State of Art on Fingerprint Recognition

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***Abstract*— Biometric system works on behavioral and physiological biometric parameters to identify an individual. Each fingerprint contains unique features and its recognizing system mainly works on local ridge feature such as ridge endings, minutiae, core point, delta, etc. However, fingerprint images have poor quality due to variations in skin and impression conditions. In personal identification, fingerprint recognition is considered the most prominent and reliable technique for matching with stored fingerprints in the database. Some techniques and algorithms are discussed to get accurate result for the recognition. Minutiae extraction is more critical step in fingerprint matching. This paper gives idea about various feature extraction and matching algorithms for fingerprint recognition systems and to find out which technique is more reliable and secure.**

***Index Terms*— Fingerprint Images, Minutiae Extraction, Ridge Endings, Ridge Bifurcation, Fingerprint Recognition.**

I. Introduction

Biometrics gives uniqueness of humans based upon one or more physical or behavioral parameters. Biometrics is a unique feature which every individual has, so there is no need to remember passwords, or carries any document for identification. Biometric characteristics can be divided in two main types.

A. Physiological character: This is related to the shape of the body and thus it varies from person to person. Examples are fingerprints, face recognition, hand geometry and iris recognition.

B. Behavioral character: It deals with behavior of a person like signature, voice, etc. Behavioral characteristics can change with age.

The biometric system can be used as verification mode or identification mode depending on the requirement of an application. Identification is the comparison of features of query fingerprint image with available fingerprint images in database. The process requires 1: n numbers of comparisons. Therefore, it is time consuming process. On other hand, verification is comparatively easy and fast process in which query fingerprint image along with identity number is provided to system and system verifies these biometric data with database content in context with identity number. The process carries 1:1 comparison and thus verification is faster, much reliable and robust process compared to identification.

The quality of the fingerprint image has crucial importance therefore a good quality fingerprint must contain at least 25 to 80 minutiae. It is quite difficult to extract minutia from poor quality fingerprint impressions which are due to very dry fingers and scars on fingers, scratches due to accidents, injuries or non-uniform contact with the fingerprint sensing device, etc. [5]. Fingerprint identification is commonly used in forensic department for criminal investigations. A fingerprint is a unique pattern of ridges and valleys on the surface of a fingertip of an individual.

(A) (B)

Fig. 1. (A) Basic Fingerprint Image (B) Ridge Ending and Ridge Bifurcation

A ridge is the single curved segment (white colored curve), and a valley is the region between two adjacent ridges (black color space between two adjacent ridges). Minutiae points (fig.1) are the local ridge discontinuities, which are of two types: ridge endings and bifurcations. These are the minutiae points which are used for determining uniqueness of a fingerprint of an individual. Recently, techniques like [2-4] have been proposed that use other features apart from minutiae for fingerprint recognition. Chen et al [2] proposes a reconstruction technique which gives fingerprint's orientation from minutiae and utilizes it in the matching stage for the improvement of the system's performance. Cao et al [3] had introduced two novel features like finger placement direction and the ridge compatibility to deal with nonlinear distortion in fingerprints. Choi et al [4] proposed many ridge features like ridge count, ridge length, ridge curvature direction and ridge type together with minutiae for the increment of the matching performance. The accuracy of any technique depends on the quality of the input image. Therefore, image enhancement techniques are frequently used for reducing the noise.

The paper is divided into four sections. Section 1 gives introduction. Overview of Fingerprint features is describe in Section 2, techniques for fingerprint matching are overviewed in section 3, conclusion and future work is given in Section 4.

II. Fingerprint Feature

Fingerprint recognition means extracting different features of fingerprint and matching these features during identification phase.

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A. *Local Features*

Local features are unique characteristics which are used for identification like "minutia points". Local ridge details are the discontinuities of local ridge structure referred to as minutiae.

