IOSR Journal of Electronics and Communication Engineering (IOSRJECE)
ISSN : 2278-2834 Volume 2, Issue 6 (Sep-Oct 2012), PP 17-21
www.iosrjournals.org

Fingerprint Recognition Using Gabor Filter And Frequency Domain Filtering

Kondreddi Gopi[1], J.T Pramod[2]
[1,2](ECE Department, MITS, Madanapalle, India)

ABSTRACT: *Fingerprint recognition is one of the most popular methods used for identification with greater degree of success. The fingerprint has unique characteristics called minutiae, which are points where a curve track finishes, intersect or branches off. In this work a novel method for Fingerprint recognition is considered using a combination of Fast Fourier Transform (FFT) and Gabor Filters to enhancement the image. The proposed method involves combination of Gabor filter and Frequency domain filtering for enhancing the fingerprint. With eight different orientations of Gabor filter, features of the fingerprint are extracting and are combined. In Frequency domain filtering, the fingerprint image is subdivided into 32*32 small frames. Features are extracted from these frames in frequency domain. Final enhanced fingerprint is obtained the results of Gabor filter and frequency domain filtering. Binarization and Thinning follows next where the enhanced fingerprint is converted to binary and the ridges are thinned to one pixel width. This helps in extracting the Minutiae parts (ridge bifurcation and ridge endings). Euclidian distance method used for performance of recognition. The overall recognition rate for the proposed method is 95% obtained as which is much better compared to histogram method where the recognition rate is 64%. This project is implemented using MATLAB.*
Keywords - *Gabor filter, fingerprint, FFT, Minutia, AFIS.*

I. Introduction

The biometry or biometrics refers to the automatic identification of an individual by using certain physiological or behavioural traits associated with the person. Traditionally, passwords and ID cards have been used to moderate access to restricted systems. However, security can be easily breached in these systems when a password is divulged to an unauthorized user or an impostor steals a card. Furthermore, simple passwords are easy to guess and difficult passwords may be hard to recall. Fingerprints are fully formed at about seven months of fetus development and finger ridge configurations do not change throughout the life of an individual except due to accidents such as bruises and cuts on the fingertips. This property makes fingerprints a very attractive biometric identifier. Fingerprint recognition represents the oldest method of biometric identification. Its history is going back as far as at least 2200 BC. Since 1897, has been used for criminal identification. A fingerprint consists of ridges and valleys. The pattern of the ridges and valleys is unique for each individual. There are two major methods of fingerprint matching: Local Features and global pattern matching. The first approach analyses ridge bifurcations and endings, the second method represents a more macroscopic approach. The last approach considers the flow of ridges in terms of, for example, arches loops and whorls. As the equal-error-rate is low, therefore fingerprint recognition is very accurate. Another important characteristic is to take into account the type from used reader, one of capacitive surface or of optical surface; we used of optical surface for this work. In an image between greater is the quality, lesser is the probability of finding a false minutia. A false minutia is created by a bad quality of the image.

II. Gabor Filter

A Gabor filter is a linear filter whose impulse response is defined by a harmonic function multiplied by a Gaussian function. Because of the multiplication-convolution property (Convolution theorem), the Fourier transform of a Gabor filter's impulse response is the convolution of the Fourier transform of the harmonic function and the Fourier transform of the Gaussian function.

A Gabor filter is a linear filter used for edge detection in image processing which is named after Dennis Gabor. Gabor filter frequency and orientation representations are similar to those of human visual system, for texture representation and discrimination it has been found to be remarkably appropriate. A sinusoidal plane wave has been modulating a 2D Gabor filter which is a Gaussian kernel function in the spatial domain. From one parent wavelet all filters can be generated by dilation and rotation, thus the Gabor filters are self-similar. *With eight different orientations of Gabor filter, features of the fingerprint are extracting and are combined.* where f represents the ridge frequency and the choice of $\delta_x{}^2$and $\delta_y{}^2$ determines the shape of the filter envelope and also the trade of between enhancement and spurious artifacts. This is by far, the most popular approach for fingerprint enhancement

$$G(x,y) = \exp\{-\tfrac{1}{2}[\frac{x^2}{\delta_x{}^2} + \frac{y^2}{\delta_y{}^2}]\}\cos(2\pi f x) \qquad (1)$$

III. Frequency Domain Filtering

The main aim of enhancement to improve the clarity of ridge structure in the recoverable region and mark unrecoverable regions

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

$$\mathrm{F(U,V)} = \sum_{\mathrm{x=0}}^{\mathrm{M-1}} \sum_{\mathrm{y=0}}^{\mathrm{N-1}} \mathrm{f(x,y)} * \exp\left\{-\mathrm{j}2\pi * \left(\frac{\mathrm{ux}}{\mathrm{M}} + \frac{\mathrm{vy}}{\mathrm{N}}\right)\right\} \qquad (2)$$

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)|.

