ISSN (ONLINE) : 2395-695X
ISSN (PRINT) : 2395-695X
Available online at www.ijarbest.com

International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST)
Vol. 1, Issue 9, December 2015

# A Novel Approach for Fingerprint Recogniton

Amzi Giftlin Lydial A[1], Mrs.Annapoorani G[2]

*M.Tech, Dept of Computer Science & Engineering, Indian Institute of Information Technology - Srirangam Tiruchirapalli, India[1]*

*Assistant Professor, Dept of Computer Science & Engineering, Anna University of Technology, Tiruchirappalli Tiruchirappalli, India[2]*

E-mail: amzi1992@gmail.com, E-mail: pooranikrish@gmail.com

*Abstract*— **Fingerprint recognition is one of most popular and accuracy Biometric technologies. Nowadays, it is used in many real applications. However, recognizing fingerprints in poor quality images is still a very complex problem. In recent years, many algorithms, models are given to improve the accuracy of the recognition system. This paper discusses on the standardized fingerprint model which is used to synthesize the template of fingerprints. In this model, after pre-processing step, we find the transformation between templates, adjust parameters, synthesize fingerprint, and reduce noises. Then, this paper use the final fingerprint to match with others in FVC2004 fingerprint database (DB4) to show the capability of the model.**

***Index Terms*— Fingerprint, minutia, recognition and segmentation.**

## I. INTRODUCTION

A fingerprint is the feature pattern of one finger Fig.1. It is believed with strong evidences that each fingerprint is unique. Each person has his own fingerprints with the permanent uniqueness. So fingerprints have being used for identification and forensic investigation for a long time.

Fig. 1 A fingerprint image acquired by an Optical Sensor

A fingerprint is composed of many ridges and furrows. These ridges and furrows present good similarities in each small local window, like parallelism and average width. However, shown by intensive research on fingerprint recognition, fingerprints are not distinguished by their ridges and furrows, but by Minutia, which are some abnormal points on the ridges Fig. 2. Among the variety of minutia types reported in literatures, two are most significant and in heavy usage: one is called termination, which is the immediate ending of a ridge; the other is called bifurcation, which is the point on the ridge from which two branches derive.

The fingerprint recognition problem can be grouped into two sub-domains: one is fingerprint verification and the other is fingerprint identification Fig. 3. In addition, different from the manual approach for fingerprint recognition by experts, the fingerprint recognition here is referred as AFRS (Automatic Fingerprint Recognition System), which is program-based. The valley is also referred as Furrow, Termination is also called Ending and Bifurcation is also called Branch

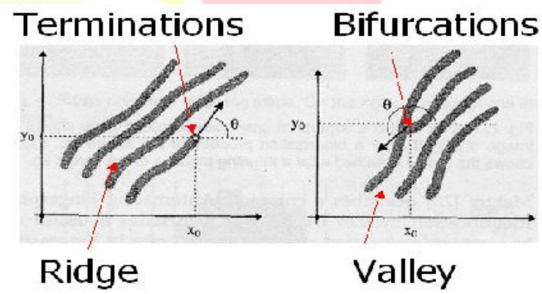


Fig. 2 Ridge and valley

Fingerprint verification is to verify the authenticity of one person by his fingerprint. The user provides his fingerprint together with his identity information like his ID number. The fingerprint verification system retrieves the fingerprint template according to the ID number and matches the template with the real-time acquired fingerprint from the user. Usually it is the underlying design principle of AFAS (Automatic Fingerprint Authentication System).

