ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

An ISO 3297: 2007 Certified Organization *Vol. 5, Special Issue 2, March 2016*

National Conference on Future Technologies in Power, Control and Communication Systems (NFTPCOS-16)

on 10, 11 and 12th March 2016

Organised by

Dept. of EEE, College of Engineering Perumon, Kollam, Kerala – 691601, India

Distortion Detection and Rectification of Dynamic Fingerprints

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ABSTRACT: Biometrics is a technology which identifies a person based on his physiology or behavioural characteristics. Fingerprint identification and recognition is a biometric method that has been widely used in various applications because of its reliability and accuracy in the process of recognizing and verifying a person's identity. Fingerprint images are acquired and stored in the database in the image acquisition stage. These images are undergone through a series of processes such as feature extraction, image binarization, image decomposition, minutiae extraction and then authenticate the results. The database used is FVC2004 DB. Distortion detection is viewed as a two-class classification problem, for which the registered ridge orientation map and the period map of a fingerprint are used as the feature vector and a SVM classifier is trained to perform the classification task. Distortion rectification is viewed as a regression problem, where the input is a distorted fingerprint and the output is the distortion field. To solve this problem, a database of various distorted reference fingerprints and corresponding distortion field is built in the offline stage, and in the online stage, the nearest neighbour of the input fingerprint is traced from the reference database and the distortion field is used to transform the input fingerprint into a normal one.

KEYWORDS: Distortion, Minutiae, Gabor Filters, Fingerprints, Feature vector.

I.INTRODUCTION

Biometrics is automated methods of recognizing a person based on physiological or behavioural characteristics. The features measured are face, fingerprints, hand geometry, handwriting iris, retinal, vein and voice. Biometric technologies are becoming the foundation of an extensive array of highly secure identification and personal verification solutions. As the level of security breaches and transaction fraud increases, the need for highly secure identification and personal verification technologies are becoming apparent. Biometric based solutions are able to provide for confidential financial transactions and personal data privacy. Fingerprint identification is one of the most well known and publicized biometrics. Because of their uniqueness and consistency over time, fingerprints have been used for identification for over a century. Fingerprint identification known as dactyloscopy is the process of comparing two instances of friction ridge skin impressions from human fingers or toes or even in the palm of the hand or sole of the foot to determine whether these impressions could have come from the same individual. Even though it is not scientifically established fingerprints are believed to be unique across individuals. Even identical twins having similar DNA are believed to have different fingerprints.

Fingerprint identification is based primarily on the minutiae, or the location and direction of the ridge endings and bifurcations (splits) along a ridge path. A ridge ending is defined as the point where a ridge ends abruptly. A ridge bifurcation is defined as the point where a ridge forks or diverges into branch ridges. A good quality fingerprint typically contains about 40–100 minutiae. Minutiae are minute details in the fingerprints. It is these minutiae points which are used for determining uniqueness of a fingerprint. A fingerprint recognition system can be classified as either a positive or negative system. In a positive recognition system, the user is supposed to be cooperative and wishes to be identified. In a negative recognition system, the user of interest (e.g. criminals) is supposed to be uncooperative and does not wish to be identified. In negative fingerprint recognition system, since malicious users may purposely reduce fingerprint quality to prevent fingerprint system from finding the true identity the consequence of low quality fingerprint is much more serious. Degradation of fingerprint quality can be photometric or geometrical. Photometric

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degradation can be caused by non-ideal skin conditions, dirty sensor surface, and complex image background. Geometrical degradation is mainly caused by skin distortion and has not yet received sufficient attention. This paper mainly addresses the issues due to geometric degradation. The two main processes in this work are distortion detection and distortion rectification. For doing experimental work, the database used is FVC2004 DB1.

