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FINGER VEIN RECOGNITION

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Abstract - *Vein based biometrics are gaining importance due to their greater accuracy and security. Finger vein based biometric systems elegantly address problems present in fingerprint systems. The vein based authentication system is a promising biometric pattern for personal identification in terms of its security and convenience. The vein patterns can only be taken from a live body. Hence it is a natural and convincing proof that the subject whose veins are successfully captured is alive. Finger vein recognition technique is enhanced using neighborhood elimination technique to reduce the repeated feature set in the extracted finger vein minutiae image. Neighborhood elimination technique is employed for the purpose of removing the redundant information while keeping the effective source information for subsequent processing.*

Key Words: Biometrics, Finger vein, Image Processing, Authentication

1. INTRODUCTION

User authentication is extremely important for computer and network system security. Some of the commonly used biometric traits[1] are face, sclera, fingerprint, iris, finger vein etc., The vein based authentication system is a promising biometric pattern for personal identification in terms of its security and convenience. It is difficult to steal since the vein is hidden inside the body and is mostly invisible to human eyes. The vein patterns can only be taken from a live body. Hence it is a natural and convincing proof that the subject whose veins are successfully captured is alive.

Finger vein authentication is a new biometric method utilizing the vein patterns inside one's fingers for personal identity verification[2]. Biometric systems based on fingerprints can be fooled with a dummy finger fitted with a copied fingerprint; voice and facial characteristic-based systems can be fooled by recordings and high-resolution images. The finger vein ID system is much harder to fool because it can only authenticate the finger of a living person.

2. EXTRACTING FINGER VEIN FEATURES

Finger vein patterns are captured by penetrating the finger with near infra-red rays to verify an individual's identity. To obtain the pattern for the database record, an individual inserts a finger into an attester terminal containing a near-infrared LED light as shown in Figure 1 or a monochrome CCD camera. The haemoglobin in the blood absorbs near-infrared LED light, which makes the vein system appear as a dark pattern of lines.[4] The camera records the image and the raw data is digitized, certified and sent to a database of registered images.

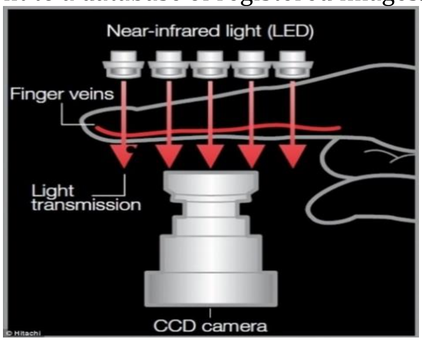


Figure 1 Finger vein sensor

Gabor filters are used as band pass filters to remove the noise and preserve true ridge/valley structures. In the finger images, there are many unwanted regions that are to be removed by choosing the interested area in that image. The useful area is said to be "Region of Interest"[3]. The obtained binary mask is used to segment the ROI from the original finger-vein image. ROI extraction is done by the two morphological operations called "OPEN" and "CLOSE". The "OPEN" operation can expand images and remove peaks introduced by background noise. The "CLOSE" operation can shrink images and eliminate small cavities. The bound is the subtraction of the closed area from the opened area. Then the algorithm removes the leftmost, rightmost, uppermost and bottommost blocks out of the bound so as to get the tightly bounded region just containing the bound and inner area. The centerlines are detected by searching for positions where the curvatures of a cross-sectional profile of a vein image are locally maximal. In this method, the centerlines of the veins can be extracted consistently without being affected by the variations in the width and brightness of the vein. The vein pattern is detected as shown in Figure 2.

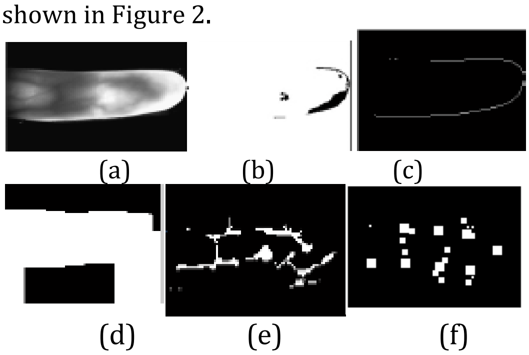


Figure 2 .(a) Input image (b) Binarized image (c) Filtered image using Gabor filter (d) ROI image (e) Extracted veins (f) Minutiae points

