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EFFECTIVE FINGER PRINT RECOGNITION BY USING MULTIMODAL FUSION

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Abstract:

Fingerprints techniques are the most widely used form of biometric identification and security essentials. The fingerprint images may be degraded and corrupted with elements of noise due to many factors including variations in skin and impression conditions, use these fingerprint images for identification and matching purposes it has to be enhanced first. The steps involved in the fingerprint recognition process are Normalization, Orientation Field Estimation, Gabor filtering, Thinning, Binarisation, Minutiae Extraction and False minutiae elimination. In this project we are implementing Normalization and Orientation Field Estimation enhancement techniques using MATLAB. Due to imperfections in the fingerprint image capture process such as non-uniform ink intensity or non-uniform contact with the fingerprint capture device, a fingerprint image may exhibit distorted levels of variation in grey-level values along the ridges and valleys. Thus, normalization is used to reduce the effect of these variations, which facilitates the subsequent image enhancement steps. The orientation field of a fingerprint image defines the local orientation of the ridges contained in the fingerprint. Firstly, the gradient is calculated for every pixel. The orientation vector for each block is derived by performing an averaging operation on all the vectors orthogonal to the gradient pixels in the block. Biometric indenters can be counterfeited, but considered more reliable and secure compared to traditional ID cards or personal passwords methods. Fingerprint pattern fusion improves the performance of a fingerprint recognition system in terms of accuracy and security. Here we are using digital enhancement and fusion approaches that provide highest accuracy of the fingerprint recognition system.

Key Words: Binarization, Minutiae Extraction & Normalization

1. Introduction:

Automated security systems are getting more and more important. Today, most of the banking transactions can be performed over the Internet and soon they can also be performed on mobile devices such as cell phones and PDAs. This rapid progress in wireless communication system, personal communication system and smart card technology in our society makes information more susceptible to abuse [2]. Due to the growing importance of the information technology and the necessity of the protection and access restriction, reliable personal identification is necessary. The key task of an automated security system is to verify that the users are in fact who they claim to be. There are three main methodologies when performing this verification. The security system could ask the user to provide some information known only to As our everyday life is getting more and more computerized the user, it could ask the user to provide something only the user has access to or it could identify some sort of trait that is unique for the user. Identifying some trait that is unique for the user is known as biometric security. A biometrics system is a pattern recognition system that establishes the authenticity of a specific physiological or behavioural characteristic possessed by a user. Uniqueness and permanence are the two properties of fingerprint identification. It is claimed that no two individuals including identical twins have the same fingerprints and does not change throughout the lifetime, with the exception of a significant injury to the finger that creates a permanent scar. Fingerprint recognition takes advantage of the fact that the fingerprint has some unique characteristics such as minutiae and the ridges. The use of multi biometric systems is considered as one of the keys to improve the accuracy of biometric systems, than single biometric parameter and one matching algorithm.

The use of fingerprints as a biometric is both the oldest method of computer aided personal identification and the most prevalent in use today. There is expectation that a recent combination of factors will favour the use of fingerprints for the much larger market of personal authentication. These factors include [1]: small and inexpensive fingerprint capture devices, fast computing hardware, recognition rate and speed to meet the needs of many applications, the explosive growth of network and Internet transactions. To find specific features for a fingerprint it is required to have a unique reference point for each fingerprint. Based on this reference point it is possible to enhance feature extraction and matching steps of fingerprint identification. This reference point will eliminate any dependency of features to rotation and displacement transformations and because of the resulting low volume features it increases the matching speed of the fingerprints. Singular points are first obtained and then the reference point will be determined [4]. There are at most two kinds of singular points in a fingerprint; core point and delta point. Most of the approaches proposed in the literature for singularity detection operate on the fingerprint orientation image. In this paper minutiae and ridge based methods are simultaneously used in order to improve the matching performance and to reduce the false matching ratio considerably.

2. Methodology:

Proposed methodology consists of several steps. First binarization will be obtained. Then orientation field will be estimated. Find minutiae and remove false minutiae in the next step. Finally fusion of two fingerprint image will be obtained.

A. Binarisation Process:

Most minutiae extraction algorithms operate on binary images where there are only two levels of interest: the black pixels that represent ridges, and the white pixels that represent valleys. Binarisation is the process that converts a grey level image into a binary image. This improves the contrast between the ridges and valleys in a fingerprint image, and consequently facilitates the extraction of minutiae. Binarisation is a process where each pixel in an image is converted into one bit and you assign the value as '1' or '0' depending upon the mean value of all the pixel. If greater then mean value then its '1' otherwise its '0'.

