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A Review on Fingerprint-Based Identification System

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Abstract: Biometric fingerprints are the most widely used personal identification tool because of their individuality, uniqueness and reliability. A fingerprint image consists of a pattern of the valleys & ridges on human fingertips. Fingerprint authentication is possibly the most sophisticated method of all biometric techniques and has been thoroughly verified through various applications. All human recognition techniques using fingerprints are based on one of the three methods: Minutiae-based, correlation-based, and hybrid. This paper provides a review of various fingerprint recognition techniques and then discusses a general minutiae-based fingerprint identification system.

Key words: Correlation, Segmentation, histogram, spatial domain.

I. INTRODUCTION

Fingerprints being the oldest and easily available trait of biometrics, offers an infallible means of personal identification. Even features such as persons gait, face or signature may change with passage of time and may be fabricated or imitated. However a fingerprint is completely unique to an individual and stayed unchanged for lifetime. Therefore, fingerprint authentication is one of the most researched and matured field of biometric authentication. Fingerprints provide an outstanding source of entropy which makes them an excellent candidate for security applications. Users cannot pass their fingerprint characteristics to others as easily as they do with their cards or passwords [11].

A fingerprint image consists of a pattern of the valleys & ridges on human fingertips. Ridges are dark whereas valleys are bright. Ridges and valleys often run in parallel; sometimes they bifurcate and sometimes they terminate. According to Galton [1], a fingerprint is constituted by a set of ridge lines which often run parallel, sometimes terminates and sometimes intersects. The discontinuities, such as an end point or a bifurcation are known as minutiae, which may divide and almost immediately reunite, enclosing a small circular or elliptical space or sometimes the independent beginning or ending of ridges.

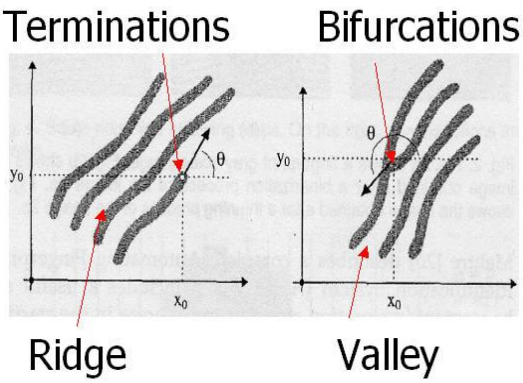

Figure 1: Minutiae (Valley is also referred as Furrow, Termination is also called Ending, and Bifurcation is also called Branch)

Figure 2: Fingerprint Image

Fingerprint authentication techniques are based on three methods: minutiae-based, correlation –based and hybrid. In minutiae-based techniques two sets of minutiae points taken from two fingerprints are aligned and then total number of matched minutiae are counted[5,8]. Accuracy and performance of minutiae-based techniques, however depends on the accurate detection of minutiae points as well as the use of sophisticated matching techniques to compare two minutiae fields that undergo non-rigid transformations. In the correlation-based approach, global patterns of ridges and furrows are compared to determine whether two fingerprints are aligned [12]. Performance of correlation-based techniques is affected by non-linear distortions and noise present in the image. In hybrid methods, local orientation and frequency, ridge shape, and texture information are used to extract fingerprint features [15]. This paper is organized as follows: Section II describes the work done related to fingerprint authentication, section III provides a general architecture of minutiae-based fingerprint recognition system, section IV discusses some challenging issues and finally conclusions are drawn in section V.

II. RELATED WORK

In the field of fingerprint identification, different types of work have been done so far. D. Maio and D. Maltoni [3] performed "Direct gray-scale minutiae detection in fingerprints". The authors proposed the concept of binarization and the conversion of an image into gray form to obtain the minutiae patter a better for the finger print matching. The authors performed the work in different environments and the result obtained were compared with

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others and found the better results. The author considers direct matching of gray scale minutiae which also gives better results in terms of speed.

L. Hong, Y. Wan and A.K. Jain [6] performed a work, "Fingerprint Image Enhancement: Algorithms and Performance Evaluation". The authors performed the enhancement of the finger print pattern and the algorithm was based on the segmentation which describes the performance of the pattern depending upon the enhancement using different techniques. The work was to obtain the results for different environment with equal compatibility. Koichi et. al. [9] proposed a fingerprint recognition algorithm combining phase-based image matching and feature-based matching for improving matching performance for both fingerprint images with poor image quality and with nonlinear shape distortions. The two approaches may result in significant improvements of recognition performance.

Gualberto Aguilar [13] used Fast Fourier Transform and Gabor Filters to enhance and reconstruct the information of the fingerprint image, as well as to extract two fundamental types of minutiae, ending points and bifurcations. Finally the extracted features are used to perform the fingerprint recognition. Asker M. Bazen et. al.[16] showed that reinforcement learning can be used for minutiae detection in fingerprint matching. They proposed a approach in which an autonomous agent walks around in the fingerprint and learns how to follow ridges in the fingerprint and to recognize the minutiae. By choosing the right structure and learning environment, the agent is able to easily specified, for they are part of the learning task as well. Arivazhagan et al. [14] proposed a fingerprint verification method using Gabor wavelets and co-occurrence matrices to obtain a finger code. Mohammed S Khalil [17] proposed a method to verify an enhanced fingerprint verification method using four statistical descriptors to characterize a co-occurrence matrix. In this method a sub image of 129 X 129 was extracted from the original image and transformed into a co-occurrence matrix. The results had been analyzed by the Program for Rate Estimation and statistical Summaries (PRESS).

