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Survey on Fingerprint Verification Methods Based on Different Type of Feature Extraction

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Abstract - Fingerprint verification is the most trustable biometric security system in the computer world. Different qualities of fingerprints are available. They are poor, medium, high and partial quality fingerprints. This paper provides a survey of different types of feature extraction and matching such as Euclidean, Correlation, Filter Bank, Transform based, Fuzzy-Neural Network, Minutiae, Pores and Multi-Feature modal. These methodologies are explained in detail to express the effectiveness, adoptability and accuracy in fingerprint matching.

1. INTRODUCTION

Finger print verification system is the most trustable biometric system in the world. However, finger print matching, especially when the finger print images have high, medium and low quality or when the matching is performed cross-sensors, is still an open research. The main problem in automatic finger print identification is to acquire reliable features from finger print image. Minutiae features are local discontinuities in the fingerprint image pattern, mainly ridge ending and bifurcation.

Fingerprints are the ridge and furrow patterns on the tip of the finger and have been used extensively for personal identification of people. The biological properties of fingerprint formation are well understood and fingerprints have been used for identification purposes for centuries. Since the beginning of the 20th century, fingerprints have been extensively used for identification of criminals by the various forensic departments around the world. Due to its criminal connotations, some people feel uncomfortable in providing their fingerprints for identification in civilian applications.

However, since fingerprint-based biometric systems offer positive identification with a very high degree of confidence, and compact solid state fingerprint sensors can be embedded in various systems (e.g., cellular phones), fingerprint-based authentication is becoming more and more popular in a number of civilian and commercial applications such as, welfare disbursement, cellular phone access, and laptop computer log-in. The availability of cheap and compact solid state scanners as well as robust fingerprint matchers are two important factors in the popularity of fingerprint-based identification systems.

Fingerprints also have a number of disadvantages as compared with other biometrics. For example, approximately 4% of the population does not have good quality fingerprints, manual workers get regular scratches on their fingers which poses a difficulty to the matching system, finger skin peels off due to weather, fingers develop natural permanent creases, temporary creases are formed when the hands are immersed in water for a long time, and dirty fingers cannot be properly imaged with the existing fingerprint sensors. Further, since fingerprints cannot be captured without the user's knowledge, they are not suited for certain applications such as surveillance.

2. EUCLIDEAN BASED FEATURE

Gabor filters are used for extracting fingerprint features from gray image cropped in the size of 128 ×128 fixed size pixels. It is supported as finding the centre point. This fingerprint recognition system method is small-scale. If the fingerprint is very large, may be, it will create the spurious ridges in the filtered image, whereas the fingerprint is very small, may be, it will merge nearby ridges into one. If the values of query finger and database finger are very large in size, the filter is extra robust to noise, but is extra likely to smooth the fingerprint image to the extent the ridge and valley details in the fingerprint is lost. On another, if the fingerprints are very small, the filter is not efficiently removing the noise. The fingerprint is mainly based on the Euclidean distance matching between two corresponding finger images. This method is more efficient and suitable for small-scale fingerprint verification system [1].

This algorithm is mainly based on three steps. First of all build a minutiae simplex that adducts a pair of minutiae and their associated textures features. Secondly use ridge based nearest neighborhood between minutiae to represent the ridge based features. The ridge based feature compared with Euclidean distance space model. Finally the relationship between the transformation and the capacious communion between two fingerprints image in terms of histogram based for initial parameter estimation [2].

The method is [3] find similarity between two fingerprints orientation fields using Euclidean and Manhattan distance measures. The fingerprint database are clustered into relevant type, it is used to avoid the exhaustive comparisons to all fingerprint image in the database.

3. CORRELATION BASED FEATURE

This method has two main advantages. The gray level intensity values are around a minutia point maintain the local information, spatial correlation give an accurate

measure of the communion between minutia regions. Secondly, no hard determination is made on correspondence amid a minutia pair. These minutiae extraction algorithm is well known method and is used Procreates analysis of congruent ridge curves is used to align the input image with the template. The images are enhanced by Gabor filter-banks and normalized cross correlation is used for the quality of minutiae match. The performance of this algorithm is slightly humble to the 2D dynamic based minutiae matcher, mainly due to the disability to handle the very low quality fingerprint images. The correlation and enhancement is supported for a fast implementation of real-time applications [4].