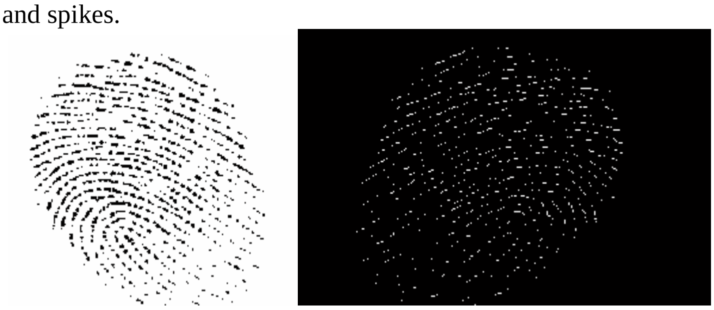
One useful property of the Gabor filter is that it has a DC component of zero, which means the resulting filtered image has a mean pixel value of zero. Hence, straightforward binarization of the image can be performed using a global threshold of zero. The binarisation process involves examining the grey-level value of each pixel in the enhanced image, and, if the value is greater than the global threshold, then the pixel value is set to a binary value one; otherwise, it is set to zero. The outcome is a binary image containing two levels of information, the foreground ridges and the background valleys. The method of image binarisztion is proposed in employed method sets the threshold (T) for making each cluster in the image as tight as possible, thereby minimizing their overlap.

Figure 1: (a) Input Image (b) Binarised Image

B. Thinning:

The final image enhancement step typically performed prior to minutiae extraction is thinning. Thinning is a morphological operation that successively erodes away the foreground pixels until they are one pixel wide. Fig 2 explains the standard thinning algorithm is employed, which performs the thinning operation using two sub iterations. This algorithm is accessible in MATLAB via the `thin' operation under the bimorph function. Each sub iteration begins by examining the neighbourhood of each pixel in the binary image, and based on a particular set of pixel-deletion criteria, it checks whether the pixel can be deleted or not. These sub iterations continue until no more pixels can be deleted. The application of the thinning algorithm to a fingerprint image preserves the connectivity of the ridge structures while forming a skeletonised version of the binary image. This skeleton image is then used in the subsequent extraction of minutiae. The process involving the extraction of minutiae from a skeleton image.

Ridge Thinning is to eliminate the redundant pixels of ridges till the ridges are just one pixel wide. An iterative, parallel thinning algorithm is used. In each scan of the full fingerprint image, the algorithm marks down redundant pixels in each small image window (3x3). And finally removes all those marked pixels after several scans. The thinned ridge map is then filtered by other three Morphological operations to remove some H breaks, isolated points and spikes.



(a) (b)

Figure 2: (a) Binarised Image. (B) Thinned Image

C. Minutiae Extraction:

The enhanced fingerprint image is binarized and submitted to the thinning algorithm which reduces the ridge thickness to one pixel wide. The skeleton image is used to extract minutiae points which are the points of ridge endings and bifurcations. The location of minutiae points along with the orientation is extracted and stored to form feature set. For extraction of minutiae point's eight connected pixels are used. The Crossing Number (CN) method is used to perform minutiae extraction. This method extracts the ridge endings and bifurcations from the skeleton image by examining the local neighbourhood of each ridge pixel using a 3×3 window [5]. The CN for a ridge pixel *P* is given by

$$CN = 0.5\sum_{i=1}^{8} | P_i - P_{i+1} |$$

$$P_9 = P_1$$

Where *Pi* is the pixel value in the neighbourhood of *P*. After the CN for a ridge pixel has been computed, the pixel can then be classified according to its CN value [5]. A ridge pixel with a CN of one corresponds to a ridge ending, and a CN of three corresponds to a bifurcation. For each extracted minutiae point, the following information is recorded:

- *x* and *y* coordinates,
- orientation of the associated ridge segment, and
- type of minutiae (ridge ending or bifurcation)

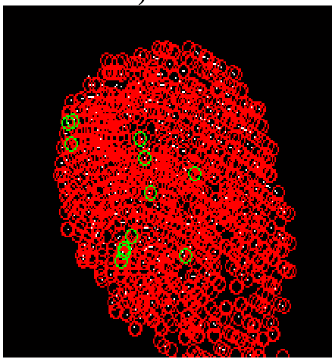


Figure 3: Minutiae Extraction

Following the extraction of minutiae, a final image post processing stage is performed to eliminate false minutiae. The Crossing Number (CN) method is used to perform minutiae extraction. This method extracts the ridge endings and bifurcations from the skeleton image by examining the local neighbourhood of each ridge pixel using a 3*X*3 window.