III FINGERPRINT RECOGNITION SYSTEM

The architecture of Fingerprint recognition system can be divided into four phases [7]: (i) fingerprint image acquisition, (ii) image enhancement process; (iii) Feature extraction from the enhanced image; and (iv) Pattern matching process.

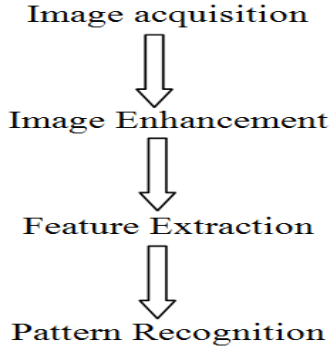

Figure 3: Steps to identify fingerprint image

(i) Image acquisition: With reference to problem domain, image sensor acquires digital images. First is a Physical device that is sensitive to the energy radiated by the object. The second, called a Digitizer, is a device for converting the output of the physical sensing device into digits form. Specialized image processing hardware consists of the digitizer and hardware that performs other primitive operations. The Computer is an image processing system which ranges from PC to Supercomputer. Software for image processing consists of specialized modules that perform specific tasks. Mass storage capability is a must in image processing applications. An image of size 1024x1024 pixels, in which the intensity of each pixel is an 8-bit quantity, requires one megabyte (MB) of storage space, if the image is not compressed. Image displays in use are mainly color TV monitors. Monitors are driven by the outputs of image and graphics display cards that are an integral part of the Computer System.

(ii) Image Enhancement: The aim of this stage is to provide a high quality image. A good quality finger print image has high contrast between ridges and valleys. A poor quality fingerprint image is low in contrast, noisy, broken, or smugy, causing spurious and missing minutiae. Techniques such as Gray-level smoothing, contrast stretching, histogram equalization, and Wiener filtering can be used as pre-processing steps before a sophisticated fingerprint enhancement algorithm is applied.

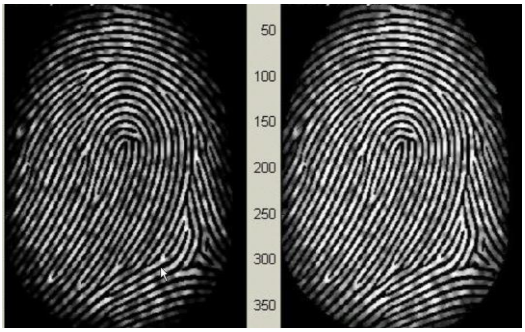

Figure 4: Histogram Enhancement: Original Image (Left). Enhanced image (Right)

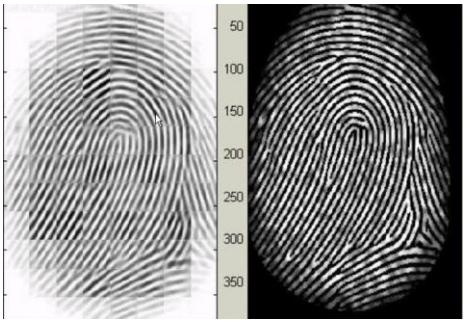

Figure 5 : Fingerprint enhancement by Fourier Transform Enhanced image (left), Original image (right)

The goal of an enhancement algorithm is to improve the clarity of the ridge structures in a fingerprint. The image is analyzed in local neighbourhoods to estimate attributes of the ridge patterns, such as ridge width, orientation and the amount of noise & image quality. A set of contextual

filters is built, based on the local information, with the aim of enhancing the underlying ridge structure while removing the noise. The complete sequence of steps for image enhancement is: (i) normalization; (ii) calculation of orientation field; (iii) region of interest extraction; (iv) Ridge extraction; and (v) ridge profiling.

(iii) Feature Extraction: Once a clean image is acquired, the minutiae features can be extracted from the image as well as their attributes and relationships. The whole process is divided into three steps: (i) thinning of reconstructed binary ridge structure achieved after image enhancement; (ii) removal of all structure imperfections from the thinned image, and (iii) minutiae extraction.

(iv) Pattern Recognition: A pattern is an arrangement of descriptors. It is characterized by the order of the elements of which it is made, rather than by the intrinsic nature of these elements. Pattern recognition is divided into two principle areas: Decision theoretic and Structural. Decision theoretic deals with patterns described using quantitative descriptors, such as length, area, and texture. Structural category deals with patterns best described by qualitative descriptors, such as the relational descriptors. Pattern recognition by machine involves techniques for assigning patterns to their respective classes-automatically and with as little human intervention as possible. Three common pattern arrangements used in practice are vectors, strings and trees. The recognition process is aimed to determine whether the fingerprint patterns have been produced by the sane finger or not. The patterns are aligned before fingerprint matching. Then a score is defined to measure the similarity between two patterns. The simplest approach is the minimum-distance classifier, which as its name implies, computes the distance between the unknown and each of the prototype vectors. The elastic technique used permits certain adaptive spatial tolerance margin to compensate for the nonlinear elastic formations [5, 7].

