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Multifeature Biometric Based Authentication System

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ABSTRACT: Biometrics authentication is an efficient method for recognizing a person's identity without spoofing. Multi feature biometric palm vein authentication is relatively a new biometric technology and is in the progression of being endlessly refined and developed. An individual's palm vein image is converted into data points by algorithms, which is then compressed, encrypted, and stored by the software. Whenever a person access it, the data is compared with the stored one and thus verification is done. This work proposes a multi feature palm vein recognition method with the extraction of multiple features using Spatio local binary pattern and modified finite radon transform. Finally, the images are classified using Support Vector Machine (SVM) algorithm. The proposed method effectively accommodates the rotational, potential deformations and translational changes by encoding the orientation conserving features. The proposed system analyses the palm vascular authentication using databases collected from multispectral IIT Delhi and CASIA database. The experimental results clearly demonstrate that the proposed multispectral palm vein authentication obtained better result compared to other methods discussed in the literature.

KEYWORDS : Biometric, Radon Transform, Spatio Temporal Local Binary Pattern, Multispectral palm vein, SVM

I. INTRODUCTION

Human authentication is one of the most challenging missions to meet growing demand for biometric applications. Among the biometric authentication, multispectral palm print has received more attention in recent years due to its reliability and uniqueness. Since multispectral palm print uses a vascular network on the hand to identify the authenticate person. Human palms are simple to present for imaging and can depict a variety of information. As a biometric authentication, there are methods such as finger print [2], iris, retina [17], speech [5], facial features [4] and hand shape [12], to identify personals provide effective approach for many real applications. However no biometric has been verified to be perfectly consistent, robust and secure.

Palm-vein recognition has the benefit of high liveliness and also ensures that the significant information is undetectable, therefore providing higher security and privacy for the users as suggested by Yingbo Zhou [11]. Multispectral palm print recognition has become widespread because of the following advantages. The vein is the inner feature of body, which makes it very complicated to covertly obtain and extremely hard to alter their integrity.

Even identical twins do not share the same vein pattern. Thus the multispectral palm print recognition technology has the capability of easy, consistency and security in wide range of civilian and forensic applications.

II. RELATED WORK

With increasing demand for human authentication, multispectral pattern were suggested in different scenarios. Gayathri & Senthil Kumar [1] proposed two different techniques for extracting multiple vein features and underwent feature level fusion to improve the performance. The proposed approach can effectively accommodate rotational variations and image distortions. Multispectral palm print biometric technology is relatively new and it is in the progression of being endlessly refined and developed. Sandip Joardar [3] proposed multispectral dorsal pattern with different technologies. The Dorsum of hand substantially used for the human recognition but has not obtained the notice of research committee. Stanly Jayaprakash & Arumugam [2] proposed Non-Fracture based Fingerprint and Finger-Knuckle print Biometric score level fusion mechanism which applies the coarse grained distribution function to efficiently attain high fitting score on test and training biometric images. Di Huang, Yinhang Wang [7] proposed a novel and effective approach to hand dorsa vein based on local feature matching.

Qiuxia Wu [6] proposed an efficient algorithm named LBP (Local binary pattern) to improve the recognition rate and to progress in accuracy. LBP is popular for texture representation owing to its discrimination ability and computational efficiency, but when used to describe the sparse texture in palm vein images, the discrimination ability is diluted, leading to lower performance, especially for contactless palm vein matching, to further improve the LBP performance, the matched pixel ratio was adopted to determine the best matching region (BMR).

Abishek Nagar [9] proposed a Multi biometric cryptosystem using fingerprint, face features, iris and applied feature level fusion and effectively implemented using two biometric cryptosystem namely fuzzy vault and fuzzy commitment but due to increasing features storage size gets enlarged. The multimodal biometric systems require storage of multiple biometric templates (e.g. fingerprint, iris and face) for each user, which results in increased risk to use privacy and system security.

Sepehr [10] proposed a principal component analysis (PCA) which is very dominant and consistent method for the use of feature extraction and dimensionality reduction. PCA is a linear method that use top most Eigen vector to reduce the dimension of the input data. PCA is a very powerful and reliable method which has been used by researchers for the purpose of feature extraction and dimensionality reduction for a long time.

