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# A novel approach of finger vein recognition for personal authentication

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## ABSTRACT

Finger vein recognition has emerged as the robust biometric modality because of their unique vein pattern that can be captured using near infrared spectrum. The large scale finger vein based biometric solutions demand the need of searching the probe finger vein sample against the large collection of gallery samples. In order to improve the reliability in searching for the suitable identity in the large-scale finger vein database, it is essential to introduce the finger vein indexing and retrieval scheme. In this work, we present a novel finger vein indexing and retrieval scheme based on unsupervised clustering. Recently, biometrics such as fingerprints, faces and irises recognition have been widely used in many applications including door access control, personal authentication for computers, internet banking, automatic teller machines and border-crossing controls. Finger vein recognition uses the unique patterns of finger veins to identify individuals at a high level of accuracy. This paper proposes new algorithms for finger vein recognition. This research presents the following three advantages and contributions compared to previous works. First, we extracted local information of the finger veins based on a LBP (Local Binary Pattern) without segmenting accurate finger vein regions. Second, the global information of the finger veins based on Wavelet transform was extracted. Third, two score values by the LBP and Wavelet transform were combined by the Minimum distance classifer. Currently, passwords, Personal Identification cards are used for personal identification. However, cards can be stolen, and passwords and numbers can be guessed or forgotten. To solve these problems, biometric authentication technology, which identifies people by their unique biological information, is attracting attention. Finger vein recognition is that it is not affected by dryness or roughness of skin or by physical injury on surface of the hand but sometimes the temperature and humidity can affect the quality of the captured image.

**Keywords:** Minimum distance classifier, LBP, ROI, Finger vein recognition.

## INTRODUCTION

Finger vein biometrics has rapidly gaining popularity for its potential characteristics useful for human identification/recognition. The finger vein pattern can be captured by penetrating the Near-Infrared Light (NIR) on the finger that will be absorbed significantly by the haemoglobin than by the surrounding tissues. Figure 1 (a) shows the region of interest from finger vein pattern captured with NIR illumination and Figure 1 (b) shows the enhanced finger vein pattern. Furthermore, the use of finger vein biometrics offers an advantage of being contactless and difficult to spoof as the vein pattern is hidden inside the skin. This enables the adaptation of the finger vein biometric based identification solution in a wide range of banking application especially in the Asian counties. The finger vein biometrics has received remarkable progress from recent decades that resulted in various feature extraction schemes that mainly includes Maximum Curvature points (MCP) [8], Wide Line Detector (WLD) [3], Repeated Line Tracking (RLT) [7], Spectral Minutiae Representation (SMR) [2] and improved Spectral

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Minutiae Representation [13]. These feature extraction schemes have demonstrated very good accuracy in building a ginger vein based identification solution. Inspite of many finger vein recognition schemes most of the analysis is limited to the small scale database. With the growing requirements of the large scale national ID programs, for example, India's UID project [15] using biometrics has imposed the challenges that include not only the robustness but also the accuracy for reliable identification. Under these circumstances, the biometric based identification solution need to search for the biometric reference in a large-scale database by ensuring a very high recognition accuracy. The natural way of addressing this situation is by introducing the indexing and retrieval scheme that can simply reduce the search space by selecting the number of likely candidates from the large scale database to facilitate the comparison and decision on the smaller dimension space.

Even though the finger vein indexing and retrieval problem was not studied extensively, there exist only one work [16] that address the finger vein retrieval problem. In [16] preliminary study on the finger vein indexing is presented using the repeated line tracking as the feature extraction scheme and Locality Sensitive Hashing (LSH) as the indexing scheme. Experimental results indicated in [16] shows the improvement in the query time at the cost of reduced hit rate when compared to the linear search. Even though the choice of LSH for finger vein is appealing, it demands the tuning of hyper-parameters and also the memory requirement to store the hash table that will grow according to the size of the database as well as the choice of hash function. Thus, in this work we introduced a novel finger vein solution using unsupervised clustering and present the in-depth analysis on the same. The novelty and main contribution of this paper can be summarized as follows:

