ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 4, Issue 5, May 2017

Survey on Various Fingerprint Image Enhancement Technique

[1] Mrs. Hemavati, [2] Gayana K.R
[1] Assistant Professor , Department of Information Science & Engineering, SIT, Tumkur
[2] M.Tech. in Cyber forensics and Information Security, SIT, Tumkur

***Abstract*— In the field of security, identification and verification of a person on the basis of biometric features has become known in our society. When biometric connected to a person body remarkably decreases the possibility of fraud. A biometric system basically is a pattern recognition system and to recognize the pattern or image .From various biometric techniques fingerprint technic is the best everyone is known to have unique fingerprint and these pattern doesn't change throughout the life, for this reason only fingerprint biometric popularly used. The quality of image plays very important role in matching the two fingerprints but most of the fingerprint recognition result in the poor matching due to poor quality of image. In this paper various image enhancement methods or techniques will be discussed by which the image quality is enhanced and matching techniques are applied.**

Keywords – Fingerprint, Gabor filters, Histogram Equalization, Binarization and Thinning.

I.INTRODUCTION

Fingerprint is an impression of the friction ridges of all or
any part of the finger .Friction ridge is an area comprised of the combination of ridge flow, ridge characteristics, and
ridge structure.

1.1 Fingerprint features:

The lines that show a pattern on the fingerprint are called Ridges and the space between two ridges is called a valley
.Each fingerprint contains minutiae or ridge characteristics
and the fingerprints are identified by examining these minutiae points .It is the minutiae points which give the property of uniqueness to the fingerprints .There are two types of minutiae points: ridge ending and bifurcation. Ridge ending represents the termination of a ridge. And bifurcation is the feature which shows the splitting of a ridge in two paths.

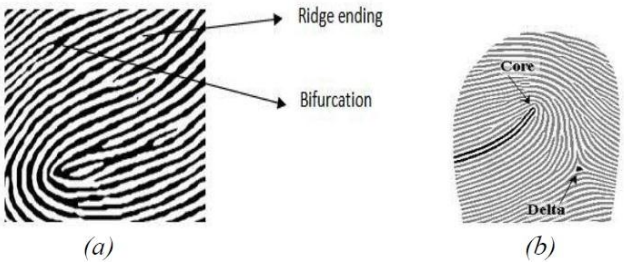

Figure: 1.2.1 (a) ridge ending and bifurcation (b) core and Delta

There are also two other features which are also used for matching of fingerprints: Core and Delta. Core is supposed to be the center from where the pattern is made. Delta is the point on a ridge from where three patterns deviate.

There are three main patterns of fingerprints:
1) Loop Pattern: The ridges flow in one side, recurve, touch or pass through an imaginary line drawn from the delta to the core and exit the pattern on the same side from which it entered.

2) Whorl Pattern: This pattern consists of a series of concentric circles.

3) Arch Pattern: In this pattern ridges flow in one side and flow out the opposite side. There are no deltas in an arch pattern.

Ridge orientation map – They are the local direction of the ridge-valley structure. They are used for classification purposes, enhancement feature verification and filtering.
Ridge Frequency map – They are the reciprocal of the ridge distance in the direction perpendicular to the local ridge orientation. They are used for filtering of fingerprint images
Singular points – They are the discontinuities in the orientation field.

They are used for fingerprint registration and classification.

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 4, Issue 5, May 2017

There are two types:
i) Core - It is the uppermost part of a curving ridge.
ii) Delta - It is a point where three ridge flows meet.
Minutiae - They are the local discontinuities of the ridge structure. Among the minutiae types, ridge endings and bifurcation are the most commonly used fingerprint representation in all AFIS.

1.2 Fingerprint recognition

Fingerprint recognition refers to the matching of two fingerprints using an automated system .The ridges pattern are used to match the fingerprints of two persons .and the minutiae are used for this matching .the minutiae points of two sample fingerprints are matched and then verified as they matched or not. The fingerprint recognition works on two domains: verification and identification. In fingerprint verification there is one to one match of fingerprints and in identification there is one to many for fingerprints.

