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Online Palmprint Authentication using Multifeature Fusion

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***Abstract* —Automated security is one of the major concern and in great demand. Authentication using palm print are probably a good choice for biometric application because they are invariant with a person, easy to present and hard to spoof. Multispectral palm print is a prospective technology for use in various applications such as military, access control, hospital, in airport and in forensic applications. This paper proposes a palm print recognition method with extraction of multiple features using Radon Transform (RT), Wavelet transform and Line Detector. The Radon Transform extracts the line features of vein pattern. The line detector detects the line features of palm print. The wavelet transform decompose the image into different levels. Finally the images are fused and classified using Local Mean K-Nearest Centroid Neighbor Algorithm (LMKNCN). The proposed system examines the hand vascular authentication using 2 databases obtained with peg and peg-less image setup gathered from IIT Delhi palm print database and CASIA database. The experimental result presented in this paper reveals that the proposed authentication method obtained better results compared to other methods.**

Index Terms— Biometric, Radon Transform, Wavelet Transform, line detector, LMKNCN

I. INTRODUCTION

Automated human authentication is one of the most challenging mission to meet growing demand for biometric applications. 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, 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.

II. RELATED WORK

With increasing demand for human authentication, multispectral pattern were suggested in different scenarios R.Gayathri and Senthil Kumar [1] have proposed two different techniques for extracting multiple vein features and underwent feature level fusion to improve the performance. The vital role in image processing is feature extraction which should accommodate rotation variant, scale variant and translation variant. Many feature algorithms are proposed based on line, shape, texture etc

One of the efficient algorithms named LBP (Local binary pattern) was introduced in [5] to improve the recognition rate and to progress in accuracy. To improve the matching score in multispectral palmprint authentication two different methods are suggested by Xingbo Zhou and Ajay Kumar [11]. In [8] researchers named Abishek Nagar, Karthik Nandakumar and Anil K Jain proposed a Multibiometric 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.

A principal component analysis (PCA) is a very dominant and consistent method which has been proposed by the researcher [9] for the use of feature extraction and dimensionality reduction. Multifeature – based palmprint is suggested by Jifeng Dai and Jie Zhu [13] have achieved lower false rejection rate (FRR) than the existing algorithms.

Di Huang and Yinhang Tang [6] have proposed a novel and effective approach to hand dorsa vein based on local feature matching. In [3] researchers developed a multispectral system based on IR image of hand dorsa and two finger webs are utilized. In [7] [10] [14] [15] researchers proposed multispectral dorsal pattern with different technologies.

III. PROPOSED SYSTEM FOR PALM VEIN RECOGNITION

The captured palm region under is subjected to preprocessing steps where ROI is extracted Here we illustrate the proposed palm print under both peg-free and peg type experimental setup. The block diagram of proposed system is shown in Fig 1.

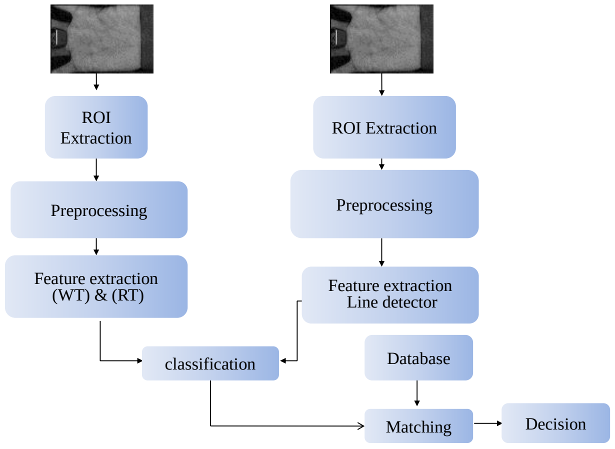

Fig.1. Block diagram of proposed system

A. Radon Transform (RT)

The Radon transform is the projection of the image intensity along a radial line oriented at a specific angle given in eqn (1)

$$R = \text{Radon}(I,\theta) \quad (1)$$

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

$$g(\rho,\theta) = \iint_{-\infty}^{\infty} S(a,b)\delta(\rho a\cos\theta b\sin\theta)dadb \quad (2)$$

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.