- We present a novel finger vein indexing and retrieval framework based on unsupervised clustering. To this extent, we investigated three different clustering schemes like: (1) K-means [6] (2) K-medoids [10] and Self Organizing Map (SOM) neural network [4] independently.
- We present a new finger vein feature extraction scheme by exploring a block wise counting of Maximum Curvature points (MCP) that will result in compact feature representation suitable for indexing.
- Extensive experiments are carried out on a large scale database of 2850 unique identities constructed using seven different publicly available finger vein databases. The obtained results demonstrated the efficacy of the proposed finger vein indexing and also the proposed finger vein feature extraction scheme. The paper is organized as follows: Section 2 present the proposed framework on finger vein indexing and feature extraction scheme, Section 3 reports the experimental results, comparison with existing state-of-the-art (SOTA) schemes and also in-depth analysis of the proposed scheme. Finally, Section 4 draws the conclusion.

## Finger vein indexing using unsupervised clustering

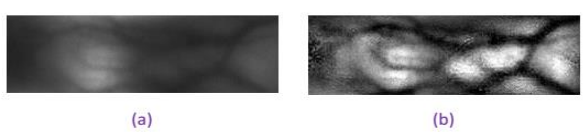



Figure 1: Finger vein image (a) ROI of finger vein (b) Enhanced finger vein

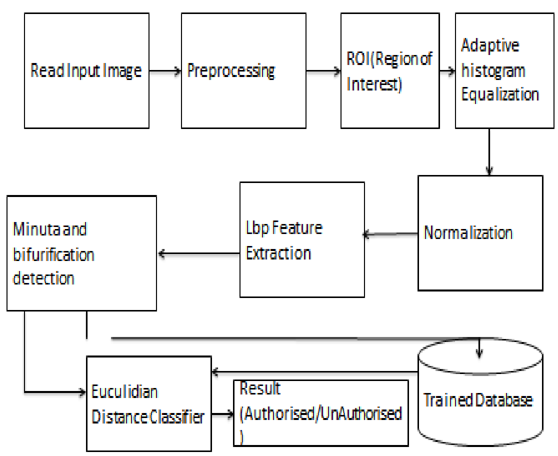
Figure 1 shows the block diagram of the proposed finger vein indexing and retrieval scheme based on unsupervised indexing. The proposed method can be structured using four different functional blocks namely: (1) Region of Interest (ROI) extraction and pre-processing (2) Feature extraction (3) Building indexing space (4)

Retrieval of the probe identity. In the following, we discuss each of these steps in detail.

## Proposed method

Finger vein recognition has emerged as the robust biometric modality because of their unique vein pattern that can be captured using near infrared spectrum. The large scale finger vein based biometric solutions demand the need of searching the probe finger vein sample against the large collection of gallery samples. In order to improve the reliability in searching for the suitable identity in the large-scale finger vein database, it is essential to introduce the finger vein indexing and retrieval scheme. In this work, we present a novel finger vein indexing and retrieval scheme based on unsupervised clustering.

Proposed Block diagram




## Algorithm usage

In proposed approach, we have used

- ❖ Wiener filter.
- ❖ ROI(Region of Interest).
- ❖ Image Enhancement (Histogram Equalisation).
- ❖ Normalisation.
- ❖ Lbp Feature extraction Minutia and bifurification detection.
- ❖ Euculidian distance classifier.
- ❖ Image Alignment for the feature extraction from the ROI images.

The algorithm used for finger vein image matching method:

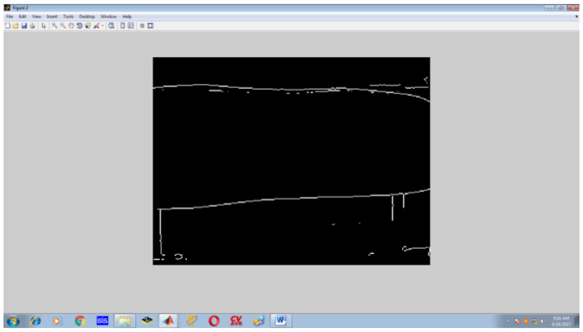
## Step by procedure

## Step 1: image acquisition

- Step a: Acquire test image
- Step b: Acquire training images one-by-one and apply following tasks in iterative fashion.