II.SYSTEM MODEL AND ASSUMPTIONS

The system flow depicts how the proposed system verifies and authenticates an input fingerprint. Fingerprint distortion detection can be viewed as a two class classification problem. Fingerprint distortion can occur in many ways. It can be caused due to displacement of the finger on the fingerprint scanner. A fingerprint displacement of just 2mm (imperceptible to the user) results in a translation of about 40 pixels in a fingerprint image scanned at a resolution of 500 dpi. Yet another cause for fingerprint distortion is partial overlapping. This problem is particularly serious for small-area touch sensors. The overlapping can be caused due to the deformations in the fingerprints and also placing the finger in an incorrect manner. We used the registered ridge orientation map and period map as the feature vector, which is classified by a SVM classifier.

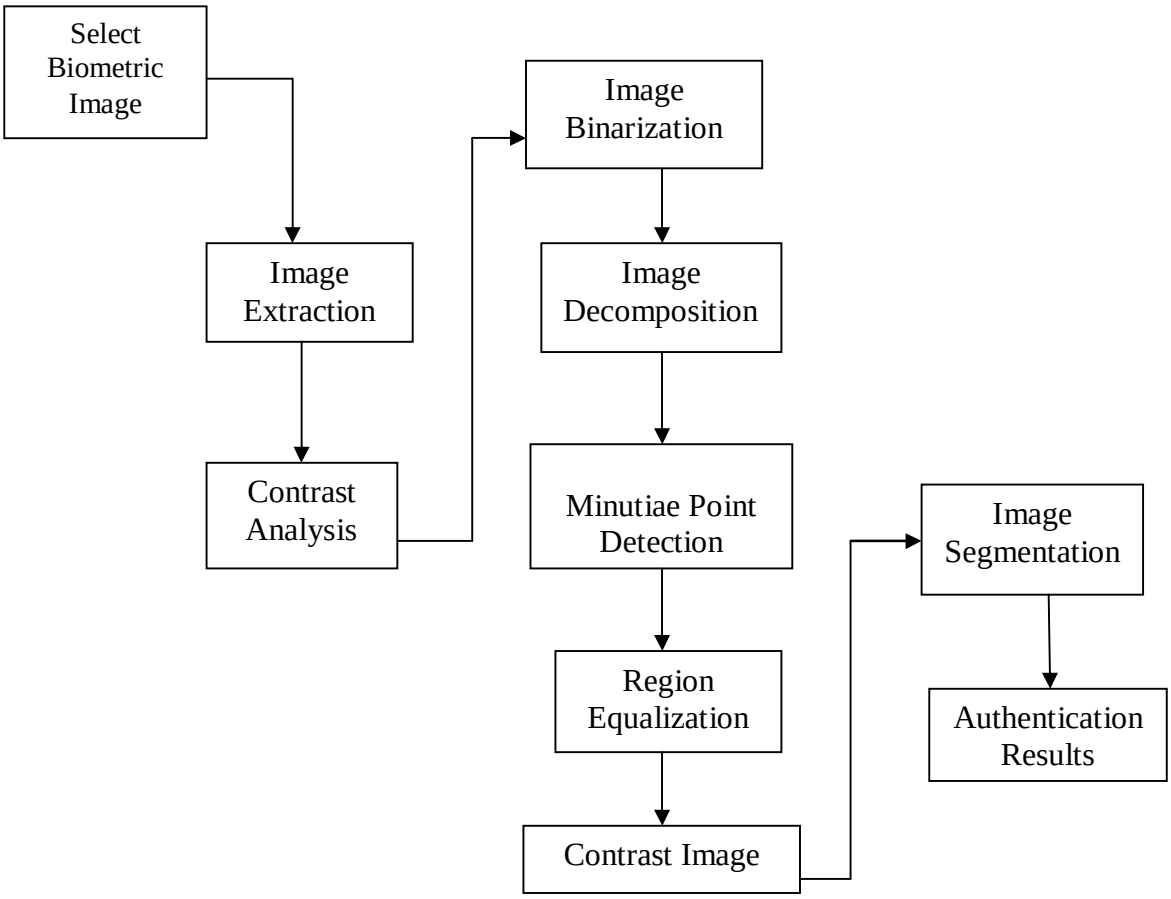

Fig 1 Flow diagram of the Proposed system

An input fingerprint will be applied to the scanner which can be either distorted or normal. If the input is normal, then the verification or matching process is the next process. The input needs to be applied within the correct coordinates of the scanner, if not it will cause the rejection of the fingerprint. The reference fingerprint is registered based on its finger center and direction. The scanner with video capture functionality was used for data collection. Each participant is

