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A Novel LDA Algorithm for Palm Vein Feature Detection and Extraction

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Abstract: Each people on the earth are all unique with respect to either one or more than one biometric features. Biometric features used to identify people much more accurate than manual verification methods. The present paper explores the feature extraction of palm vein pattern using linear discriminate analysis (LDA) algorithm. Here we found pattern similarity of real palm vein images for three different samples using LDA algorithm.

Keywords: Pattern, LDA

1. Introduction

A palm vein of the human beings to develop biometric identification system attracts lots of research industry attention. Palm vein biometric system intended to provide comprehensive non-transferable means of recognisizing people rather of on cards and badges. A key importance of palm vein biometric authentication is based on palm vein pattern. The palm vein pattern characterizes uniqueness with accuracy, compare to traditional biometric features like faces, finger print and palm print.

Fig.1 depicts anatomy of human skin made up of three layers, such that each layer contains different proposition of blood and fat. A non-transferable mechanism is adopted to recognize palm-vein patterns which involves with passing light to penetrate the skin. Range of light wavelength varies from 700nm to 900nm. This non-contact sensor system acquires different spectra information from all three layers giving rise to unique palm veins pattern. Palm vein pattern acquire through sensors are transferred into characteristics/attributes in order to embed in palm vein biometric system.

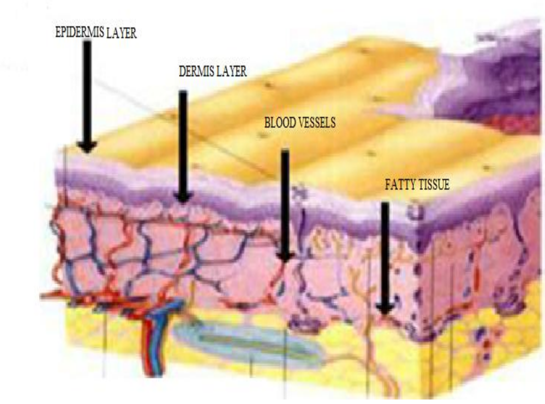

Fig.1 Cross sectional view of skin

There is lot of discussion and research explored from the past one decade regarding palm vein authentication system due to its uniqueness and feasibility for practical application.

2. Palm Vein Processing Model

Fig.2 shows the block diagram of the palm vein processing model from image acquisition to feature extraction and validation process. Each stage shows the extracted image process and also simulation obtained as discussed in result.

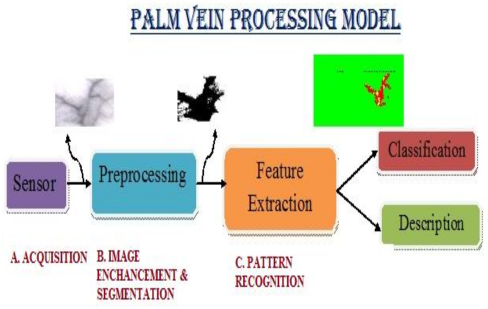

Fig.2 Palm Vein Processing Model

A. Acquisition

Palm vein image get from the standard database (PUT[1] Vein Database) for the analysis purpose. For an image there are more than one set (m_i) is obtained and processed. Future planning is to build our own data set using low costing CMOS sensor to improve accuracy and reliability.

B. Preprocessing

For the measurement (m_i) set preprocessing has to be carried like image enhancement and segmentation follows the removal of noise during acquisition process.

C. Feature Extraction

Here more than one feature set (f_i) extracted from the preprocessed image and further those sets are optimized (o_i) to maximize the process execution time. Our work on feature extraction is mainly depends upon texture of palm vein images. It includes image quality, orientation and age.

D. Matching

Matching or decision (d_i) process determines the degree of similarity between the stored data set and claimed features. This is the final decision stage for verification and satisfaction level of authentication as explained in mathematical model as decision space D.

Fig.3 shows the complete design flow of PVFE Algorithm implementation steps.

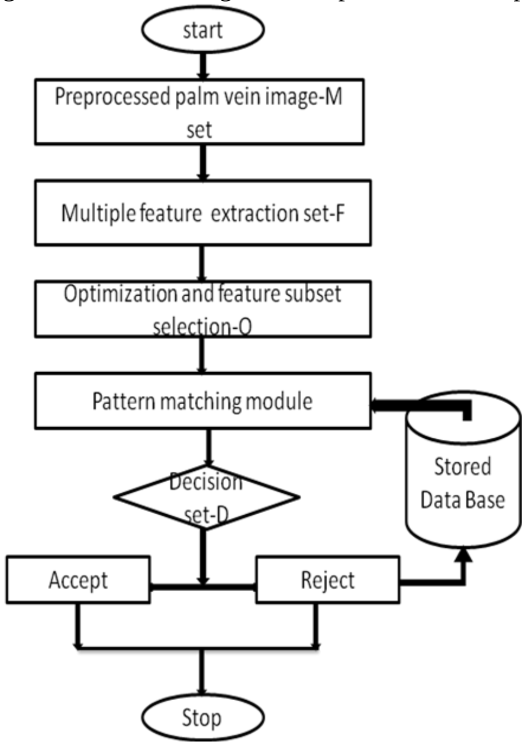

Fig.3 PVFE Design Flow

Flow chart explains the steps involved in palm vein pattern recognition from measurement space to decision space.