The fingerprint matching algorithm [5] designed for matching latent fingerprints. This algorithm is used a robust alignment method (descriptor based Hough transforms) and is to align fingerprints image and measures similarity amid fingerprints by considering both orientation field and minutiae information. To be congruent with the general practice in latent fingerprint matching, the orientation fields are reconstructed from minutiae. This algorithm relies only on the manually marked minutiae; this can be supported in the defence enforcement applications. This method is applied for two different type latent fingerprints DB with large background DB. This algorithm performs sublime than the three fingerprints. This method is more precise than two COTS matchers.

The scheme [6] examines strength of the ridge at various orientations, using set of eight Gabor filters whose spatial values correspond to the potty inter ridge spacing in the fingerprints. A Standard Deviation (SVD) map coherent in the local pixel intensities to the variation in each of the eight filtered fingerprint images is generated. The SVD map is sampled at habitual intervals in both the vertical and horizontal directions, to build the ridge feature map. This map provides fixed-length representation for a finger image. When a query fingerprint is obtainable to the system, SVD map of the query fingerprint and the template of the ridge feature map are correlated.

4. FILTER BANK BASED FEATURE

This is mainly concentrate fingerprint recognition includes local ridge orientation, reference point detection, and fingerprint feature extraction using Gabor filter. This methodology increases the accuracy; so as to develop an algorithm is developed automatically adjust the parameters of Gabor filters and designing a capable classifier to test the algorithm with a large fingerprint database [7].

In the Filter Bank based feature extraction and verification method there is no need to detect minutiae to fingerprint image. This method decomposes a fingerprint into 8 directional sub-band outputs using Directional Filter Bank and the decomposed sub-band outputs are produced the directional energy, this is distributed for each block. Only dominant directional vigorous components are employed as components of input feature vector, which serve to decrease noise and reform efficiency. For the rotational alignment, more input feature vectors are considered which a range of rotations are extracted, and these input feature are compared to the enrolled template feature. This method reduces the memory space and execution time related with verification, the efficient Directional Filter Bank exploitation and structure of directional exact information. Rotation is achieved to find the minimum Euclidean distance between the matching feature vectors. In this type the reference point is positioned near by the image border, this type may be complex to establish the regional of interest; however this problem is solve "don't care" options [8].

Filter-based algorithm to capture local and global details uses a bank of Gabor filters in a fingerprint as a compacted fixed length Finger-Code. The Euclidean distance is used for the fingerprint matching; the matching process is based on between two corresponding Finger-Codes. The following problem is solved this method. The core point cannot be located in noisy images accurately and the matching scheme is not able to tolerate large deformation in the ridge pattern due to finger pressure [9].

Touch-less fingerprint identification system uses a digital camera. The query fingerprint that was acquired with digital image camera, in this type image contains low contrast betwixt the valleys and the ridges in fingerprint images, defocus image and motion blurriness image. This methodology comprises pre-processing, feature extraction in fingerprint and matching stages. The Gabor filter is used in the feature extraction and the verification results are obtained with the SVD [10].

Eight directional Gabor filter bank is used for fingerprint matching system, it is supported to the poor quality fingerprint image, global and local information are available in the fingerprint. Extracted feature vectors from the directional representation of enhanced fingerprint image [11].

5. FFT, DCT, DWT, TRANSFORM BASED FEATURE

This method used Fast Fourier Transform (FFT) for fingerprint feature extraction and this is also evaluated by the k-nearest neighbour classifier [12].

A wavelet transform is applied on the input image and the edge components are equivalent to the image valley line is extracted from the signal by which sector division was carried out. The binarization process and thinning process are performed on the edge image component. And the fingerprint valley lines are separated complexly. A non-contact method offers the further improvement is able to perform acquirement of finger farm. The rotation process is very complicated in fingerprint process. The central line is computed using the fingerprint form information, and the aris is set tip of the finger image rotation [13].

Curve Scanned Discrete Cosine Transform (DCT) coefficients method is used to fingerprint feature extraction. The ridge line and minutiae points are

extracted from fingerprint using DCT. The oscillate patterns are contained in top-left corner of the DCT coefficients, coefficient can be dived in curved scanned fashion, DCT feature are extracted from the divided DCT coefficients. The k-NN classifier measures the matching rate [14].
Similarity measure between query and database fingerprint images by considering both orientation and minutiae field information. This method applies to be consistent of latent fingerprint matching. Because the minutiae are manually marked by the user, the minutia is supported to reconstruct the orientation of fingerprint image [15].

