientation-selective properties and has optimal resolution in both spatial and frequency domain. This filtering is done on images results from wavelet decomposition and then finally, image is reconstructed to get enhanced image. Experiments are conducted on the 500dpi resolution fingerprint images commercially available from FVC2002 fingerprint database.

R.DharmendraKumar.al [4] discuss about the enhancement of fingerprint image for the fingerprint recognition. This target can decomposed into image pre-processing, feature extraction and the feature match. For the each sub-task, some classical and the up-to-date methods in literatures are analysed. Based on analysis, integrated solution for fingerprint recognition is developed for the demonstration. MATLAB is also used in this project. For program, optimization at coding level and algorithm level are proposed to improve the performance of this fingerprint recognition system. The performance enhancements are shown by experiments conducted upon a variety of fingerprint images. The experiments illustrate some key issues of fingerprint recognition that are consistent with what the available literatures say.

Dr.S.Pannirselvam.al [5] he used the high boost filter and Gaussian filter for efficient finger print image quality. In the proposed methodology, original is filtered using High Pass filter and the Gaussian filter for the noise removal. Finally, the High Boost filter is apply for better enhancement and the performance of the image quality is measured using Mean Squared Error (MSE) and Peak Signal Noise Ratio (PSNR). It is proved that our methodology provides better result in improving the image quality and better enhancement.

HongchangKe.al[6] proposed an improved Gabor filtering for fingerprint image enhancement technology is proposed by using orientation selection and the frequency selection characteristics of Gabor filtering, the local orientation of fingerprint image and ridge line frequency are the parameter of the Gabor filtering function, two-dimensional Gabor filter is divided into a one-dimensional band-pass filtering and one-dimensional low-pass filtering. The algorithm has increased the computing speed and efficiency and has a good robustness.

SandhyaTarar.al [7] has proposed an algorithm of fingerprint image enhancement by using Iterative Fast Fourier Transform (IFFT). Iterative image reconstruction algorithms play an important role in fingerprint identification systems in order to achieve higher degree of efficiency. With the fast increase of sizes of fingerprint data and design of reconstruction algorithm is of great importance in order to improve performance. The Fourier-based frequency orientation methods have the potential to considerably reduce the computation time in iterative reconstruction. We also designed an approach for removing the false minutia generated during the fingerprint processing and a method to reduce the false minutia to increase the efficacy of identification system.

PankajDeshmukh.al.[8] propose a new method in fingerprint enhancement with application of wavelet transform which is more efficient than the existing methods. At present, methods that are in use are the ones involving the use of Gabor filtering and the Fourier filtering. But accuracy of these techniques is far from the satisfactory. A new technique is also being proposed that incorporates wavelet transform and the Gabor filtering.

III. CONCLUSION

At present the methods that are in use are the ones involving the use of Gabor filtering and Fourier filtering. The first technique consists of implementation of 2D Fourier Transform for the enhancement stage. This is the computationally fastest method since it classifies the orientations to 16 directions.

But this results in lesser accuracy since it assumes the frequency to be constant throughout which is not the case. In second method, the improvement is done by introduction of Gabor filters which takes into account both the frequency and orientation of the image and the filtering is done with the greater accuracy. Thus, Wavelet Transform has been found to be a very effective tool in denoising and the compression techniques. But accuracy of these techniques is far from satisfactory. A new mechanism has been proposed that incorporates Gabor filtering & Wavelet transformation.

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