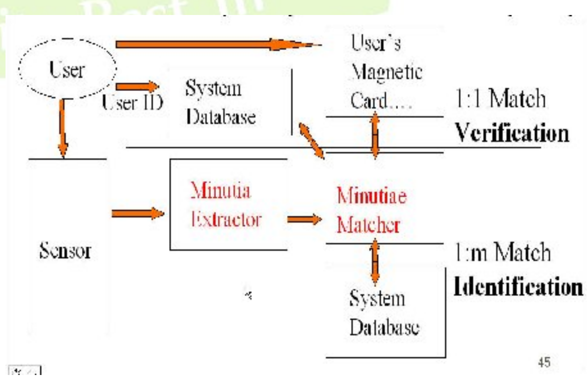


Fig. 3 Verification vs. Identification

ISSN (ONLINE) : 2395-695X
ISSN (PRINT) : 2395-695X
Available online at www.ijarbest.com

International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST)
Vol. 1, Issue 9, December 2015

## II. RELATED WORK

G. Sambasiva Rao et al., [1] proposed fingerprint identification technique using a gray level watershed method to find out the ridges present on a fingerprint image by directly scanned fingerprints or inked impression. Robert Hastings [2] developed a method for enhancing the ridge pattern by using a process of oriented diffusion by adaptation of anisotropic diffusion to smooth the image in the direction parallel to the ridge flow. The image intensity varies smoothly as one traverse along the ridges or valleys by removing most of the small irregularities and breaks but with the identity of the individual ridges and valleys preserved.

Jinwei Gu, et al., [3] proposed a method for fingerprint verification which includes both minutiae and model based orientation field is used. It gives robust discriminatory information other than minutiae points. Fingerprint matching is done by combining the decisions of the matchers based on the orientation field and minutiae. V. Vijaya Kumari and N. Suriyanarayanan [4] proposed a method for performance measure of local operators in fingerprint by detecting the edges of fingerprint images using five local operators namely Sobel, Roberts, Prewitt, Canny and LoG. The edge detected image is further segmented to extract individual segments from the image.

Raju Sonavane, and B.S. Sawant [5] presented a method by introducing a special domain fingerprint enhancement method which decomposes the fingerprint image into a set of filtered images then orientation field is estimated. A quality mask distinguishes the recoverable and unrecoverable corrupted regions in the input image are generated. Using the estimated orientation field, the input fingerprint image is adaptively enhanced in the recoverable regions. Eric P.

Kukula, et al., [6] purposed a method to investigate the effect of five different force levels on fingerprint matching performance, image quality scores, and minutiae count between optical and capacitance fingerprint sensors. Three images were collected from the right index fingers of 75 participants for each sensing technology. Descriptive statistics, analysis of variance, and Kruskal-Wallis nonparametric tests were conducted to assess significant differences in minutiae counts and image quality scores based on the force level. The results reveal a significant difference in image quality score based on the force level and each sensor technology, yet there is no significant difference in minutiae count based on the force levels of the capacitance sensor. The image quality score, shown to be effected by force and sensor type, is one of many factors that influence the system matching performance, yet the removal of low quality images does not improve the system performance at each force level.

M. R. Girgisa et al., [7] proposed a method to describe a fingerprint matching based on lines extraction and graph matching principles by adopting a hybrid scheme which consists of a genetic algorithm phase and a local search phase. Experimental results demonstrate the robustness of algorithm. Luping Ji, and Zhang Yi [8] proposed a method for estimating four direction orientation field by considering four steps, i) preprocessing fingerprint image, ii) determining the primary ridge of fingerprint block using neuron pulse coupled neural network, iii) estimating block direction by projective distance variance of a ridge, instead of a full block, iv) correcting the estimated orientation field.

Duoqian Maio et al., [9] used principal graph algorithm by kegl to obtain principal curves for auto fingerprint identification system. From principal curves, minutiae extraction algorithm is used to extract the minutiae of the fingerprint. The experimental results shows curves obtained from graph algorithm are smoother than the thinning algorithm. Alessandra Lumini, and Loris Nanni [10] developed a method for minutiae based fingerprint and its approach to the problem as two - class pattern recognition. The obtained feature vector by minutiae matching is classified into genuine or imposter by Support Vector Machine resulting remarkable performance improvement.