IV. Proposed Enhancement

From the previous subsections is clear that both approaches present desirable features that can be combined to obtain better image enhancement results. Thus this project proposes to use a combination of Fourier transform and Gabor filtering to carry out the image enhancement task. In the final image with minutiae's detected in each stage is observed. Since we have the two enhanced images an algebraic sum is made and only the resulting pixel will be white, if in the two images the pixel is white too.

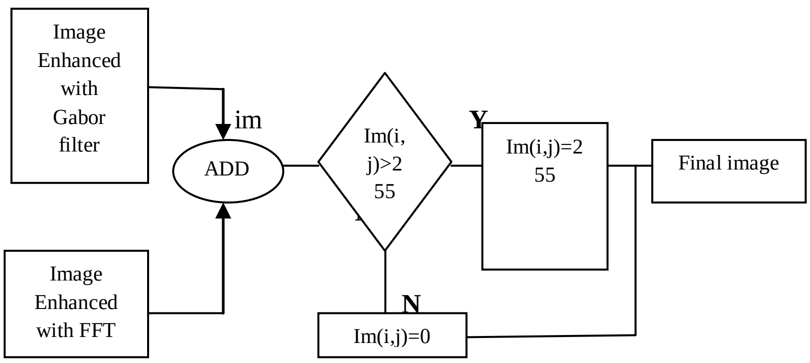

Fig.1. Block diagram of proposed fingerprint enhancement method

V. Binarization

Image binarization is the process of turning a gray scale image to a black and white image. In a gray-scale image, a pixel can take on 256 different intensity values while each pixel is assigned to be either black or white in a black and white image. This conversion from gray-scale to black and white is performed by applying a threshold value to the image. In MATLAB, a value of one means the pixel is white, whereas a value of zero indicates the pixel is black. For a gray-scale image, the pixels are decimal values between zero and one. When a threshold is applied to an image, all pixel values are compared to the input threshold. Any pixel values below the threshold are set to zero, and any values greater than the threshold are set to one. By the end of this process, all pixel values within the image are either zero or one, and the image has been converted to binary format.

VI. Thinning

Ridge Thinning is to eliminate the redundant pixels of ridges till the ridges are just one pixel wide. 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. In my testing, such an iterative, parallel thinning algorithm has bad efficiency although it can get an ideal thinned ridge map after enough scans. Their method traces along the ridges having maximum gray intensity value. However, binarization is implicitly enforced since only pixels with maximum gray intensity value are remained. Also in my testing, the advancement of each trace step still has large computation complexity although it does not require the movement of pixel by pixel as in other thinning algorithms. This is done by using the following MATLAB□ s thinning function.

VII. Minutia Detection

After the fingerprint ridge thinning, marking minutia points is relatively easy. But it is still not a trivial task as most literatures declared because at least one special case evokes my caution during the minutia marking stage. In general, for each 3x3 window, if the central pixel is 1 and has exactly 3 one-value neighbours, then the central pixel is a ridge branch. If the central pixel is 1 and has only 1 one-value neighbour, then the central pixel is a ridge ending.