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asked to press a finger on the scanner in a normal way, and then distort the finger by applying a lateral force or a torque and gradually increase the force. Thus each finger produces 1 to 10 videos and each video contains only one of ten distortion types. In every video the first frame is the normal fingerprint and the last frame contains largest distortion which is used for training and testing purpose. The Feature extraction process takes place here. Feature extraction is related to dimensionality reduction. In image extraction, feature vector extraction is done. Here since we registered the orientation map and period map of the input fingerprint in a fixed coordinate system, we used those two factors for extracting the feature vector with the help of a classifier – Support Vector Machine. This helps in extracting the feature and helps to determine whether the input applied given to the scanner is distorted or normal. In feature extraction process the orientation map and period map are sampled using a sampling grid. The sampling grid of orientation map contains only the portion just above the fingerprint and sampling grid of the period map contains the whole part of the fingerprint. After sampling the two grid elements the SVM Classifier is used to perform the classification task and this determines whether the input applied is distorted or not.

The method used for contrast adjustment is histogram equalisation. Histogram equalization is to expand the pixel value distribution of an image so as to increase the perceptional information. It is a general process used to enhance the contrast of images by transforming its intensity values. As a secondary result, it can amplify the noise producing worse results than the original image for certain fingerprints. For an input image, some processing stages should be used before extracting minutiae. One of these stages is binarization. In this stage the gray-scale image converts into a binary image. A binary image can be processed well than a gray-scale image. Thresholding is done in order to separate the image from the background. Thresholding plays a major in binarization of images. Thresholding can be categorized into global thresholding and local thresholding. Decomposition of the image means making the image capable of extracting the very fine details of it. Here in this step noise removal, image smoothening etc are done. Gabor Filters are used for filtering purpose and smoothening of image is done using Gaussian smoothening.

A Gabor filter is a linear filter whose impulse response is the multiplication of a harmonic function with a Gaussian function. As per convolution theorem, the convolution of Fourier Transform (FT) of harmonic function and FT of Gaussian function is nothing but FT of a Gabor filter's impulse response. The filter consists of a real and an imaginary component, which represent the orthogonal directions. In image processing, a Gabor filter is a linear filter used for edge detection. Frequency and orientation representations of Gabor filters are similar to those of the human visual system, and they have been found to be particularly appropriate for texture representation and discrimination. Gaussian smoothing is also used as a pre-processing stage in computer vision algorithms in order to enhance image structures at different scales. Gaussian filters are generally isotropic, that is, they have the same standard deviation along both dimensions. An image can be filtered by an isotropic Gaussian filter by specifying a scalar value for sigma. Gaussian smoothing is also used as a pre-processing stage in computer vision algorithms in order to enhance image structures at different scales. Gaussian filters are generally isotropic, that is, they have the same standard deviation along both dimensions. An image can be filtered by an isotropic Gaussian filter by specifying a scalar value for sigma.

A fingerprint is the pattern of ridges and valleys on the surface of a fingertip. Each individual has unique fingerprints. The uniqueness of a fingerprint is exclusively determined by the local ridge characteristics and their relationships. The ridges and valleys in a fingerprint alternate, flowing in a local constant direction. The two most prominent local ridge characteristics are: ridge ending and ridge bifurcation. A ridge ending is defined as the point where a ridge ends abruptly. A ridge bifurcation is defined as the point where a ridge forks or diverges into branch ridges. Collectively, these features are called minutiae. In order to achieve high accuracy minutiae with varied quality fingerprint images, segmentation algorithm needs to separate foreground from noisy background which includes all ridge-valley regions and not the background. In this project, minutiae extraction is done using Optimization technique. The number and locations of the minutiae vary from finger to finger in any particular person, and from person to person for any particular finger (for example, the thumb on the left hand). When a set of finger images is obtained from an individual, the number of minutiae is recorded for each finger. Suppose that the i^{th}minutia is represented as $\mathsf{M}_i = (x_i, y_i, \sigma_i, t_i)$, and they represent the position of the minutia (x and y), the orientation and the type of minutia, respectively.