Sharath Pankanti et al., [11] proposed Scale Invariant Feature Transformation (SIFT) to represent and match the fingerprint. By extracting characteristic SIFT feature points in scale space and perform matching based on the texture information around the feature points. The combination of SIFT and conventional minutiae based system achieves significantly better performance than either of the individual schemes. Manvjeet Kaur et al., [12] have introduced combined methods to build a minutia extractor and a minutia matcher. Segmentation with Morphological operations used to improve thinning, false minutiae removal, minutia marking. Haiping

Lu et al., [13] proposed an effective and efficient algorithm for minutiae extraction to improve the overall performance of an automatic fingerprint identification system because it is very important to preserve true minutiae while removing spurious minutiae in post-processing. The proposed novel fingerprint image post-processing algorithm makes an efforts to reliably differentiate spurious minutiae from true ones by making use of ridge number information, referring to original gray-level image, designing and arranging various processing techniques properly, and also selecting various processing parameters carefully. The proposed post-processing algorithm is effective and efficient.

Prabhakar S, Jain. A.K. et al., [14] has developed filter-based representation technique for fingerprint identification. The technique exploits both local and global characteristics in a fingerprint to make identification. Each fingerprint image is filtered in a number of directions and a 640-dimensinal feature vector is extracted in the central region of the fingerprint. The feature vector is compact and requires only 640 bytes. The matching stage computes the Euclidian distance between the template finger code and the input finger code. The method gives good matching with high accuracy.

Ballan M [15] introduced Directional Fingerprint Processing using fingerprint smoothing, classification and identification based on the singular points (delta and core points) obtained from the directional histograms of a fingerprint. Fingerprints are classified into two main categories that are called Lasso and Wirbel. The process includes directional image formation, directional image block representation, singular point detection and decision. The method gives matching decision vectors with minimum errors, and method is simple and fast.

ISSN (ONLINE) : 2395-695X
ISSN (PRINT) : 2395-695X
Available online at www.ijarbest.com

International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST)
Vol. 1, Issue 9, December 2015

## III. METHODOLOGY

For the fingerprint image preprocessing stage, this project use Histogram Equalization and Fourier Transform to do image enhancement. And then the fingerprint image is binarized using the locally adaptive threshold method.

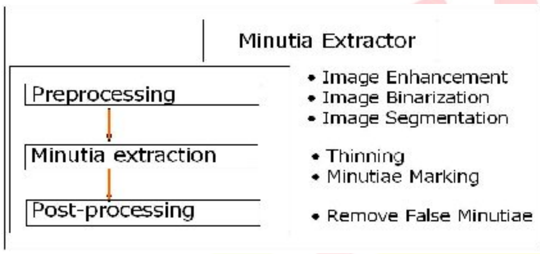


Fig. 4 Minutia Extractor

The image segmentation task is fulfilled by a three-step approach: block direction estimation, segmentation by direction intensity and Region of Interest extraction by Morphological operations. Most methods used in the preprocessing stage are developed by other researchers but they form a brand new combination in my project through trial and error. Also the morphological operations for extraction ROI are introduced to fingerprint image segmentation by myself.

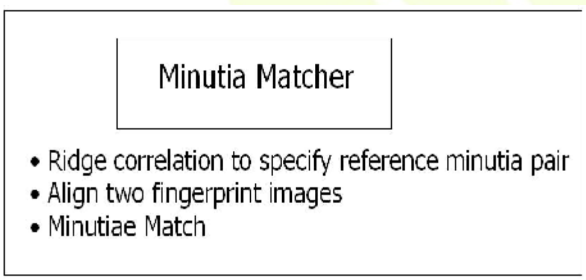


Fig.5 Minutia Matcher

For minutia extraction stage, three thinning algorithms are tested and the Morphological thinning operation is finally bid out with high efficiency and pretty good thinning quality. The minutia marking is a simple task as most literatures reported but one special case is found during my implementation and an additional check mechanism is enforced to avoid such kind of oversight. For the postprocessing stage, a more rigorous algorithm is developed to remove false minutia. Also a novel representation for bifurcations is proposed to unify terminations and bifurcations.

### A. Preprocessing

Fingerprint Image enhancement is to make the image clearer for easy further operations. Since the fingerprint images acquired from sensors or other medias are not assured with perfect quality, those enhancement methods, for increasing the contrast between ridges and furrows 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. To enhance the fingerprint the Histogram Equalization is used.

