Personal Authentication Using Hand Vein

[1]N. V. Krishnaveni,
PG Scholar,
Department of ECE,
Akshaya College of Engineering and Technology,
INDIA.

[2]K. Sivasankari,
Associate Professor,
Department of ECE,
Akshaya College of Engineering and Technology,
INDIA.

[3]Veena Vijayan
PG Scholar,
Department of ECE,
Akshaya College of Engineering and Technology,
INDIA.

Abstract

Biometric identification with the vein patterns is a more recent technique. The vein patterns in the hands are assumed to be unique to each individual and they do not change over time except in size. As veins are under the skin and have a wealth of differentiating features, an attempt to copy an identity is extremely difficult. BOSPHOROUS hand vein database was utilized in this project work. Image was initially normalized, followed by feature extraction. Based on the angles and length between minutiae, the invariant triangles were formed. From this, triplet score were assigned using score assignment process. Finally matching was done between the hand vein database and the extracted hand vein image and the person is identified. The Equal Error Rate obtained in the base paper is 1.26%. There are some main reasons for the reduction in EER when compared to the previous work. At the same time, when it is compared with the statistical method using Independent Component Analysis (ICA) and Non Negative Matrix Factorization (NMF) Algorithm, obtained result is more efficient.

Keywords: *Triplet triangulation, Hand vein, matching scheme.*

1. Introduction

Nowadays there is a rapid development in the BIOMETRIC technology. Biometric is the term used in computer science to refer to the field of mathematical analysis of unique human features. It refers to the identification of humans by their characteristics and traits. Specifically Authentication is defined as the act of confirming the truth of the datum or entity. Traditionally identification includes token-based identification systems, such as a driver's license or passport and knowledge-based identification system, such as a password or personal identification number. Since the identification on the individual is unique, they are more reliable in verifying identity than token and knowledge based methods.

2. Classification of Biometric Technology

There are two main classifications in biometric technology, they are Behavioural based method and physiological based method. Voices, Signature are the behavioural based characteristics of a person and these come under behavioural based method. Face, figure, vein, and hand vein are the physiological characteristics of a person and these come under physiological based method.

3. Previous Work

J.M.Cross,C.L.Smith[7] proposed a prototype low cost automatic thermo graphic imaging system. Matching involves comparing a given signature against either a single template or library of templates. The estimates of the FAR and FRR for VEXED are initial estimates only because they are based on small sample size; namely 20 people and 100 hand images. C-L.Lin, K.C.Fan[9] proposed a novel approach to personal verification using the thermal images of palm-dorsa vein-patterns. It also introduce a logical and reasonable method to select a trained threshold for verification.

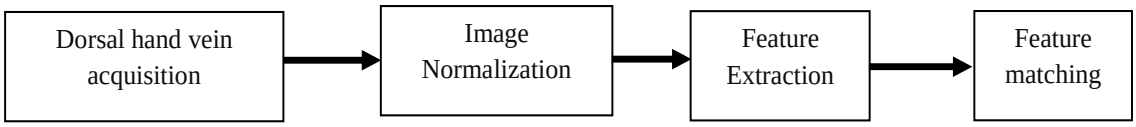

Figure 1. Block diagram of authentication system

The database with 32user had been taken into consideration. FAR obtained is 1.5% and FRR obtained is 3.5%.T.Tanaka, manipulations for best effort. They used the database with 25 users. As a result, they obtained high certification ratio in there system. The system obtains FAR of 0.73% and FRR of 4%.L.Wang, G.Leedham[11] proposed a LHD based verification method. During the verification stage, three undirected LHDs where computed. By choosing 9.0 to be the threshold value, the system achieves 0% false acceptance rate (FAR) and 0% false rejection rate (FRR) for all the 108 images in both the testing set (containing 72 images) and the template set (containing 36 images).Though 0% is obtained it is only for 12 users. When the number of user increase EER also increases**.** Y.Ding, D.Zhuang [18] discussed about the theoretical foundation and difficulties of hand vein recognition. It is mainly based on the distance between the feature points in the dorsal hand vein. The database used here contains 48users. The system obtains FAR as 0% and FRR as 0.9%.Aycan et al [3] proposed a biometric technique based on the statistical processing of the hand vein patterns. They used BOSPHORUS hand vein database in which the hand veins from the persons are collected under realistic conditions. EER obtained is 1.98 for single enrolment.