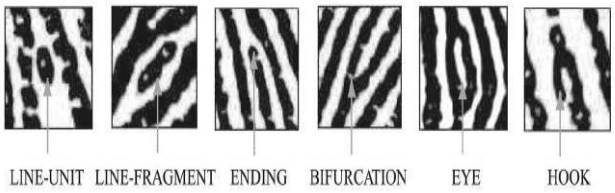

Fig. 2. Some of the Common Minutiae Types

There are about 150 different types of minutiae; they are categorized based on their configuration. Mainly "ridge ending" and ridge bifurcation" are used.

B. *Global Features*

Global Features are the characteristics that human being can see with the naked eye. Some of the global features are core, delta, etc.

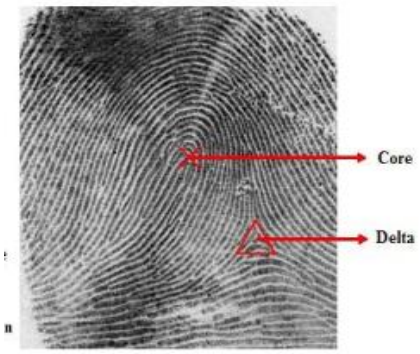

Fig. 3. Core point and Delta point

Core point: The nearly center of finger prints, which is used as reference point for reading or classifying the print is called as a core point.

Delta point: Delta point is a point where three ridge flows meet.

III. TECHNIQUES FOR FINGERPRINT MATCHING

Matching fingerprint images is an extremely difficult, mainly due to the large variability in different impressions of the same finger i.e. large intra class variations. The main factors responsible for the intra-class variations are displacement, rotation, partial overlap, non-linear distortion, variable pressure, changing skin condition, noise, and feature extraction errors. Therefore, fingerprints from the same finger may sometimes look quite different whereas fingerprints from different fingers may appear quite similar.

There are three categories of fingerprint matching approaches.

A. Minutia based Matching

B. Pattern matching

C. Correlation based Matching

A. *Minutia Based Matching*

Fingerprints are graphical ridge patterns present on human fingers, because of the unique features and they are same throughout the life of a person, used for people identification. A common hypothesis is that certain features of the fingerprint ridges, called minutiae, are able to capture the invariant and discriminatory information present in the fingerprint image.