[1] PUT Vein pattern database is free available for research purposes can be applied as common platform for evaluation and comparison of new segmentation and classification algorithms.

2.1 DATABASE

PUT Vein pattern database consists of 1200 images presenting human vein patterns. Data was acquired from both hands of 50 students (P) of 100 different patterns for palm region. Pictures were taken in 3 series (S), with one week interval between each series. The simulation function is carried through MATLAB tool. Table.4 shows the designated data base simulation comparison for all three series, feature extraction of a student considered for pattern analysis and classification.

3. Linear Discriminant Analysis (LDA)

LDA algorithm is for dimensionality reduction in pre-processing step for pattern-classification and better class-separability in order to avoid over fitting and to reduce computational costs.

Summary of LDA algorithm:

1.Compute the d*d-dimensional mean vectors for the different classes from the dataset.

2.Compute the scatter matrices (in-between-class and within-class scatter matrix).

3.Compute the eigenvectors (ee1,ee2,...,eedee1,ee2,...,eed) and corresponding eigen values (λλ1,λλ2,...,λλd) for the scatter matrices.

4.Sort the eigenvectors by decreasing eigen values and choose k*k eigenvectors with the largest eigen values to form a d×kd×k dimensional Matrix WWWW (where every column represents an eigenvector).

5.Use this d×kd×k eigenvector matrix to transform the samples onto the new subspace.

4. Results And Discussion

Here for the analysis purpose the palm vein image had taken from the standard real database and the simulation is as shown in Fig.4. Fig.4.1 (a) shows the palm vein image taken from IR sensor.

4.1 PRE – PROCESSING STEPS: SIMULATION RESULTS

Pre-processing is the technique of enhancing data images prior to computational processing. Preprocessing the images involves eliminating low frequency background noise, masking, normalizing the intensity of images and removing reflections. The steps involved in preprocessing and result is explained in the following section.

4.1.1 Normalization: Normalization is a process that changes the range of pixel intensity values and eliminating image variations. For example, if the intensity range of the image is 10 to 170 and the desired range is 0 to 255 the process entails subtracting 10 from each of pixel intensity, making the range 0 to 160. Then each pixel intensity is multiplied by 255/160, making the range 0 to 255.

4.1.2 Image Segmentation: The goal of image segmentation is to cluster pixels into salient image regions. Segmentation used for boundary estimation, object recognition, image compression. The result of image segmentation of an acquired image is as shown in Fig.4 (b) is a set of segments that cover the entire image or contours extracted from the image

4.1.3 Image Binarization: In Binarization, the grey scale image is converted into binary image. The binary image decides a threshold value as shown in Fig.4 (c). The pixels whose value are more than the threshold (>0.5) are converted to white pixels, and the pixels whose value are below or equal to the threshold (≤0.5) value are converted to black pixels.

4.1.4 Noise Elimination: Removing small unwanted minutiae in an image. A sequence of data involves useful data, inconsistent data and noisy data. Noise elimination preprocessing reduces the noisy and inconsistent data as shown in Fig.4 (d). The data corrupted with noise is recovered with preprocessing noise elimination techniques.

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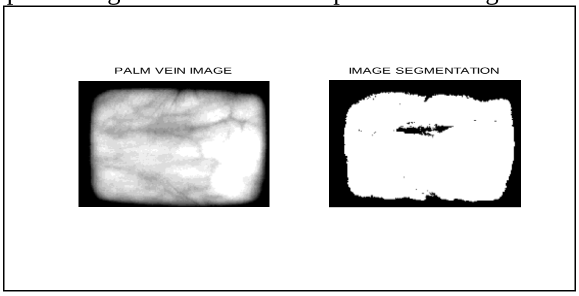
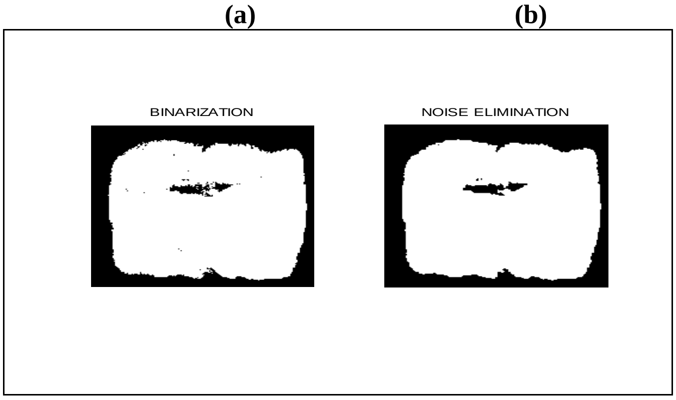
4.1.5 Thinning: It transforms binary image into another simplified image.
Thinning is also known as morphology or skeletonization or edge detector as shown in Fig.4 (e). The behavior of the thinning operation is determined by a structuring element. The binary structuring elements used for thinning here are hit and miss transformation.