VIII. Implementation

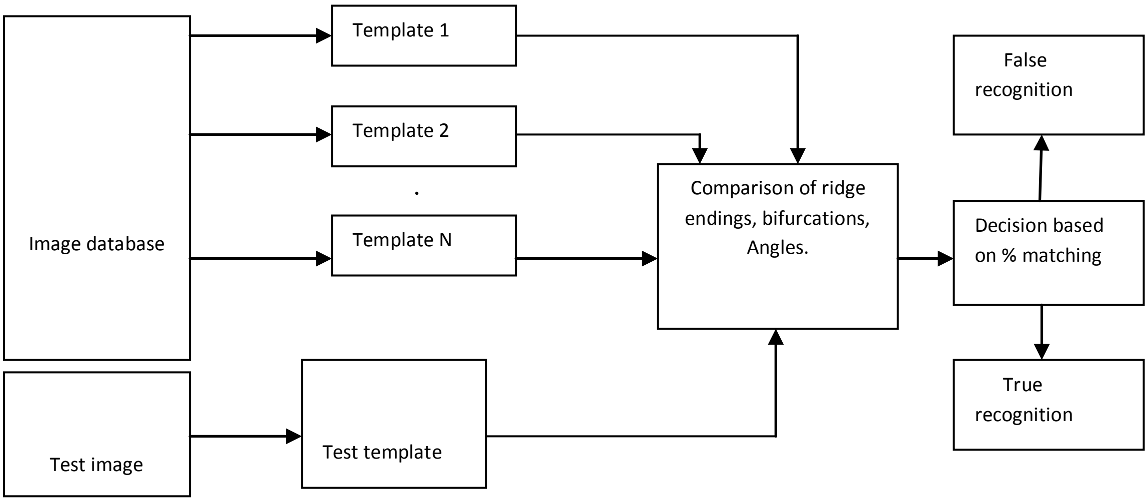

Fig.2. Implementation Block diagram

The block diagram which is used for fingerprint recognition is shown in the above figure. Image database consists of number of fingerprint images. Each fingerprint creates their own templates. The templates consists of ridge endings, ridge bifurcations and angle of orientations. Each fingerprint creates their own templates. Test image is nothing but the fingerprint image that is used for recognition. The test image can also create their own test template. Test template consists of ridge endings, ridge bifurcations and angle of orientations. Ridge endings and ridge bifurcations consists of X and Y coordinates. Then we can compare the edges, bifurcations, angles of image database templates and test templates.