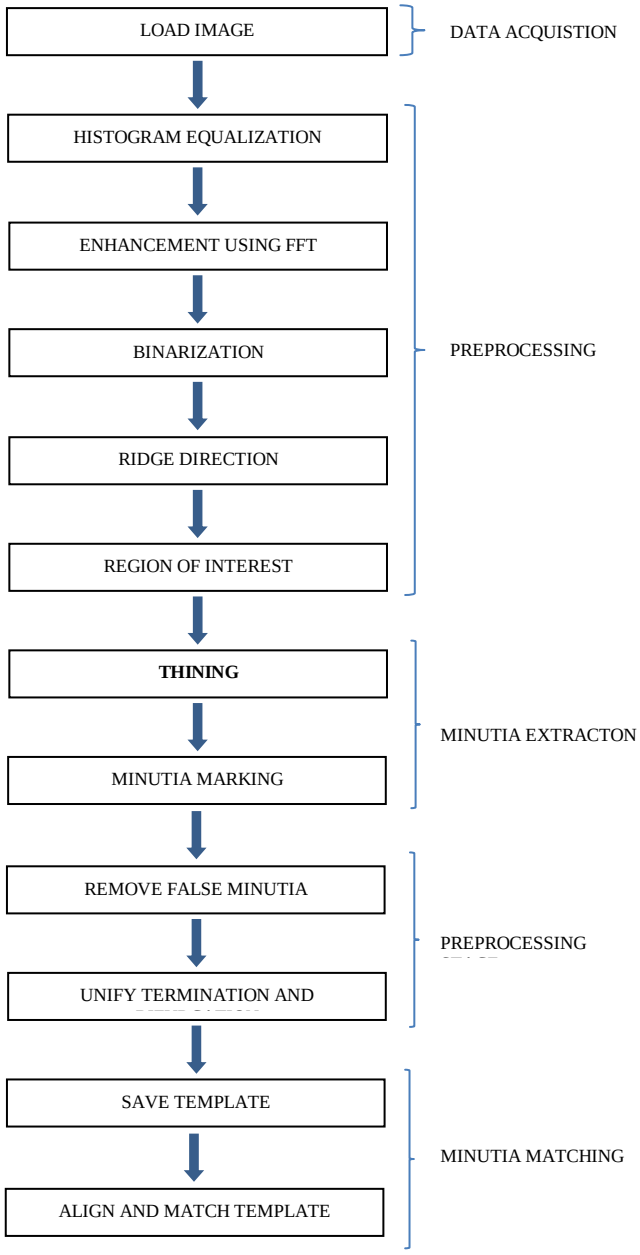

Fig.4. Flowchart of the Minutia Based Approach

A minutia detected in a fingerprint image can be characterized by a list of attributes that includes the minutia position, the minutia direction, and the type of minutia (ending or bifurcation). The representation of a fingerprint pattern is the combination of all detected minutiae. By representing the minutiae set as a point pattern, the fingerprint verification problem can be reduced to a minutiae

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point pattern matching problem. Minutia-based extraction is one of the popular methods in fingerprint recognition. A reliable minutiae extraction algorithm is used to extract the features, such as ridge bifurcations and ridge ends. The overall idea of minutia extraction mainly consists of three components, orientation field estimation, ridge extraction, and minutiae extraction and post processing. Fig. 4 illustrates the flowchart of minutia based approach in fingerprint recognition.

The minutiae based fingerprint recognition systems achieves very high accuracy. The drawbacks of this approach are:

a. Compressed (or noisy) images cannot be used with these recognition systems as they require high quality fingerprint images;

b. Minutiae based systems are slow for real time applications;

c. These systems have low recognition rates.

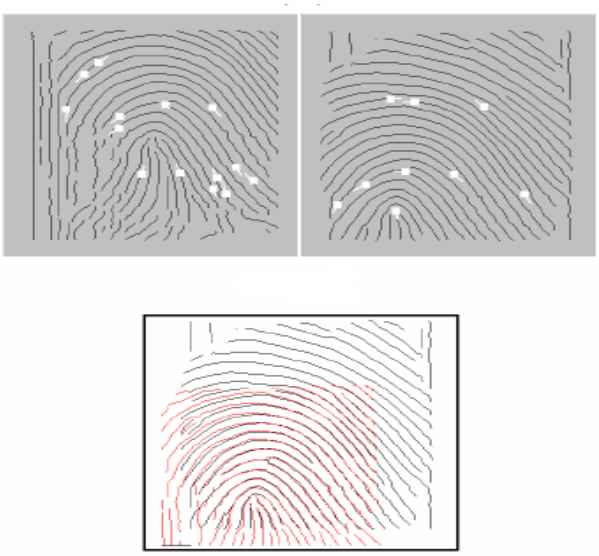

Fig. 5. Failed minutiae match (above), successful ridge match (below)

B. *Pattern Based Matching*

Unlike the minutiae technique, just discussed, which based on a few singularities, pattern matching uses the complete discriminatory information available in a fingerprint. Pattern matching method uses a global approach using special representations of the whole fingerprint. There are various different ideas on how to obtain a unique representation.

Recently, the ISO/IEC developed a standard for exchanging formats of various pattern matching templates. This includes methods with quantized co-sinusoidal triplets, discrete Fourier transformations and Gabor filters. There are two methods of pattern matching are presented and discussed: ridge matching and filter bank-based matching.

1) *Ridge Matching*

The basic idea of ridge matching is that the global ridge pattern of a fingerprint is matched with another fingerprint. This is performed using algorithms, which are able to identify the fingerprint ridges. Then the two fingerprints are superimposed and a matching score is computed using a pixel-wise XOR operator.

The advantage of ridge pattern matching is that it only needs two areas with clear ridges to manage a successful match as demonstrates in Fig. 5. The drawback of this algorithm is that, correlating the ridges of two fingerprints are computationally expensive, so the complete matching process requires a lot of computation time, especially for the identification.