4. Proposed Work

Authentication is the act of confirming the truth of an attribute of a datum or datum or entity. It is derived from a Greek, meaning genuine or real. The hand vein authentication approach in this work is based on the hand vein triangulation. There are four stages in the authentication process. A) Image AcquisitionB) Image Normalization C) Feature Extraction D) Feature Matching

4.1 Image Acquisition

Image Acquisition is the process of getting the images that are required for the authentication process. BOSPHORUS Hand vein database was collected from BOGAZICI University, Turkey. In general, the structure of the vein patterns can be detected and captured with the help of infrared sensors. Typically, there are two kinds of imaging technologies, namely Far-Infrared (FIR) and Near Infrared (NIR) imaging. . FIR technology that works within the range 8-14 nm is more suitable for capturing the large veins in the back of the hand, but it is sensitive to ambient conditions and does not provide a stable image quality. On the other hand, NIR imaging that works within the range 700-1000 nm produces good quality images when capturing vein patterns in the back of the hand, palm, and wrist. This band is more tolerant to changes in environmental and body conditions. Hence NIR imaging technique is used in this database, along with this reflection method have been chosen for image acquisition [3]. Table 1 shows the database information.Each subject underwent four imaging sessions that consisted of the left hand

- Under normal condition (N),
- After having carried a bag weighing 3 kg. for one minute (B),
- After having squeezed an elastic ball repetitively for one minute (A),
- After having cooled the hand by holding an ice pack on the surface of the back of the hand (I).

Table 1 Database Information

Gender	Left/Right Handed	Age	Number of Persons	Condition
Male Persons	2\98	16-63	58	N,B,A,I
Female Persons	2\98	16-63	42	N,B,A,I

4.2 Image Normalization

In general terms, Normalization is of any process that makes something more normal or the process that makes the image more suitable for the further process. The pre-processing stage is shown in Figure 2. Initially when the image is acquired the Region of Interest (ROI) should be extracted [5]. After that normalization steps can be continued. The image acquired sometimes may contain noise and uneven illumination. This would result in the poor quality of the image. Next the edges are detected using the Mexican Hat Operator. There are many edge detection techniques available but in this

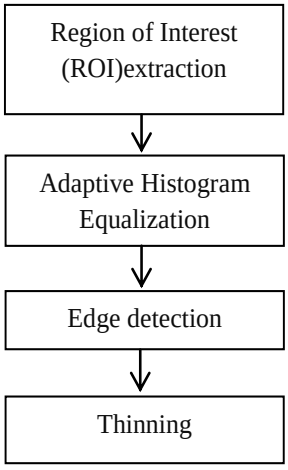

Figure 2. Normalization steps

work Mexican Hat Operator is used, Since it smoothens the image and reduce the noise effect, following this the thinning are implemented.

Region of Interest Extraction

Using the figure tips and inter-finger point the region of interest can be extracted. After finding the inter-finger points, it is given some specification i.e.) the inter-finger points between the index finger and middle finger is F_1, between the middle finger and ring finger is F_2, between the ring figure and little finger is F_3 [1]. By taking the midpoint of these three points and extending it by 20%, a new plot is obtained. The next step in normalization is Histogram Equalization.

Histogram Equalization

The histogram of an image is a plot of the number of occurrences of the gray levels in the image against the gray level value. It provides a convenient summary of the intensities in an image, but it is unable to convey any information regarding spatial relationships between pixels.In this work Adaptive Histogram Equalization technique is used. It enhances the contrast of the gray scale image by transforming the value using Contrast Limited Adaptive Histogram Equalization (CLAHE). It operates on small region in the image called tiles, rather than on the entire image.