IV. CHALLENGING ISSUES

Fingerprint matching based on minutiae features often make assumption that the two fingerprints to be matched are of approximately same size. However, this assumption is not valid in practical. Even two fingerprints captured using two different scanners may have different size. Also two images with different orientation may fail to match in minutiae-based techniques due to relative change in their minutiae locations. In Rotated fingerprint matching, it is difficult to match minutiae of two images because due to rotation, coordinate locations ofall the minutiae points are changed. In partial fingerprint matching , it is also difficult to match minutiae of two images because due to missing part of the fingerprint, coordinate locations of all the minutiaepoints are changed. Concisely, we can summarize the issues with minutiae-based recognition as follows:

(i) The coordinate locations of minutiae points may change even with slight rotation.
(ii) In partial fingerprint images, the number of minutiae points is relatively less.
(iii) In partial fingerprint images, a change in reference point leads to change in coordinate locations of minutiae points.

However, Madhuri and Richa Sharma [18] proposed a fingerprint recognition technique based on local robust features, which is performed in presence of rotation and partial fingerprint images.

V. CONCLUSION

Fingerprint recognition methods for human authentication are fast and accurate for more reliable and secure system. This paper provides a review of existing fingerprint recognition techniques and then discusses architecture of minutiae-based recognition system. The performance of minutiae-based techniques depends on the accurate detection of minutiae points as well as the use of sophisticated matching techniques. The main issue with minutiae-based method is that the two fingerprints to be matched are of approximately same size. Two images with different orientation may fail to match in minutiae-based system. Future research work can be carried out to improve the quality of the images by improving the image enhancement techniques and to develop a better matching technique for partial and rotated fingerprint images.

REFERENCES

[1] Francis Galton, “Finger Prints” by Macmillan & Co., London, New York, 1892.
[2] Dario Maio and Davide Maltoni, “A structural approach to fingerprint classification” In 13th International Conference on Pattern Recognition, 1996.
[3] D. Maio and D. Maltoni, “Direct gray-scale minutiae detection in fingerprints”, IEEE Transactions Pattern Analand Machine Intell, 1997, 19(1) pp 27-40.
[4] B. Jahne, “Digital Image Processing: Concepts, Algorithms, and Scientific Applications”, Springer-Verlag, NY [1997].
[5] A. K. Jain, L. Hong and R. Bolle, “Online fingerprint verification”, in IEEE Transactions on Pattern Analysis and Machine Intelligence, 1997, pp 302-313.
[6] L. Hong, Y. Wan and A. K. Jain, “Fingerprint Image Enhancement: Algorithms and Performance Evaluation”, IEEE Transactions on PAMI, 1998, Vol 20, pp 777-789.
[7] D. Simao-Zortia et al., “Imaze Quality and position varability assessment in minutiae-based fingerprint verification”, IEEE proceedings , 2003, vol. 150 pp 402-408.
[8] T. Y. Jea, V. Govindaraju, “A minutiae-based partial fingerprint recognition system”, in Pattern Recognition” 2005, pp 1672-1684
[9] Koichi et al., “A Fingerprint Recognition Algorithm Combining Phase-based Image Matching and Feature-based Matching” in Springer, 2005 pp 316-325.
[10] Fernando Alonso-Fernandez et al., “An Enhanced Gabor Filter-Based Segmentation Algorithm for Fingerprint Recognition Systems”, in Proceedings of the 4th International Symposium on Image and Signal Processing and Analysis, 2005, pp 239-244.
[11] S. C. Dass and A. K. Khan, “Fingerprint-based recognition”, in Technometrics 2007, pp 262-276.
[12] A. Cavusoglu and S. Gorgunoglu,“a Robust Correlation-based Fingerprint Matching Algorithm fr Verification”, in Journal of applied Sciences, 2007 pp 3286-3291.
[13] Gualberto Aguilar, Gabriel Sanchez, “Fingerprint Recognition” IEEE, 2007.
[14] S. Arivazhagan et al. , “ Fingerprint Verification using Gabor Co-occurrence Features” in International Conference on Computational Intelligence and Multimedia Applications, 2007 pp 281-285.
[15] L. Nanni and A. Lumini, “Local binary patterns for a hybrid fingerprint matcher” Pattern Recognition, 2008 41(11) pp 3461-3466.
[16] Asker M. Bazen et al., “A Reinforcement Learning Agent for Minutiae Extraction from Fingerprints” 2008.
[17] Mohammed S Khalil et al. “Fingerprint Verification Based on Statistical Analysis”, IEEE, 2010.
[18] Madhuri and Richa Mishra, “ Fingerprint Recognition using Robust Local Features”, in IJARCSSE, 2012, Vol. 2, Issue 6, pp 1-5.