Chaitanya Kommini [14] proposed multispectral dorsal pattern with different technologies. The Dorsum of hand substantially used for the human recognition but has not obtained the notice of research committee. Jifeng Dai & Jie Zhou [13] proposed Multifeature based palmprint recognition which have achieved lower false rejection rate (FRR) than the existing algorithms. Moreover, the hemoglobin which flows in the veins is sensible to NIR light, this way allowing a good quality of acquisition of the hand veins.

Yingbo Zhou & Ajay Kumar [11] proposed a review of prior work in the paper on palm vein identification presented in the previous section outlines the need for the comparative performance on the most promising palm vein feature extraction and matching approaches. Zhang proposed an online system of multispectral palmprint verification. Multispectral imaging has been employed to acquire more discriminative information and increase the antispoof capability of palmprint. A data acquisition device is designed to capture the palmprint images under Blue, Green, Red, and near infrared (NIR) illuminations in less than 1s. A large multispectral palmprint database is then established to investigate the recognition performance of each spectral band. Their experimental results show that the Red channel achieves the best result, whereas the Blue and Green channels have comparable performance but are slightly inferior to the NIR channel. Chen & Wang Y [16] proposed a work for a new palm vein matching method based on ICP algorithm. They proposed a method to improve the verification performance of a contract free palm print recognition system by means of feature level image registration and pixel level fusion of multi spectral palm images. Matched filters are used for the feature extraction. This method involves image acquisition through a dedicated device under contact free and in multi spectral environment. The contactless palm vein identification is more hygienic and can offer higher user acceptability and preserve the vascular patterns from distortion and therefore deserves further research efforts. Zhang Y.B & Bhattacharya B proposed a work for Palm vein extraction and matching for personal authentication. In this work, they proposed a scheme of personal authentication using palm vein. They used matched filters for the feature extraction. Their system includes Infrared palm images capture, Detection of Region of Interest, Palm vein extraction by multi scale filtering, matching. In general, in the various work present in the literature, after the acquisition phase, some preprocessing algorithms are used such as histogram equalization, and low pass filtering.

In the literature discussed above is a combination of both unimodal and multimodal biometric recognition systems. In this paper two robust technologies are proposed to improve computation efficiency and recognition accuracy. The proposed methodologies are Radon Transform (HT) and Spatio Local Binary Pattern (SLBP).

III. PROPOSED SYSTEM FOR PALM VEIN RECOGNITION

The palm-vein images employed in our work were acquired under near-infrared illumination (NIR). The images generally appear darker with low contrast. We first estimate the background intensity profiles by dividing the image into slightly overlapping blocks and the average gray level pixels in each block are computed.

Palm vein authentication has a high level of authentication accuracy due to the uniqueness and complexity of vein patterns of the palm. Deoxygenated hemoglobin in the blood flowing through the veins absorbs near-infrared rays, causing it to be visible as black regions to the scanner. Arteries and capillaries, whose blood contains oxygenated hemoglobin, which does not absorb near infrared light, are invisible to the sensor, hence we chosen veins.

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In order to obtain the required palm vein features the image is subjected to preprocessing where the enhancement is done. By enhancing the image it makes the feature extraction process easy. Therefore, more stringent preprocessing steps are required to extract a aligned ROI. The preprocessing steps essentially recover a fixed size ROI from the acquired images which have been normalized to accommodate the translational and rotational changes. The acquired palm images are first binarized, so that we are able to separate the palm region from the background region. After segmentation, the ROI images are scaled to generate a fixed size region.

A. *ROI Extraction*

A region of interest (ROI) is defined by creating a binary mask, which is a binary image that is the same size as the image you want to process. It is a portion of an image where the filtering or any other operations can be made.