Segmentation of images can be done either in the pre-processing or post processing stage as per the need. Before extracting the feature of a fingerprint, it is important to separate the fingerprint regions (presence of ridges) from the background. This limits the region to be processed and therefore reduces the processing time and false feature

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extraction. A correct segmentation may be, in some cases, very difficult, especially in poor quality fingerprint image or noisy images, such as presence of latents. The same information used for quality extraction, such as contrast, ridge orientation and ridge frequency can be used for the segmentation or inclusive the quantified region quality may be used directly by considering as background the regions with quality below some threshold. Normally, the segmentation is also computed by block in the same way as the quality extraction. The fingerprint area contains information that may be useful in many fingerprint processing stages, while the rest of the image might contain relatively useless information and unwanted signals, such as noise. Fingerprint image segmentation is, therefore, an important fingerprint processing step because, if done correctly, it serves to separate information from noise.

Authentication is any process by which a system verifies the identity of a user who wishes to access it. Since access control is normally based on the identity of the User who requests access to a resource, Authentication is essential to effective Security. Here the authentication is done by verifying the fingerprints. The cross matching of fingerprints is done after a series of processes. While doing the authentication process, on screen display of the result verification will be shown.

V. RESULT AND DISCUSSION

In this section, we first evaluate the proposed distortion detection method. Then, we evaluate the proposed distortion rectification algorithm by performing matching experiments on the database – FVC 2004 DB1. Initially input should be given and a secondary input is applied. Then feature extraction process has been done. The contrast of the image is adjusted in order to identify the edge of the image so that the minute values of the fingerprints can be identified.

After detecting the edges of the image, the image will undergo segmentation to identify the minutiae present in the primary input as well as in the secondary input.

Fig. 2 Decomposing the image to find the minutiae points with 50 iterations.

The minutiae point extractions is done to fine the exact matching and this is done using the optimization technique. If both the inputs are same then matching regions would be high else the value of the matching regions would be low.

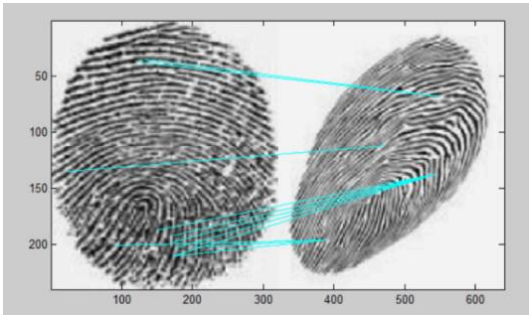

Fig .3 Matching the Minutiae points.

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VI.CONCLUSION

This project aimed at developing a robust system of identifying the distorted fingerprint and rectified the distorted fingerprints. The method was applied for the images in the database FVC 2004 DB1. The very first step is to properly register the fingerprint image to the system, and contrast of the image is adjusted to process the input image. Then feature vector is extracted by using the ridge orientation map and the period map. Further proceeded by calculating the image border. In image decomposition process, image is decomposed and fine tuned. The minutiae extraction was done using the optimization technique and Minutiae matching have been checked. The authenticated results were displayed in the on-screen display.

Even though the current system is robust, efficiency needs to be cross checked .The minutiae extraction method is most commonly used method of verifying the fingerprints. Rectification of the distorted input method has to be proved for more traditional methods. In future work distortion detection and rectification of rolled fingers has to be addressed with the help of the optimization technique with the help of experts in the forensics as well as the machine intelligence section. The experiment can be extended to use the images in other databases of NIST using the same method.

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