IX. Results

Fig.3. input image

Fig.4. Gabor filter enhancement

Fig.5. FFT enhancement

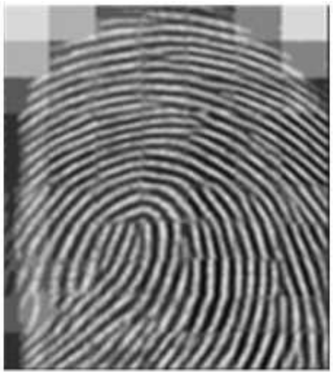

Fig.6. Proposed enhancement

Fig.7. Binarized image

Fig.8. Thinned image

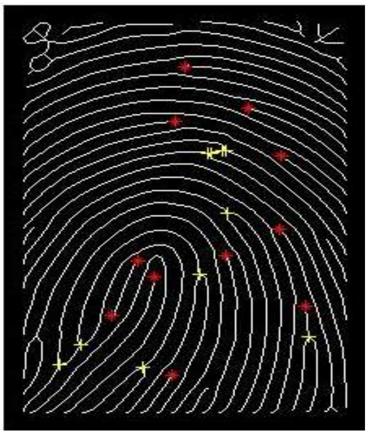

Fig.9. Minutia marking

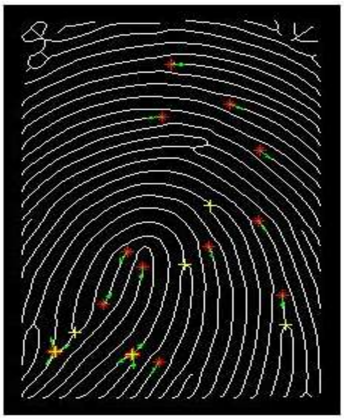

Fig.10 False minutia removal

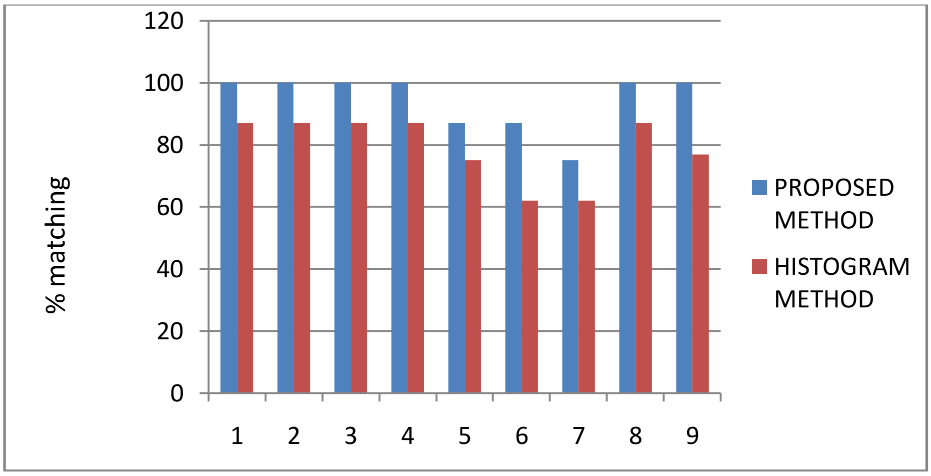

Fig.11. Percentage recognition comparison for proposed method and histogram method

X. Summary And Conclusion

This project Fingerprint recognition using Gabor filter and Frequency domain filtering involves the following steps: collection of database, Gabor filter enhancement, FFT enhancement, Proposed enhancement, Binarization, Thinning, Minutia detection.

The image database consists of eight fingers of nine different persons. So, the database consists of totally seventy two fingers. It can also be downloaded from fingerprint verification combination 2002(FVC 2002). With eight different orientations of Gabor filter, features of the fingerprint are extracting and are combined. In Frequency domain filtering, the fingerprint image is subdivided into 32*32 small frames. Features are extracted from these frames in frequency domain. In this project we used combination of Gabor filter and FFT enhancements. For the resultant enhanced image binarization[21] technique was applied in which black pixels are assigned to '0', white pixels are assigned to '1'. Thinning was applied to the binarized image which produces the Skeleton structure [2]. Then we mark the minutia's, by using this minutia markings the recognition was done [3].

The overall recognition rate for the proposed method is 95% obtained as which is much better compared to histogram method where the recognition rate is 64%. This project is implemented using MATLAB.

XI. Conclusion

From the reported investigations, it can be concluded that the overall recognition rate is higher for the proposed method compared to the histogram method. In this project we use Euclidian distance method for fingerprint recognition. Usually the reason for fault recognition or low recognition rate occurs due to positioning of fingerprint. For example fingerprints in the database or the ones used for testing might be oriented in a particular angle or might be positioned for left or right, top or bottom of the image. Due to this, fingerprint matching might get faulty. One way to reduce the fault recognition is to reorient or readjust the fingerprints such that the core comes at the center of the image and then start the matching process[8]. This can be scope for future improvement of the project.

REFERENCES

[1] Leung, M. Engeler, and Frank, "Fingerprint image processing using neural network". Proceedings of the IEEE conf. on Computer and CommunicationSystems, pp. 671-774, 1990.
[2] Louisa Lam,Seong Whan Lee "Thinning Methodologies A ComprehensiveSurvey", IEEE Transactions on Pattern Analysis and Machine Intelligence", Vol.14, no. 9, pp. 869-885, 1992.
[3] Dario Maio and Davide Maltoni "Direct Gray-Scale Minutiae Detection in Fingerprints", IEEE Transactions on pattern Analysis and Machine Intelligence, Vol. 19, no. 1, pp. 27-40, 1997.
[4] Ton van der Putte and Jeroen Keuning "Biometrical Fingerprint Recognition", Fourth Working Conference on Smart Card Research and Advanced Applications, pp 289-303, 2000.
[5] Zsolt Miklo, Kova CS Vajna "A Fingerprint Verification System Based onTriangular Matching and Dynamic Time Warping", IEEE Transactions on PatternAnalysis and machine Intelligence, Vol. 22, NO. 11, pp. 1266-1276, 2000.
[6] A.K.Jain, R.Bolle, and S.Pankanti, "Biometrics Personal Identification inNetworked Society", Kluwer Academic Publishers New York, Boston, Dordrecht,London, Moscow, pp. 1-64, 2002.
[7] Bolle, R.,Serior, A.Ratha, and Pankanti, "Fingerprint minutiae a constructivedefinition". Proceedings of the workshop on Biometric Authentication, PP, 58–66(2002)
[8] Milene Arantes, Alessandro Noriaki Ide "A System ForFingerprint MinuteClassification and Recognition" Proceedings of the IEEE International Conference on Neural Information Processing, Vol. 5, pp. 2474-2478, 2002.