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

$$\theta = \frac{\theta_1+\theta_2}{2} \quad (3)$$

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

$$GZ = \lambda_X Z \quad (4)$$

Then the Eigen value equation for the square matrix G the order p $_x$ p can be represented as

$$GI - \lambda_X IZ = 0 \quad (5)$$

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

$$\det(G-\lambda I) = 0 \quad (6)$$

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 the entities, the features extracted using radon transform for all the images would have similar size. But the achieved radon transform may not be a square matrix because each pixel in the image has angle, magnitude and direction attributes. In order to make the attained radon matrix to square matrix extra zeros are included in the rows/columns to each subject. At last Eigen values are calculated for the radon matrix. It is observed that the proposed multispectral pattern image illustrates the directional features by projecting the lines into different orientations.

B. Wavelet transform

Wavelet transform have become one of the most important tool of signal representation. Wavelet transform in two dimensional are used in image processing Wavelet analysis can be used to divide information of an image into approximation and detail sub signal. The sub signal shows three detail sub signals on the horizontal, vertical and diagonal details. If these details are small they can be set to zero without significant changes in the image. Hence filtering and compression can be achieved.

A wavelet function can be represented as in eqn (7)

$$\int_{-\infty}^{\infty}\varphi(t)dt = 0 \quad (7)$$

The wavelet function is normalized as $\|\varphi(t)\|=1$ and centered at t=0.a time-frequency function is obtained by scaling m and translating it by μ:

$$\varphi_{\mu,m}(t) = \frac{1}{\sqrt{m}}\varphi\left(\frac{t-\mu}{m}\right) \quad (8)$$

Now the wavelet transform of f $\in L^2$ (N) at time μ and scale m:

$$W\{f(\mu,m)=\{f,\varphi_{\mu,m}\}=\int_{-\infty}^{\infty} f(t)\frac{1}{\sqrt{m}}\varphi\left(\frac{t-\mu}{m}\right)dt \quad (9)$$

Now defining a variable R_φ, where

$$R_\varphi = \int_0^{+\infty}\frac{|\hat{\phi}(\omega)|^2}{\omega}d\omega \quad (10)$$

The condition to be satisfied is $R_\varphi \le +\infty$, then any $f \in L^2(R)$ has its inverse wavelet transform

$$f(t) = \frac{1}{R_\varphi}\int_0^{+\infty}\int_{-\infty}^{+\infty} W\{(\mu,m)\}\frac{1}{\sqrt{m}}\varphi\left(\frac{t-\varphi}{m}\right)du\frac{ds}{s^2} \quad (11)$$

The integral R_φ is finite and ensuring that $\hat{\varphi}(0)=0$ which explains that wavelets must have a zero average.

C. Line Detector

The line detector is an important concept in authentication process where they extract different line features which can be saved and verified in verification stage. The lines are detected by constructing convolution matrices.

The convolution matrix [f, g, h] can be represented as

$$f = [X_1 X_2 X_3]$$
$$g = [Y_1 Y_2 Y_3]$$
$$h = [Z_1 Z_2 Z_3] \quad (12)$$

Construct the sparse matrix using the convolution matrix. Let X be the input image

$$Wf = convn(X, f)$$
$$Wg = convn(X, g)$$
$$Wh = convn(X, h) \qquad (13)$$

Thus showing the convolution image with horizontal lines. Placing the condition with K=1, the absolute value of convolute image are added shown in eqn (14)

$$W = abs(Wf) + abs(Wg) \qquad (14)$$

Using the above formula and varying the k value transformed images are obtained. Yielding the images with +45 degree line detection and vertical lines. Using the above obtained lines sum of all images is calculated. Hence the final sum image can be used for verification process.