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 has the bimodal type Fig. 7a, the histogram after the histogram equalization occupies all the range from 0 to 255 and the visualization effect is enhanced Fig.7b

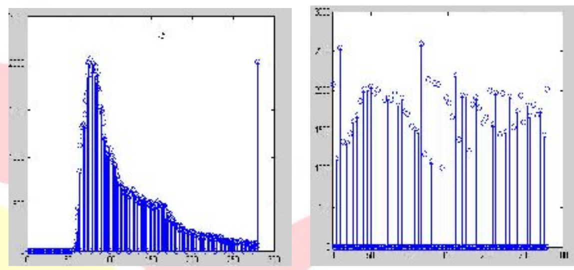

Fig. 7a the Original histogram of a fingerprint image
Fig. 7b Histogram after the Histogram Equalization

### B. Image Binarization

Fingerprint Image Binarization is to transform the 8-bit Gray fingerprint image to a 1-bit image with 0-value for ridges and 1-value for furrows. After the operation, ridges in the fingerprint are highlighted with black color while furrows are white. A locally adaptive binarization method is performed to binarize the fingerprint image. Such a named method comes from the mechanism of transforming a pixel value to 1 if the value is larger than the mean intensity value of the current block (16x16) to which the pixel belongs Fig.2.4.

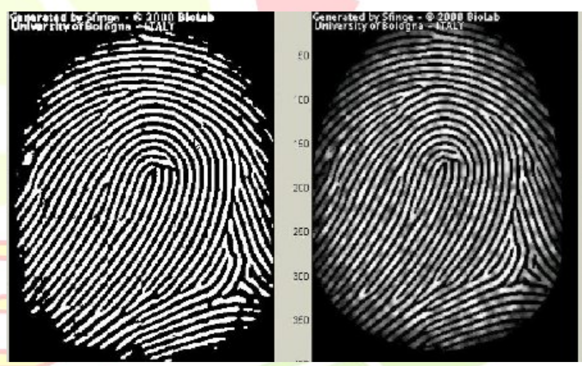

Fig. 8 the Fingerprint image after adaptive binarization
Binarized image(left), Enhanced gray image(right)

### C. Image Segmentation

In general, only a Region of Interest (ROI) is useful to be recognized for each fingerprint image. The image area without effective ridges and furrows is first discarded since it only holds background information. Then the bound of the remaining effective area is sketched out since the minutia in the bound region are confusing with those spurious minutia that are generated when the ridges are out of the sensor. To extract the ROI, a two-step method is used. The first step is block direction estimation and direction variety check, while the second is intrigued from some Morphological methods.

Given two set of minutia of two fingerprint images, the minutia match algorithm determines whether the two minutia sets are from the same finger or not.

An alignment-based match algorithm partially derived from the is used in my project. It includes two consecutive stages: one is alignment stage and the second is match stage.

1. Alignment stage. Given two fingerprint images to be matched, choose any one minutia from each image, calculate the similarity of the two ridges associated with the two referenced minutia points. If the similarity is larger than a threshold, transform each set of minutia to a new coordination system whose origin is at the referenced point and whose x-axis is coincident with the direction of the referenced point.
2. Match stage: After we get two set of transformed minutia points, we use the elastic match algorithm to count the matched minutia pairs by assuming two minutia having nearly the same position and direction are identical.

## IV. Experimental Results

### *A. DataBase*

Database used for experiment is DB4 FVC2004. Several fingerprint images in this database are low quality. Size of each fingerprint images is 288x384 pixels, and its resolution is 500 dpi. FVC2004 DB4 has 800 fingerprints of 100 fingers (8 images for each finger). Fingerprint images are numbered from 1 to 100 followed by a another number (from 1 to 8) which mean that the image fingerprint is first to 8th impression of certain finger

Fig. 9 Fingerprint image after evaluated

## V. Conclusion

This paper combined many methods to build a minutia extractor and a minutia matcher. The combination of multiple methods comes from a wide investigation into research paper. Also some novel changes like segmentation using Morphological operations, minutia marking with special considering the triple branch counting, minutia unification by decomposing a branch into three terminations, and matching in the unified x-y coordinate system after a two-step transformation are used in this paper. Also a program coding with Netbeans going through all the stages of the fingerprint recognition is built. It is helpful to understand the procedures of fingerprint recognition. And demonstrate the key issues of fingerprint recognition.