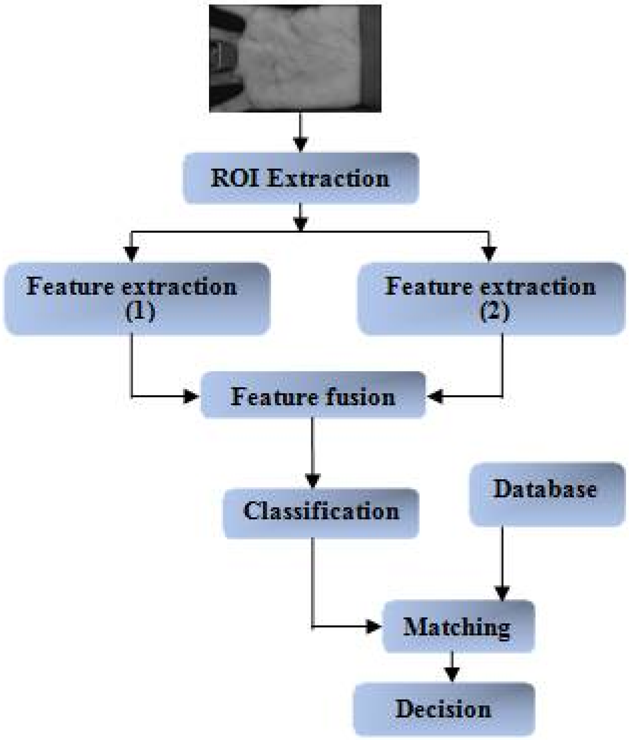

Fig. 1. Block diagram of proposed multifeature palm vein system

B. Radon Transform (RT) Feature Extraction

Radon transform can be used for line detection. In this paper, palm lines are detected from the ROI as features using Radon transform. The Radon transform is the projection of the image intensity along a radial line oriented at a specific angle. The proposed method is based on applying the Radon transform on palm vein image f (x, y) and then computing the projection of the image. The resulting projection is the sum of the intensities of pixels in each direction, i.e. a line integral. The result is a new image R that can be written mathematically by defining

$$\rho = x\, Cos\theta + y \sin\theta$$

The Radon transform is the projection of the image intensity along a radial line oriented at a specific angle. But the radon transform based feature detector unsuccessful to detect peak and do not afford to provide an indication of line length or end positions. In generalized radon transform the line constraint is not instantly ahead. To conquer the above limitations a modification is carried out in radon transform

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R = Radon (I,**Error! Reference source not found.**)

The above form returns the radon transform R of the intensity image I for the angle theta degrees. Let us consider a function (a, b) be a Cartesian coordinate of a point in 2-D Euclidean space and S (a, b) be the image intensity. Then the radon transform is denoted as

$$g(\rho,\theta) = \int\int_{-\infty}^{\infty} S(a,b)\delta(\rho a\cos\theta b\sin\theta)dadb$$

where $\delta()$ is the Dirac delta samplings function and θ is the angle obtained from the distance vector. The ρ and θ value of line is determined by average of the two values.

$$\rho = \frac{\rho_1 + \rho_2}{2} \text{ and}$$

$$\theta = \frac{\theta_1 + \theta_2}{2}$$

Thus for the processed radon image, the Eigen values are calculated. Consider a matrix G, a scalar λ_x is called an Eigen value of G if there is a nonzero vector Z such that

$$GZ = \lambda_X Z$$

Then the Eigen value equation for the square matrix G can be represented as

$$GI - \lambda_X IZ = 0$$

where I is the identity matrix of order p $_x$ p. To get a non-trivial solution for Z, the determinant form is

$$\det(G - \lambda I) = 0$$

It is seen that the angle of projection varies from 0 to 180 and hence the image is a matrix. The ROI of the multispectral palm print image is identical for all identities. But the achieved radon transform may not be a square matrix because each pixel in the image has angle, magnitude and direction attributes. Hence the matrix size increases. In order to make the attained radon matrix to square matrix extra zeros are included in the rows/columns to each subject. It is observed that the proposed multispectral pattern image illustrates the directional features by projecting the lines into different orientations.

C. Spatio Temporal Local Binary Pattern (SLBP)

Local Binary Pattern (LBP) is an efficient texture operator which labels the pixels of an image by thresholding the neighbourhood of each pixel and considers the result as a binary number.
Formally, given a pixel at (*Xc*, *Yc*), the resulting LBP can be expressed in decimal form as

$$LPB_{P,R}(X_C, Y_C) = \Sigma\, s\,(i_p - i_c)$$

Where i_c is the value of central pixel, i_p represents the value of N neighbourhood pixels. s(x) is a sign function that is defined as follows

$$S(x) = \begin{cases} 1 \text{ if } x \geq t \\ 0 \text{ if } x \leq t \end{cases}$$

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Where t is a threshold which is often set to 0.
The original LBP operator was defined to only deal with the spatial information. Later, it was extended to a spatiotemporal representation for dynamic texture analysis. For this purpose, the so-called Spatio Temporal Local Binary Pattern (STLBP).