4.1.6 Feature Extraction From skeletonizationed binary image: Minutiae extraction is for ridge bifurcations and terminations. This operation reduces spurious minutiae. LDA algorithm is applied here and the result is as shown in Fig.4 (f).

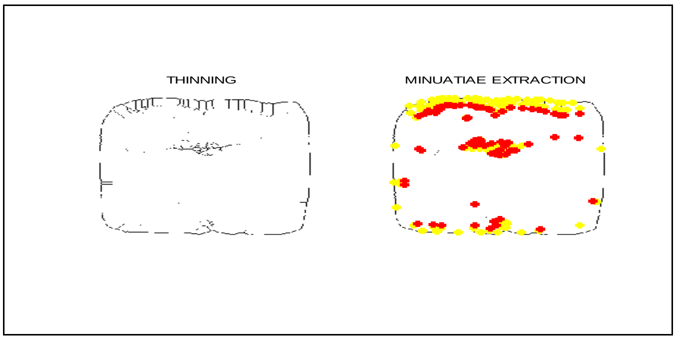
Fig.4 shows the simulated preprocessing results of left hand palm vein image of five students.



(a) **(b)**



(c) **(d)**



(e) **(f)**

Fig. 4 Simulation Results: (a) Palm vein Image (b) Segmented image (c) Binarization (d) Noise Elimination (e) Thinning (f) Feature Extraction

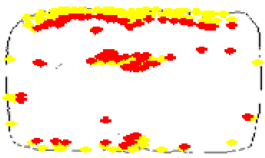
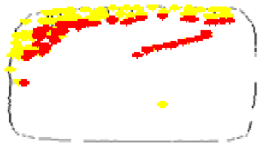
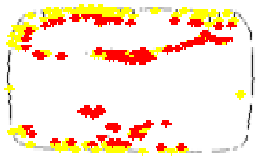
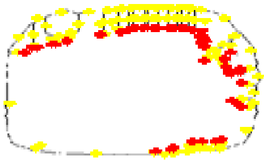
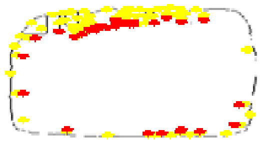
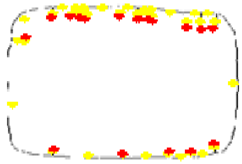
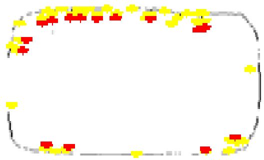
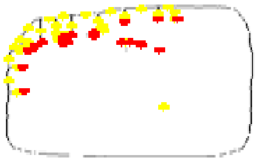
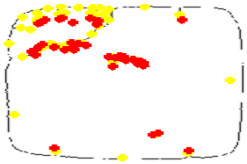
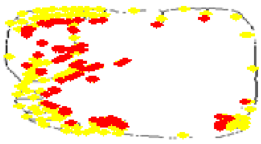
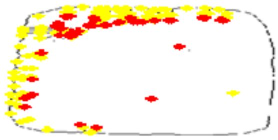
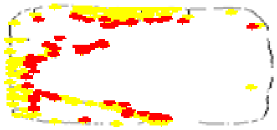
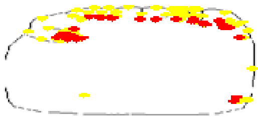
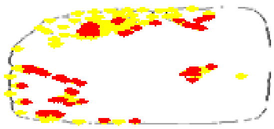
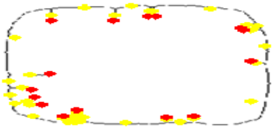
Sl.No.	Database designation (person left hand palm vein image PL)	Remarks Minutiae extraction		
		Series1(S1) First Week	Series2(S2) Second week	Series3(S3) Third Week
1.	P1L			
2.	P2L			
3.	P3L			
4.	P4L			
5.	P5L			

Table.4: Feature extraction pattern for three series of five students

5. Conclusions

The preprocessing techniques for feature selection and extraction using LDA approach is achieved with 99% with undisturbed pattern. Since patterns is preserved and unchanged irrespective of the time as tabulated. Our next goal is to build the efficient algorithm for pattern validation and recognition. This result is applied to neural network for validation process.

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