2. FINGERPRINT ENHANCEMENT TECHNIQUES

The various fingerprint enhancement techniques are discussed below:

2.1 Enhancement using Histogram Equalization (HE):

The histogram of an image represents the relative frequency of the various gray levels of image .Using histogram equalization we can get a uniform histogram for the output image .Thus this is a technique for the improvement in the contrast of an image by adjusting the intensity of every gray level of the image. In this technique without affecting the global contrast the lower contrast areas gain a higher contrast. The main aim of HE is to find a gray-level transformation function T to transform an image 'f' such that the histogram of T (f) is equalized. The main advantage of HE is that it is very simple and efficient. The drawbacks are, they tend to change the brightness of the image and they do not preserve the brightness of the image

2.2 Enhancement using 2D Fourier Transform (FT):

Fourier Transform is a transformation technique that transforms the image from spatial domain to frequency domain. The steps involved in enhancing the fingerprint using this transform are given in Figure 2.1.

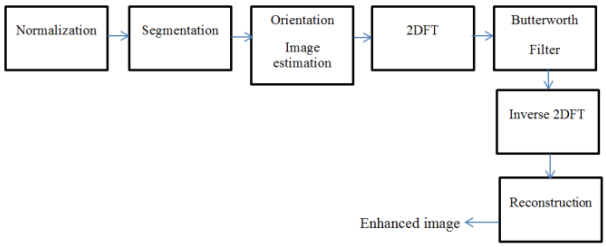

Figure.2.1 Steps involved in Enhancement using 2DFT

A. Normalization: It is done to reduce the differences in grey level values along the ridges and valleys so that the pixel values in the image have a specified mean and variance. The desired mean and variance were chosen to be 0 and 1 respectively, so that the new intensities of the pixels for the normalized image would be between -1 and 1.

B. Segmentation: It is done to separate the actual fingerprint area from the image background by dividing the image into many blocks. A threshold is set to exclude the background from the fingerprint area.

C. Orientation estimation: the orientation estimation is a necessary process in the improvement process as the successive Gabor filter stage depends on the local orientation for the purpose of effectively improve the fingerprint image.

D. 2DFT: By using 2D Fourier Transform the image is converted from spatial domain to frequency domain.

E. Butterworth Filter: The image in frequency domain is then filtered through 16 Butterworth filters with each filter tuned to a particular orientation. The number of directional filters corresponds to the set of directions used to calculate the orientation image.

F. Inverse 2DFT: After each directional has been applied to the frequency domain image, the inverse Fourier transform is used to convert each image back to the spatial domain, producing a set of directionally filtered image called as pre-filtered images.

G. Reconstruction: The final stage of the enhancement process is to reconstruct the image from the pre-filtered image by using the value of the ridge orientation at each pixel in the raw image and the filtering direction of each pre-filtered image.

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 4, Issue 5, May 2017

H. Disadvantage:
The frequency content was taken to be constant throughout.

2.3 Enhancement using Gabor filters:

As the ridge orientation and ridge frequency parameters are determined Gabor filter are engaged since they contain frequency selective and orientation selective asset. Gabor filter can be utilized to successfully maintain the ridges structure during noise removal process.

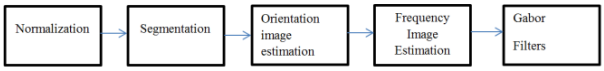

Figure.2.2 Steps involved in Enhancement using Gabor filter

A. Frequency Orientation Estimation: It estimates the approximate ridge frequency for the fingerprint image by dividing it into blocks of 8 x 8 pixels.

B. Gabor Filtering: Finally filtering is performed to remove noise and preserve the ridge structures. The image is filtered by a bank of Gabor filters (Band Pass Filters) tuned to the corresponding local frequency and orientation for each neighborhood.

C. Advantages:

a. The enhanced image is of high efficiency since the Gabor filter has both frequency selective and orientation selective properties.

b. The method have optimal resolution in both spatial and frequency domains

D. Disadvantages:

a. Reduction in contrast.

b. Produces a large number of spurious minutiae points.

c. High computational complexity.

d. Overall increase in running time of identification and verification process.

e. Creation of artifacts in the enhanced image.

f. Increase in identification and verification errors.