Edge Detection

Edge detection is the process of finding meaningful transitions in an image. Edge detection is one of the lower levels of image processing. The points

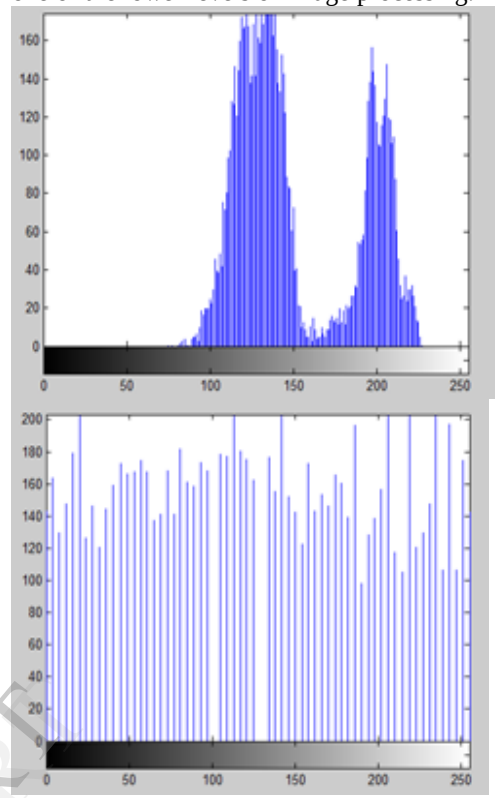

Figure 3. Histogram Representation

Sharp changes in the brightness occur typically from the brightness occur typically from the border between different objects. These points can be detected by computing intensity difference in local image regions. LOG or Mexican hat operator is used for this edge detection process. A prominent source of performance degradation in the Laplaian operator is noise in the input image. The noise effect can be minimized by smoothing the image prior to edge enhancement. The LOG operator will smooth the image through convolution with Gaussian-shape kernel. It is then followed by the application of laplacian operator. The sequence of operation involved in an LOG operator is given in the following steps

- Smoothing the input image
- Laplacian operator is applied.
- Zero crossing in the second derivative is determined.

Thinning

Thinning a binary image done to a unit-width skeleton is useful not only to reduce the amount of pixels, but also to simplify the computational

procedures, required for shape description. It will thin objects to lines. It removes pixels so that an object without holes shrinks to a minimally connected stroke, and an object with holes shrinks to a connected ring halfway between each hole and the outer boundary.

4.3. Feature Extraction

The feature is the process in which the key points are extracted from the image. These key points are used for the further matching process. In this work the key points are extracted from the image using the triangulation connected component method. Triangulation is the process that takes a region of space and divides it into sub regions. Minutiae are considered to be the key points and it is denoted as M_i. It can be represented by its position, type, and the number of connected component present in it. $M_i=(p_i,q_i,m_i,c_i)$ where (p_i,q_i) denotes the position, m_i denotes the type of minutiae i.e., it may be vein bifurcation or endings. $C_i$denotes the number of connected component in the image. The vein point where vein forks or diverge into branches is known as vein bifurcation and the point where the vein get terminated or disappears abruptly is known as vein endings. This is shown in Figure. 4, by calculating the number of connected component in the vein map and assigning labels to those connected component add one more feature to the extraction process.

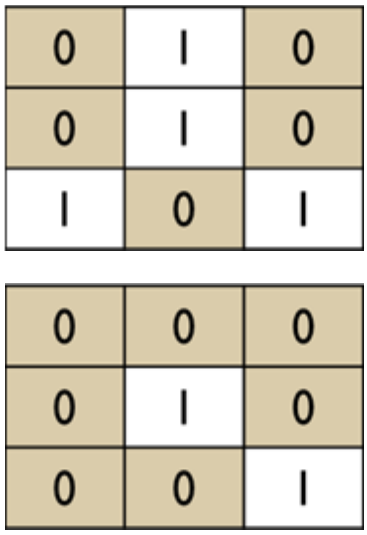

Figure 4. Vein Bifurcations and Vein Endings

The invariants are based on the sides and angles of the minutiae triangle [1]. Table 3 shows the triplet types under which each images are classified.