D. Support Vector Machine (SVM) Classifier

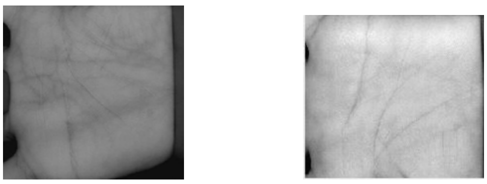
Support Vector Machines are based on the concept of decision planes that *define decision boundaries.* A decision plane is one that separates between a set of objects having different class memberships. An example is shown in the illustration below. In this example, the objects belong either to class GREEN or RED. The separating line defines a boundary on the right side of which all objects are GREEN and to the left of which all objects are RED. Any new object (white circle) falling to the right is labeled as GREEN (or as RED should it fall to the left of the separating line).
Support Vector Machine (SVM) is primarily a classier method that performs classification tasks by constructing hyper planes in a multidimensional space that separates cases of different class labels. SVM supports both regression and classification tasks and can handle multiple continuous and categorical variables.

IV. EXPERIMENTAL RESULTS

Experiments are executed on multispectral palm vein database from IIT Delhi and CASIA. The database includes 160 images from 40 subjects. The database contains image captured from visible and infrared light. Various steps are involved in authentication process.

A. ROI Extraction

The raw image captured using the IR spectrum can be given as input to the system in which Region of Interest (ROI) can be extracted as shown in fig 4. The original image as in fig 4a is the raw image which is given as input to the ROI algorithm through which ROI gets extracted which is shown in Fig.3

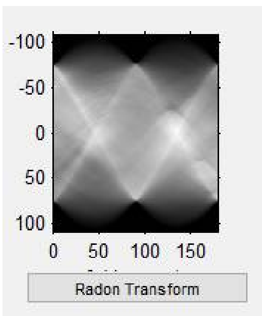


(a) (b)

Fig. 2. (a) Original image and (b) ROI image

B. Feature Extraction

Vein feature are extracted using techniques such as Radon Transform and Spatio Temporal Local Binary Pattern. The extracted feature using two descriptors are shown in Fig 4a and 4b respectively.



(a)

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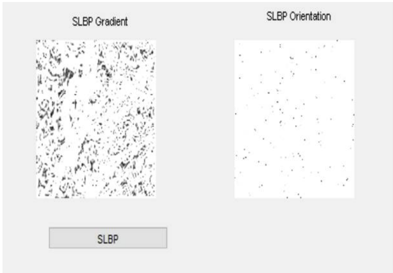

(b)

Fig.4. (a) Radon Transform (b) Spatio temporal Local Binary Pattern

C. Support Vector Classification and Matching

Classification is done by comparing the test image with already trained data set and to find this particular test image belongs to which class and the match result is obtained.

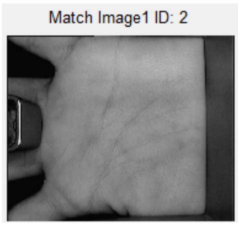

Fig. 3. Matching image 1

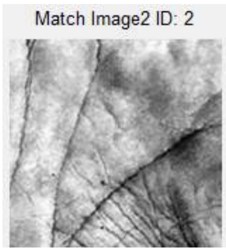

Fig .4 .Matching image 2

The experimental results shown here suggest that the proposed algorithms for extracting Multifeature achieves significantly improved recognition rate then the existing algorithms. Out of 160 images 157 images were matched with the test images. Hence achieved accuracy rate of 97.5%.

D. Performance

The performance improvement is achieved because of the multiple features. The proposed algorithms achieved better FAR and FRR rate than the other algorithms.

V. CONCLUSION

The proposed work investigated a novel approach for personal authentication using palm-vein biometric system. Multispectral palm vein image databases are collected and their texture features are extracted using Spatio Temporal Local Binary Pattern and Modified Radon Transform for both test and trained images by simulation. Then Support

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Vector Machine (SVM) Classification method is used to find the class to which the test sample belongs. The test samples are matched with trained samples for the personal authentication. The experimental results reveal that using Spatio Temporal Local Binary Pattern and Radon Transform as a feature extraction method and SVM as a classifier, it is the most appropriate one among the other methods in terms of palm vein recognition. The performance gain achieved from the additional training samples is quite significant when the sample size is small, but the redundant information is accumulated rapidly as the training sample size increases. We presented rigorous experimental results and compared with the existing method which is shown in performance graph. We achieved 97.5% of identification rate from the multispectral palm print image of IIT Delhi and CASIA database. Further, more capable algorithms and classification techniques can be implemented to increase the matching score for legal users.

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