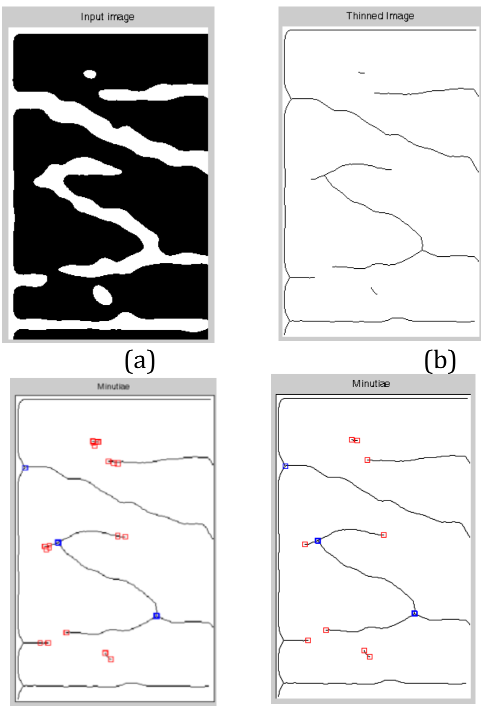
3. PROPOSED FEATURE REDUCTION USING NEIGHBORHOOD ELIMINATION TECHNIQUE

In the acquired finger vein minutia images, the redundant points are eliminated. The elimination of redundant points will enhance the matching reliability and reduce computational complexity. Neighborhood elimination technique is employed for the purpose of removing the redundant information while keeping the effective source information for subsequent processing.
This technique is applied on the normalized point-set of finger vein. For each point of finger vein, those points that lie within the neighborhood of a certain radius are removed. In order to determine the neighbors of each specific point, the spatial information is used.

For each minutia of finger vein, neighborhood elimination removes those points that lie within a certain radius *r* around it. For a given minutia (*x*, *y*), points satisfy the Spatial distance S_d as expressed in Equation 1 will be eliminated.

$$S_d = \sqrt{(x - x_i)^2 + (y - y_i)^2} \leq r \qquad (1)$$

where (*xi*, *yi*) is a minutia, either from a sclera vein or a finger vein image. *'r'* is computed using Euclidean distance. Based on experiment, *r*=8 pixels is applied to finger vein minutiae elimination. After neighborhood redundant point elimination, the reduced finger vein point-sets are obtained, as shown in Figure 3 (a-d).



(a) (b) (c) (d)

Figure 3 (a) Finger vein (b) Thinned image
(c) Extracted Minutiae (d) Minutiae after elimination

The matching is done using point pattern matching technique[5]. This technique aims at finding the percentage of points "paired" between the concatenated feature point set of the database and the query images. Experiments have been conducted to demonstrate the performance of the proposed method for biometric recognition. Homologous Multi-modal Traits database which is named SDUMLA-HMT, created by the Group of Machine Learning and Applications, Shandong University in 2010 is used. The finger vein database is composed of 3,816 images.

The metrics used for evaluation are False Acceptance rate (FAR) and False Rejection Rate (FRR). The FRR is the frequency that an authorized person is rejected access. The finger vein recognition was carried out with 100 images taken from the database. The users are grouped into ten users and the results are tabulated for FAR and FRR. Table I shows the resulted (FRR) as obtained from Equation 2 and Equation 3. From the result, as shown in Figure 4 it can be observed that the proposed technique results in lesser False Rejection Rate when compared to the existing techniques.

$$FRR(n) = \frac{\text{Number of rejected verification attempts for a qualified person } n}{\text{Number of all verification attempts for a qualified person } n}$$

$$FRR = \frac{1}{N}\sum_{n=1}^{N} FRR(n) \qquad (2)$$

The FAR is the frequency that a non-authorized person is accepted as authorized.

$$FAR(n) = \frac{\text{Numberofsuccessfulindependentfraudattemptsagainstapersonn}}{\text{Numberofallindependentfraudattemptsagainstapersonn}}$$

$$FAR = \frac{1}{N}\sum_{n=1}^{N} FAR(n) \qquad (3)$$

Table 1 FAR & FRR

Number of Users	FAR	FRR
1-10	7.98	9.86
11-20	7.8	8.98
21-30	7.2	9.65
31-40	7.3	9.5
41-50	7.88	9.2
51-60	7.9	9.9
61-70	8.1	9.87
71-80	7.75	9.9
81-90	7.8	9.82
91-100	7.5	9.85

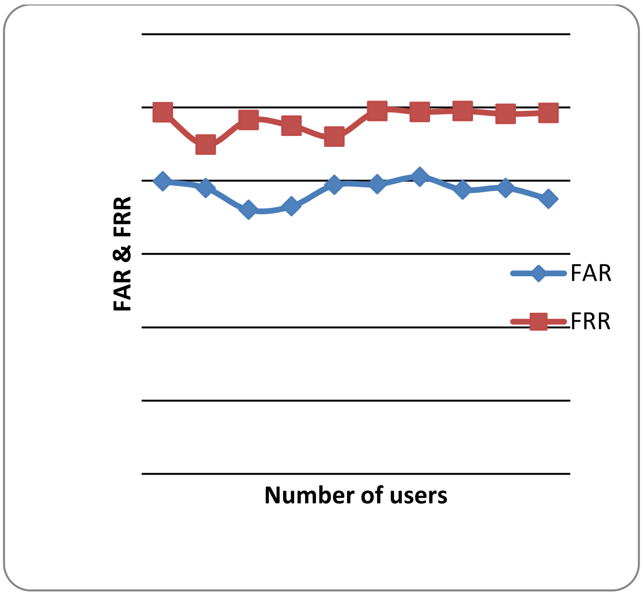


Figure 4 FAR & FRR

4. CONCLUSION

The redundant minutiae points are removed using neighborhood elimination technique to enhance the performance of the system. There are a variety of factors taken into consideration in this biometric system, such as the number of intersections in the vein pattern, and the pattern around the intersection point. This intersection spot will be taken by the system itself, taking the intersecting point as the mid-point. Thus finger vein authentication by means of this new method will ensure high level of security. The reduced feature set method proposed has high accuracy and improved performance.

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BIOGRAPHY

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