Table 2. Invariants formed

Triplet type	Minutiae Type		
ε_j	m_1	m_2	m_3
1	b	b	b
2	b	b	e
3	b	e	e
4	e	e	e

4.4 Feature Matching

In this stage, based on the features extracted, the image already stored in the database is recalled and compared to the test image for verification. This can be a one-to-one match or a database search (one-to-many), which are essentially many one-to-one matches until a match is found. The score assignment scheme is hierarchical and assigns higher scores to more likely true matches. If two triplets having three bifurcation points, i.e., type 1, are matched then there is higher probability that they corresponds to the same user vein map. Therefore, such matches are assigned higher scores. However, those matching triplets formed due to three vein endings, i.e., type 4, have small probability/reliability that they have originated from the vein map of the same user.

5. Result and Discussion

In this work a hand vein called BOSPHORUS hand vein database was utilized. It uses near infrared imaging technology, under adverse conditions mirroring real life situations and designed a new biometric identification technique based on hand vein patterns. The authentication technique is based on the triangulation method. Using MATLAB software the simulation results are obtained. The Figure shows the screenshots results obtained. Here the input hand vein under normal conditions is taken and they are processed to authenticate the person. Figure 5 shows the input image chosen for the process from the BOSPHORUS hand vein database. After getting the image, the region of interest for the further process is

taken. Fig 6 ROI Image shows the ROI region extracted from the input image.

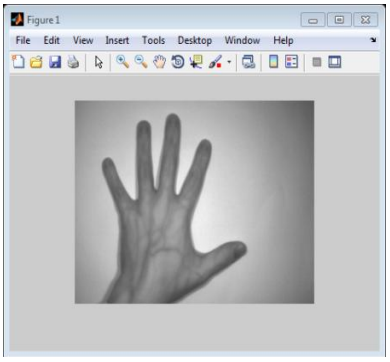

Figure 5 Input hand vein image

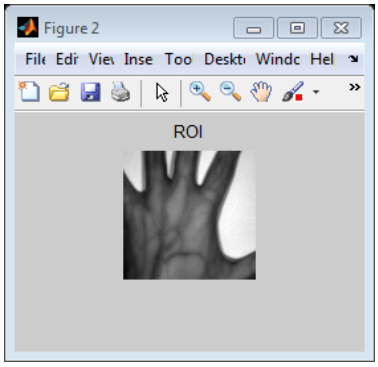

Figure 6 ROI Extracted from input image

Figure 7 shows the image after Adaptive Histogram Equalization. It is used to enhance the contrast of the image. It shows the equalized image so that the detailed information can be taken from that. After the Histogram equalization step, the Mexican Hat Operator applied to get the edges in the hand vein image. It is then followed by thinning process and the Fig 8 shows the result of thinned image, here the thinning is performed by removing the holes.