## References

[1] G.Sambasiva Rao, C. NagaRaju, L. S. S. Reddy and E. V. Prasad, "A Novel Fingerprints Identification System Based on the Edge Detection", International Journal of Computer Science and Network Security, vol.8, pp. 394-397, (2008). J. U. Duncombe, "Infrared navigation—Part I: An assessment of feasibility," *IEEE Trans. Electron Devices*, vol. ED-11, pp. 34-39, Jan. 1959.

[2] Robert Hastings, "Ridge Enhancement in Fingerprint Images Using Oriented Diffusion", IEEE Computer Society on Digital Image Computing Techniques and Applications, pp. 245-252, (2007).

[3] Jinwei Gu, Jie Zhou, and Chunyu Yang, "Fingerprint Recognition by Combining Global Structure and Local Cues", IEEE Transactions on Image Processing, vol. 15, no. 7, pp. 1952 – 1964, (2006). W.-K. Chen, *Linear Networks and Systems*, Belmont, CA: Wadsworth, 1993, pp. 123-135.

[4] V. Vijaya Kumari and N. Suriyanarayanan, "Performance Measure of Local Operators in Fingerprint Detection", Academic Open Internet Journal, vol. 23, pp. 1-7, (2008).

[5] Raju Sonavane and B. S. Sawant, "Noisy Fingerprint Image Enhancement Technique for Image Analysis: A Structure Similarity Measure Approach", Journal of Computer Science and Network Security, vol. 7 no. 9, pp. 225-230, (2007).

[6] Eric P. Kukula, Christine R. Blomeke, Shimon K. Modi, and Tephen J. Elliott, "Effect of Human Interaction on Fingerprint Matching Performance, Image Quality, and Minutiae Count", International Conference on Information Technology and Applications, pp. 771-776, (2008).

[7] M. R. Girgisa, A. A. Sewisyb and R. F. Mansourc, "Employing Generic Algorithms for Precise Fingerprint Matching Based on Line Extraction", Graphics, Vision and Image Procession Journal, vol. 7, pp. 51-59, (2007).

[8] Luping Ji, Zhang Yi, "Fingerprint Orientation field Estimation using Ridge Protection", The Journal of the Pattern Recognition, vol. 41, pp. 1491-1503, (2008).

[9] Duresuoquian Miao, Qingshi Tang, and Wenjie Fu, "Fingerprint Minutiae Extraction Based on Principal Cures", the Journal of the Pattern Recognition Letters, vol. 28, pp. 2184-2189, (2007)..

[10] Alessandra Lumini, and Loris Nann, "Advanced Methods for Two-Class Pattern Recognition Problem Formulation for Minutiae-Based Fingerprint Verification", the Journal of the Pattern Recognition Letters, vol. 29, pp. 142-148, (2008).

[11] Unsang Parh, Sharath Pankanti,and A. K. Jain, "Fingerprint Verification using SIFT Features", SPIE Defense and Security Symposium, (2008).

[12] Manvjeet Kaur, Mukhwinder Singh, Akshay Girdhar, and Parvinder S. Sandhu, "Fingerprint Verification System using Minutiae Extraction Technique", Proceedings of World Academy of Science, Engineering and Technology vol. 36, pp. 497-502, (2008).

[13] Haiping Lu, Xudong Jiang and Wei-Yun Yau, "Effective and Efficient Fingerprint Image Post processing", International Conference on Control, Automation, Robotics and Vision, vol. 2, pp. 985- 989, (2002)

[14] Prabhakar, S, Jain, A.K, Jianguo Wang, Pankanti S, Bolle, "Minutia Verification and Classification for Fingerprint Matching", International Conference on Pattern Recognition vol. 1, pp. 25-29, (2002).

[15] Ballan.M, "Directional Fingerprint Processing", International Conference on Signal Processing, vol.2, pp. 1064-1067, (1998).