6. FUZZY AND NEURAL NETWORK BASED FEATURE

This is feasible to develop an analog synapse, a complete Artificial Neural Network (ANN) a neuron using only basic possession of MOSFETs in a principle CMOS fabrication process. This is demonstrating that the inherent quadrate nonlinearity with reverence to synapse weight value is ability of the synapse to function is not detrimental in feed-forward and Least Mean Square (LMS) Training modes of operation. This research is offering results from both theoretical and experimental. Simple synapse process proves useful in Very Large Scale Integration (VLSI) systems on a chip and we prove its feasibility for other CMOS products with on-chip integration [16].
Genetic Programming (GP) is used in this method, which learns to detect composite operators and features are evolved from combinations of stale image processing operations [17].
In this methodology fusion of two methodologies are used, one is a fuzzy front end and another one is a neural back end. This is using extracted important of fingerprint feature and also use in minutiae feature [18].
Fingerprint minutiae extraction from skeleton image is described. The neural network is applied and locates various minutiae to the fingerprint skeleton image. The neural network trained and identifies the fingerprint shapes and types of minutiae points [19].
The fingerprint enhancement is supported to the Fuzzy based minutiae extraction and fingerprint recognition is used for Genetic Algorithm. Fuzzy rule based systems eliminate the false minutiae in fingerprint [20].

7. MINUTIAE BASED FEATURE

This paper described in [21] fingerprint minutiae extraction using 3*3 fixed size templates. The templates are applied on the binary image and find the minutiae. So this method is carried to eliminate false minutiae.
The algorithm is [22] used to reconstructing the phase image. This algorithm not only gives reconstructing the whole fingerprint image, but also the reconstructed fingerprint image contains few spurious minutiae. This algorithm reconstructs the image continuous phase from minutiae.
The latent fingerprint with rolled fingerprint matching found in the crime scenes to rolled fingerprint images enrolled in law enforcement databases. To find the minutiae feature are extended which include singularity, ridge quality, ridge flow, ridge wavelength, and skeletonization. This methodology is inferior between major three different by the automatic matcher. The latent fingerprint has lot of noises and distortion. The feature extraction and matching process leads to some information loss. Latent examiners can adjudge a pair of fingerprint images as unmatched based on unmatched minutia feature which is located in the best quality region of the two fingerprints images. This is a risky statement for fingerprint algorithms. Manual feature markings are very useful in the latent fingerprint matching [23].
A Laplacian-like image pyramid is supported for enhancement process and is used to decompose the original image into sub-band congruent to different spatial scales. Performed the contextual smoothing these pyramid level. Using parabolic symmetry features is suggested in this method, not require explicit or any other morphological operations for the feature extraction. A robust conventional minutiae extraction is alternatively developed in this method [24].

8. PORES BASED FEATURE

Fingerprint pore extraction method discriminate the additional information from fingerprint by demonstrating to extract the locations of perspiration pores from the fingerprint grayscale image. Modified Squared Error Approach is supported to this method. This paper extracts pores accuracy and improve matching scheme [25].
The algorithm in [26], mainly concentrate and utilized to dots incipient feature for partial to full fingerprint matching. A contrast invariant local phase symmetry measure is introduced in this method. Committee to Define an Extended Feature Set (CDEFFS) is proposed, that can be useful to extracted dots and incipient for partial fingerprint.

9. MULTI-FEATURE FOR LATENT FINGERPRINT BASED FEATURE

Fingerprint matching algorithm use ridge based features and minutiae feature. The ridge based feature consist four elements. First of all ridge count, secondly ridge length, thirdly ridge curvature direction, and finally ridge type. These are described the connection between the minutiae. And the conventional minutiae features are used in this method. The Breadth First Search (BFS) matching scheme detect the fingerprint matched minutiae pairs. The contourlet filter bank structure can be providing directional decomposition and flexible multi-scale for the image. Directional multi-resolution analysis provides successive refinements to the spatial and directional resolution [27] [28].

Normally the fingerprints have minutiae and texture information. A bank of Gabor based filters is used to pluck the features from the fingerprint template and input images. This method has not been accounted for non linear deformations fingerprint images because of contact area is small in size [29].

10. CONCLUSION

In this article various techniques of fingerprint enhancement and matching process have been discussed. An overview of all related fingerprint matching techniques had been presented in this survey paper. Eight types of feature based finger recognition methods are described in this paper. There is still need for further improvements in fingerprint recognition methods. Among the available methods the minutiae based verification method is suitable for Good and fair quality fingerprints. For poor quality fingerprints, the multi feature based methods are much suitable. To reduce the drawbacks of fingerprint biometric, multi modal biometrics can be considered.

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