D. False Minutiae Elimination:

False minutiae may be introduced into the image due to factors such as noisy images, and image artefacts created by the thinning process. Hence, after the minutiae are extracted, it is necessary to employ a post processing stage in order to validate the minutiae. It can be seen that generate false bifurcations. The spike structure creates a false bifurcation and a false ridge ending point. Hence, after the minutiae are extracted,, where as both the hole and triangle structures generate false bifurcations. The spike structure creates a false bifurcation and a false ridge ending point.

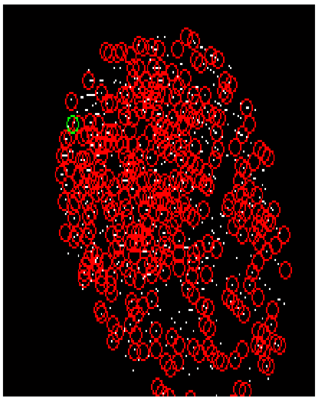


Figure 4: Removable of False Minutiae

E. Fusion Process:

Fingerprint image fusion is the process of combining relevant information from two fingerprint images into a single image. No individual trait can provide 100% accuracy. It will provide more accuracy by using fragment algorithm. Set 90% threshold level and compared the images.

3. Experimental Results:

Figure 5 explains the Fingerprint normal image contain noise and imperfections. Therefore fingerprint enhancement process is needed. For Normalization, an algorithm based on the mean and variance of the images pixel densities is implemented in Matlab. For Orientation Process, an algorithm based on edge detection using canny operators to estimate the orientation field of the image is implemented in Matlab.

Since the results obtained were satisfactory, the same algorithms were implemented on Matlab. For fusion of two fingerprint images, an algorithm based on fragment is implemented in Matlab. The fusion process provides more security since the fused image contains more information compared to single fingerprint image. The hardware and memory demands are reduced since fusion technique is carried out. It provides 99% accuracy for finger printing.

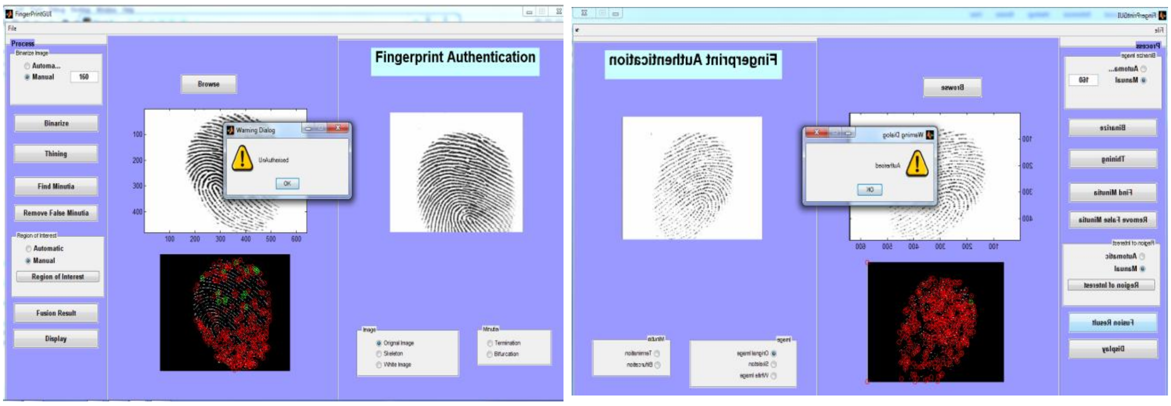


Figure 5: Screen Shot of Authorised Output & Figure 6: Screen Shot of Unauthorised Output

6. Conclusion:

Images from optical scanner contain noise and imperfections. Therefore fingerprint enhancement process is needed. For Normalization, an algorithm based on the mean and variance of the images pixel densities is implemented in Matlab. For Orientation Process, an algorithm based on edge detection using CANNY operators to estimate the orientation field of the image is implemented in Matlab. It provides more accuracy to finger print image and less sensitivity to noise.

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