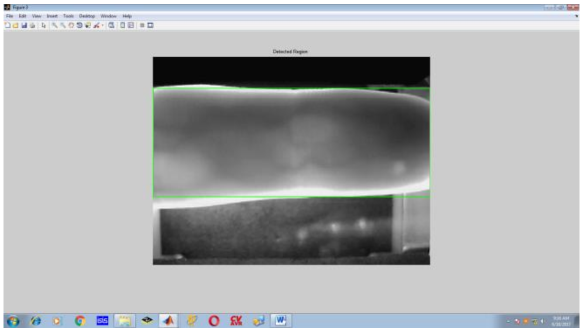
### Step2: test and training image pre-processing

- Step a: Remove noises using Wiener Filter
- Step b: By using wiener filter To reduce the Mean square Error and increase the PSNR value.
- Step c: Compute grey-threshold
- Step d: Binary Conversion
- Step e: Obtain the boundaries of the hand.



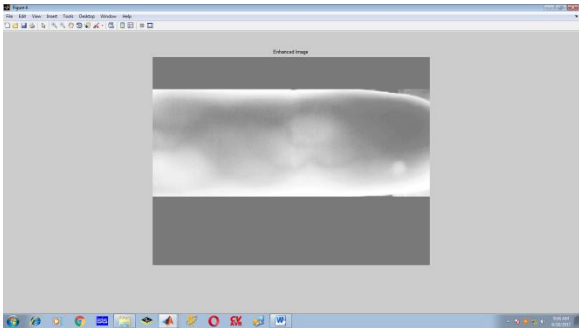
### Step3: ROI extraction

- Step a: Rotate the picture
- Step b: Obtain the center of the finger
- Step c: Set (x1, y1) and (x2, y2) values
- Step d: Extract Region of Interest (ROI)



### Step 4: apply local binary pattern technique for feature specification

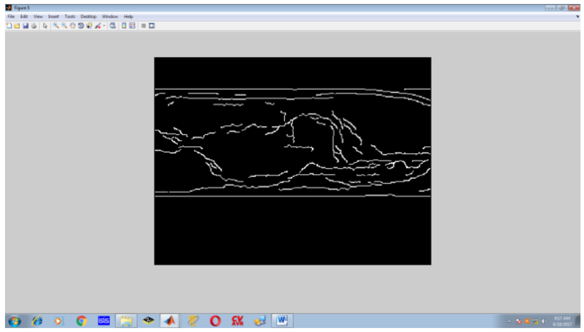
- Step a: LBP operator--> summarizes the local special structure of an image.
- Step b: For every pixel in image
- Step c: LBP is defined as an ordered set of binary comparisons of pixel intensities between the center pixel and its eight surrounding pixels.
- Select d: Each pixel of an image is labeled with an LSB code-First it divide the image into several blocks and it starts



Calculating the LSB histogram for each block after that it will combine every LSB histogram for that image then the LSB histogram is made for one vector

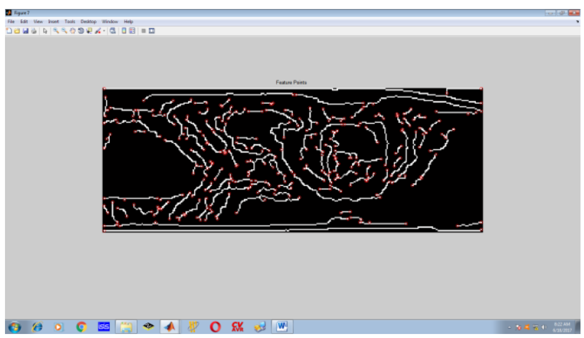
**Step 5: extract minutiae points**

- Step a: Compute the minutiae points
- Step b: Coordinates of intersection Points (Minutiae coordinates)