2.4. Enhancement using Gabor filters combined with wavelet transforms:

Wavelet transform is an effective tool in reducing noise. Images are analyzed at multiple scales. Wavelet coefficients contain both time and frequency information as basic functions.

A. Normalization: As discussed in Section 2.2.

B. Wavelet Decomposition: The image is decomposed into multi-resolution representation using wavelet transform. The convolution of the different base function with the input signal causes different effects in different resolutions. Generally one or two decomposition levels are selected.

C. Reconstruction: After modifying the approximation sub-mage with Gabor filters, the final image of the enhancement process is reconstructed. Normally the wavelets used in reconstruction are the same as that used in the decomposition process.

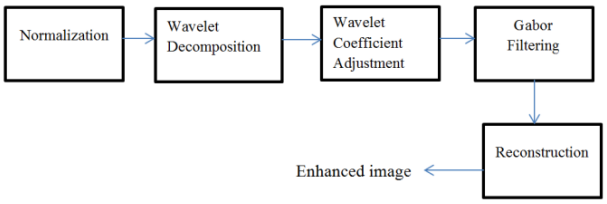

Figure.2.3 Steps involved in Enhancement using Gabor Filters combined with wavelet transform

D. Advantages:

a. Effective de-noising.

b. Increases the contrast between the ridge and the background

c. Improved enhanced image.

E. Disadvantage:

a. Computationally expensive

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 4, Issue 5, May 2017

2.5. Binarization and Thinning:

The operation that converts a gray-scale image into a binary image is known as binarization. A pixel with the value 0 is displayed as black; pixels with the value 1 are displayed as white. Thinning means reducing binary objects or shapes in an image to strokes that are a single pixel wide. Finger print ridges are fairly thick; it may be desirable for subsequent shape analysis to thin the ridges so that each is one pixel thick. Thinned (one pixel thickness) ridgelines are obtained using morphological thinning operations. Binarization can be carried out using an adaptive thresholding. Each pixel is assigned a new value (1 or 0) according to the intensity mean in a local neighborhood of (mxn pixels).

Thinning: One of the most common uses of thinning is to reduce the threshold output of an edge detector such as the Sobel operator, to lines of a single pixel thickness, while preserving the full length of those lines (i.e. pixels at the extreme ends of lines should not be affected). A simple algorithm for doing this is the following: Consider all pixels on the boundaries of foreground regions (i.e. foreground points that have at least one background neighbor). Delete any such point that has more than one foreground neighbor, as long as doing so does not locally disconnect (i.e. split into two) the region containing that pixel. Iterate until convergence. This procedure erodes away the boundaries of foreground objects as much as possible, but does not affect pixels at the ends of lines. This effect can be achieved using morphological thinning by iterating until convergence with the structuring elements.

CONCLUSION

The fingerprint recognition systems are affected by the quality of the fingerprint image. The image acquired by various devices are affected by the noise, blur etc. So there is a need for enhancing the fingerprint images to get better results .The techniques presented in this paper will help in enhancing the fingerprint image and help in better matching in fingerprint recognition systems.

REFERENCES

[1] Greenberg, Shlomo, et al. "Fingerprint image enhancement using filtering techniques." Pattern Recognition, 2000. Proceedings. 15th International Conference on. Vol. 3. IEEE, 2000.

[2] Manju, M., and V. Kavitha. "Survey on Fingerprint Enhancement Techniques." International Journal of Computer Applications 62.4 (2013).

[3] C Greenberg, Shlomo, et al. "Fingerprint image enhancement using filtering techniques." Pattern Recognition, 2000. Proceedings. 15th International Conference on. Vol. 3. IEEE, 2000.

[4] Saini, Annu. "Image enhancement techniques for fingerprint images." IJETTCS 1.3 (2012).

[5] Jyotika Chopra and Dr. P.C. Upadhyay. “Various Fingerprint Enhancements and Matching Technique” International Journal of Electronics and Communication Engineering, ISSN 0974-2166 Volume 5, Number 3, pp. 279-289, 2012.