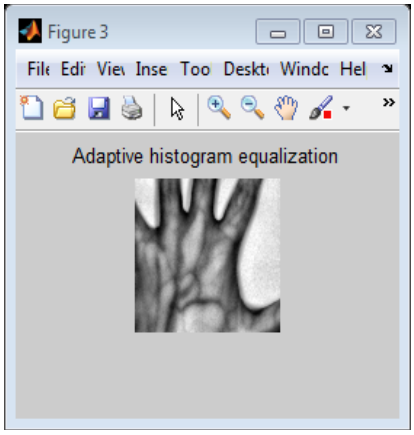

Figure 7 Image after applying CLAHE

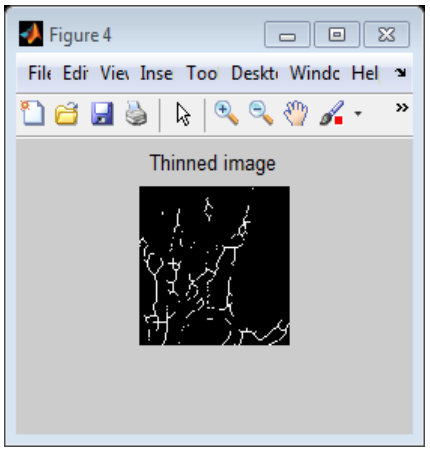

Figure 8 Thinned image

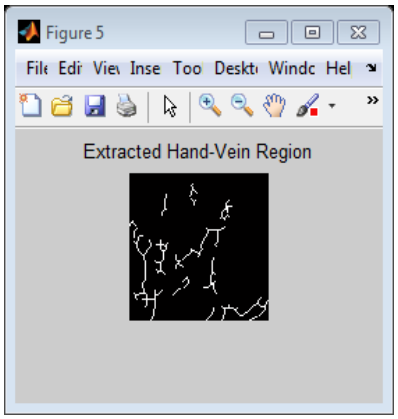

Figure 9 Extracted region

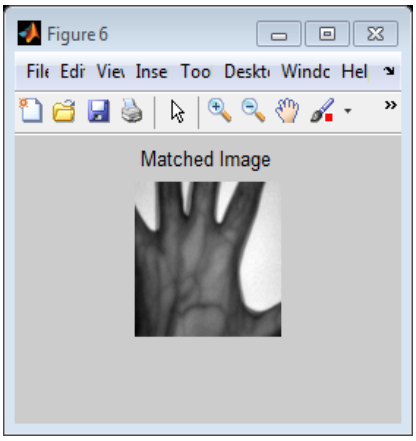

Figure 10 Authenticated image

From the thinned image the regional properties like number of connected components, minutiae triangles are analyzed. The triangulation method was applied to the thinned hand vein image and hand vein are extracted and is shown in Figure 9. After getting the extracted image the score was generated using the score

assignment scheme, based on the triplet type. The score assignment scheme is hierarchical. The higher score was generated to more likely matched image. Based on this score generated the matching process were carried out between hand vein database and Extracted hand vein. The result is shown in Figure 10. After the matching process, performance is evaluated. It is based on the FAR, FRR and EER. Table 4.1 shows False Acceptance Rate and False Rejection rate. For each hand vein image FAR and FRR are obtained. It was observed that most of the values for FAR obtained were around 1 to 1.5% and for the FRR it was around 0 to 1.25%.

Table 3 Performance evaluation

FAR	FRR
1.03%	0.54%
1.04%	0.63%
1.21%	0.68%
1.23%	0.75%
1.26%	1.20%
1.28%	1.26%

The equal error rate is the point at which the False Rejection Rate and the False Acceptance Rate are equal. In this work the point obtained was 1.26%.

6. Conclusion

In this work a hand vein called BOSPHORUS hand vein database was utilized. It uses near infrared imaging technology, under adverse conditions mirroring real life situations and designed a new biometric identification technique based on hand vein patterns. The authentication technique is based on the triangulation method. The EER rate obtained in this project work is 1.26%. There are some main reasons for the reduction in EER when compared to the base paper work. The first reason is the difference in the image acquisition process. In this work BOSPHORUS Hand vein database was collected and it consists of 1200 images, whereas in the previous work real time data was collected with less number of images. The extraction of Region of Interest had also the difficulties and we are not able to obtain the expected EER.

7. Future Scope

Although this work had produced more accurate result. Further improvement in the performance is expected. It was analyzed that the accuracy in the distance calculation during the matching process can be improved by calculating it through the correlation method.

8. Acknowledgement

I take this opportunity to express my gratitude and sincere thanks to everyone who helped me with their valuable guidance in this work.

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