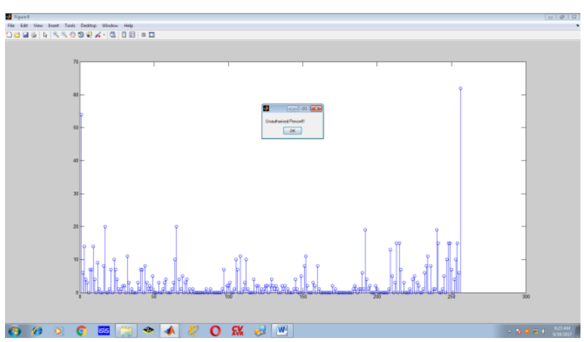
**Step 6: apply curve analysis over the minutiae point information**

- Step a: Apply calculus methods to obtain the curves
- Step b: Find and count the lines or the curves connecting two point
- Step c: Find the amplitude, phase and actual curve length




**Step 7: return the matching finger-vein sample and recognize the person by using euclidian distance classifier**

- Step a: Match the curve details with training data
- Step b: Show the match with highest similarity as the recognized sample and calculate Euclidian distance.
- Step c: Find the person ID and correlate the person recognition.



## Finger vein database

In this work, we have constructed a heterogeneous dataset by including the finger vein images from seven different publicly available databases: (a) UTFVP [18] (b) ICFVR [19] (c) HMT [20] (d) FVUSM [9] (e) ployU [5] (f) Vera [17] (g) HiGFVDB [14, 12]. This new heterogeneous finger vein database is comprised of 685 plus subjects that resulted in 2850 unique finger veins. Since each finger vein is unique, we consider each finger vein as the unique enrollment that resulted in 2850 unique identities and each of these unique identities has 2 samples. Thus, the whole database used in this work is comprised of 5700 finger vein samples. Table 1 shows the distribution of the subjects as well as fingers from 7 different finger vein databases used to construct a single heterogeneous database.

## Performance evaluation protocol

In order to effectively evaluate the database, we divide the whole database into three independent (or no overlapping) datasets namely: development, training and testing. The development dataset is comprised of 273 unique identities with 273 × 2 = 546 finger vein samples. The development database is used only to tune the parameters of the ROI extraction as well as the proposed feature extraction scheme. The training dataset is comprised of 1075 identities that will result in 1075 × 2 = 2150 finger vein samples used only to build the cluster space using either K-means or K-medoids or SOM neural network. Lastly, the testing dataset is comprised of 1502 unique identities that are used solely to report the performance of the proposed indexing and retrieval scheme. The testing dataset is further divided into two groups namely gallery and probe. Since each identity has 2 samples, we assigned first sample to gallery and second sample to probe. Finally, the data partition into development, training and testing is repeated for 10 times and average of the results are reported.

We now present the results of the proposed finger vein indexing and retrieval based on the un-supervised clustering. In order to generate the clusters, we have investigated three different well established schemes like K-means [6], K-medoids [10] and Self Organizing Map (SOM) neural network [4] independently. In case of K-means and Kmedoids, the performance largely depends on the initialization. Hence, both K-means and K-medoids clustering schemes are run for 500 times with a different set of initialization and finally we pick the one with the smallest sum of distances between all feature vectors and the respective cluster centers. Further, we have also carried out the Silhouette measure [6] to fix the optimum number of clusters. Figure 4 shows the variation of the average Silhouette measure versus number of clusters (K) that indicates the smaller values of K results in more coherent clusters than large values of K. However, in case of SOM neural network clustering we followed the experimental procedure to try with various values of clusters and then to choose the one that yield the best PSE and PEN.

# CONCLUSION

This study presents a survey of vein recognition techniques for biometric authentication and identification. The state-of-the-art overview consists of the principle, general framework, key techniques, available methods classification, performance evaluation, application fields and status and future trends. As a new biometric feature exploited, validity and efficiency of this promise technique are demonstrated in both theoretical analysis and commercial applications.

In future work, we plan to pre-align the finger vein image based on the detected finger vein region and minutia points such as bifurcation and ending points of finger vein lines. We also plan to increase the dataset including more various ages, genders and occupations.

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