IV. EXPERIMENTAL RESULTS

Experiments are executed on multispectral palmprint 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 a a re involved in authentication process.

A. Feature Extraction

Palm feature gets extracted using techniques such as Radon Transform. The extracted feature using Radon descriptor descriptors is shown in Fig 2 respectively.

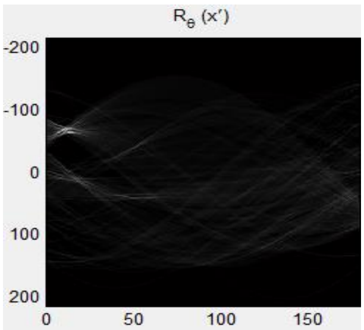

Fig.2. Radon Transform

The second feature extraction is using Wavelet transform where the vertical, horizontal and diagonal information of palm print is acquired and they are fused into single image. The extracted feature is shown in Fig 3.

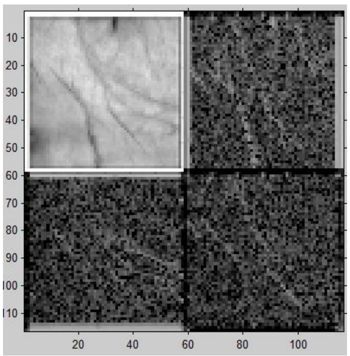

Fig.3.Wavelet Transform

The third feature extraction is using line detector where the line information like 30 degree, 45 degree, 90 degree are obtained from the preprocessed palm print image. The sum of all images is used for fusion process. The sum of all images is shown in Fig 4.

Fig 4. Sum of all filter image

B. Fused image and Classification

For better authentication purpose the extracted features using 3 different algorithms are to be fused. The feature fusion is an important technique than other fusion levels. Since the feature set are preserved without any loss of information. Hence it plays a major role in verification stage. The fused image is shown in Fig 5.

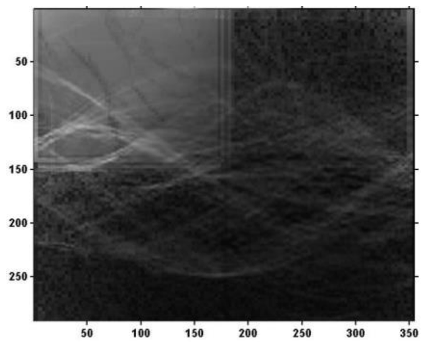

Fig 5. Feature Fusion

Local Means K-Nearest Centroid Neighbor Classification

K- Nearest Neighbor (KNN) rule is a simple and efficient algorithm in pattern classification. This method performs significantly well, particularly in the small size. To improve the classification performance LMKNCN classifier is proposed where the nearest neighbors of an image are estimated. The decision is made based on matching which is used to tell that either the test image belongs to particular trained image if matched or not matched. Classification is done by comparing the test image with the already trained data Set and to find this particular test image belongs to which class.Fig.6 shows the classification of image, the test image is classified on the various aspects for better authentication.

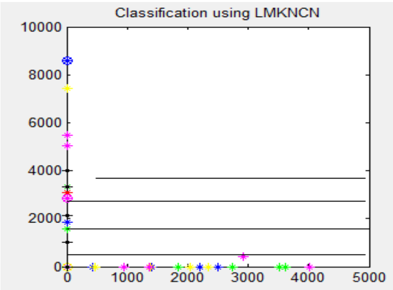

Fig 6. Classification of image using LMKNCN

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%.

V. CONCLUSION

The proposed work investigated a novel approach for personal authentication using palm-vein and palm-print biometric system. The proposed feature extraction and matching approach can effectively accommodate the potential image deformations, translational, and rotational variations by matching to the neighborhood of the corresponding regions and generating more reliable matching scores. The fused images classified using Local Mean K-Nearest Neighbor Classification method which is used to find the class to which the test sample belongs. The test samples are matched with trained samples for the personal authentication. We presented rigorous experimental results and compared with the existing method. 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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