2) *Filter bank – based Matching*

The essential idea of the filter bank-based technique is that before matching the fingerprint, it is filtered using appropriate filters. In practice, these filters are wavelet filter banks, like the widely used Fourier filters and the quite new Gabor filters. The function of these filters is to enhance the ridges and soften the valleys. Then the filtered image of the fingerprint is converted into a representation, the template. The templates are then matched. The result is a value called the matching score, which indicates how good the two fingerprints match to each other. It has disadvantages such as being sensitive to proper placement of finger and the need of large storage for templates.

C. *Correlation Based Matching*

In this method two fingerprints are superimposed and compute the correlation between the corresponding pixels for different alignments. Usually a cross-correlation measures image similarity between two images [8]. Due to displacements and rotations the simple cross-correlation is not enough; it should be measured considering different positions and angles.

In general, the correlation is not a robust matching method because of i) non-linear distortions that make the impressions of the same finger very different; ii) the skin condition may significantly vary the image characteristics (brightness, contrast, ridge thickness); iii) the computation of the cross-correlation for different positions and angles is computationally inefficient. Correlation-based matching computing local correlation has been proposed by [7] while, in [9], has been proposed to use a symmetric phase only filter with restricted domain to reduce the effect of the noise.

Result of this technique is rarely accepted because of several reasons such as Non-linear distortion, Skin condition and finger pressure cause image brightness, contrast variation, and the technique is computationally very expensive.

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IV. CONCLUSION AND FUTURE WORK

In this review paper basic of fingerprint features are discussed, we also discussed some fingerprint matching techniques and their pros and cons. Though in this review it is found that minutia based matching widely used for fingerprint recognition. There is a need to develop new hybrid methods that will give better performance in fingerprint recognition.

REFERENCES

[1] S. Chavan, P. Mundada, D. Pal. Fingerprint Authentication using Gabor Filter based Matching Algorithm. International Conference on Technologies for Sustainable Development (ICTSD-2015), Feb. 04 - 06, 2015, Mumbai, India.

[2] F. Chen, J. Zhou, C. Yang. Reconstructing Orientation Field From Fingerprint Minutiae To Improve Minutiae Matching Accuracy. *IEEE Transactions On Image Processing*, Vol. 18, Issue 7, 2009, Pp. 1665 - 1670.

[3] K. Cao, X. Yang, X. Tao, P. Li, Y. Zang, J. Tian, "Combining Features For Distorted Fingerprint Matching", Journal Of Network And Computer Applications, Vol. 33, 2010, Pp. 258 - 267.

[4] H. Choi, K. Choi, J. Kim. Fingerprint Matching Incorporating Ridge Features With Minutiae. *IEEE Transactions On Information Forensics And Security*, Vol. 6, Issue 2, 2011, Pp. 338 - 345.

[5] S. P. Kodgire, A. Mohan, "Automatic Fingerprint Recognition Systems: A review," IJECSCSE, Volume 3, Issue 3, Pp. 11-15.

[6] V. Panchal, "A Review on Finger Print Recognition Systems", International Journal of Emerging Technologies in Computational and Applied Sciences, Vol.4, Issue 5, March-May 2013, Pp. 455 - 460 .

[7] K. Nandakumar, A. K. Jain, "Local Correlation-based Fingerprint Matching," in *Proc. ICVGIP, Kolkata,* 2004, Pp. 1 - 6.

[8] *Handbook of Fingerprint Recognition*, 2nd ed., Springer Publishing Company, London, UK, 2009, Pp. 258 - 268.

[9] K. Ito, A. Morita, T. Aoki, T. Higuchi, H. Nakajima, and K. Kobayashi. A fingerprint recognition algorithm using phase-based image matching for low-quality fingerprints. *IEEE International Conference on image processing*, volume 2, September 2005, pages 33 - 36.

[10] R. Mourya , Sarita, " Fingerprint matching techniques: review," International Journal of Science, Technology & Management, Vol. 4, Issue 1, May 2015, Pp.222 - 227.

[11] N. K. Jalutharia, "Fingerprint Recognition and Analysis," M.E. thesis, Dept. Electrical and inst. Eng., Thapar. Univ., Patiala, 2010.

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