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Palmprint Recognition Using Radon Transform

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Abstract: In this paper we have proposed a novel person identification system that uses palmprint features extracted by using Radon transform. The palmprint image has been viewed as a texture image. The local features from the extracted ROI of a palmprint represent the texture information present in the palmprint image in better sense. Radon transform computes the line integral along parallel paths in a certain direction. Here we have computed line integrals of the palmprint image at 60 different directions ranging from 0-180 degree with the interval of 3 degree. These feature vectors of size 185×60 have been used as the feature map. Performance of the proposed algorithm has been tested using PolyU database and the in-house generated database. Maximum recognition accuracy of 95.60% for PolyU palmprint database and that of 97.20% for the in-house generated palmprint images have been achieved with the algorithm. The algorithm is computationally efficient as the testing time required is 0.86 sec.

Keywords: palmprints, Radon transform, region of interest, Euclidian distance.

I. INTRODUCTION

Biometrics helps to provide the identity of the user based on the physiological or behavioural characteristics of the person. Every biometric technology has its own merits and limitations. Thus, there is no system exist which can be considered as the best for all applications [1]. One of the well known biometrics systems having very high accuracy is iris based system [2]. But iris acquisition system is very expensive and has high failure to enrolment rate. Also it requires very high cooperation from user. Fingerprint based systems are most widely used in the world because of its simplicity, low cost and good accuracy. Small amounts of dirt or grease on the finger may affect the performance of fingerprint based system. Hand geometry based system suffers from high cost and low accuracy. The ear based recognition has a problem of ear being partially or fully occluded due to hair or cap [3]. Face based recognition system is low cost requiring only a camera mounted in a suitable position such as the entrance of a physical access control area. However, face based systems are less acceptable than fingerprint based systems [4].

Palmprint is the region between wrist and fingers and has features like principle lines, wrinkles, datum points, delta point, ridges, minutiae points, singular points and texture pattern that can be considered as biometric characteristics. Compared to other biometric systems, palmprint based identification system has many advantages: 1) Features of the human hand are relatively stable and unique. 2) It needs very less co-operation from users for data acquisition. 3) Collection of data is non-intrusive. 4) Low cost devices are sufficient to acquire good quality of data. 5) The system uses low resolution images but provides high accuracy. 6) Compared to the fingerprint, a palmprint provides a larger surface area so that more features can be extracted. 7) Because of the use of lower resolution

imaging sensor to acquire palmprint, the computation is much faster at the pre-processing and feature extraction stages. 8) System based on hand features is found to be most acceptable. 9) palmprint also serves as a reliable human identifier because the print patterns are not found to be duplicated even in mono-zygotic twins [5].

Palmprint based systems make use of structural features, statistical features and multiple combinations. The structural features of palmprint include principle lines, wrinkles, datum points, minutiae points, ridges and crease points. C. Han et al [6] used Sobel and morphological operations to extract line-like features from palmprints. N. Duta et al [7] used isolated points along the principle lines as the features. A system based on ridges of the palmprint eliminating creases has been proposed by J. Funada et al [8]. D. Zhang et al [9] used end points of principle lines referred as datum points. These datum points used as the features found to be location and directional invariant. J. Chen et al [10] proposed a palmprint based system that uses crease points. X. Wu et al [11] considered directional line energy features which are characterised with the help of crease points for identification of palmprint. Like fingerprint, each palmprint also contains ridges and minutiae which can be used for matching palmprint images [12]. The statistical features of palmprint include Principle Component Analysis [13], Linear Discriminant Analysis [14], Independent Component Analysis [15], Fourier Transforms [16], Gabor filter [17], fusion code [18], competitive code [19], ordinal code [20], line orientation code [21], flexion crease recognition [22] and Wavelets [23] etc. The systems in [24-26] have used PCA, LDA, ICA, PCA along with wavelets, FFT and Gabor

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filter to extract features. Fusion of palmprint features with other traits like fingerprint [27], palm veins [28], hand geometry [29], face [30], and iris [31] to improve accuracy of the system have been attempted by the researchers.

Block diagram of the system

The personal identification system using palmprints operates in two modes, enrolment and identification. In the enrolment mode, several palmprint samples of the persons are passed to the system. The samples captured by palmprint scanner are passed through pre-processing and feature extraction to produce the templates which are then stored in the database. In the identification/recognition mode, the query palmprint image is passed to the system. These query palmprints passes through pre-processing and feature extraction. The extracted features are compared with templates in the database in order to find the correct match. Block diagram of the palmprint recognition system using Radon transform is as shown in Figure 1. It contains five modules, palmprint acquisition, preprocessing, feature extraction, matching and storage. A palmprint image is captured by palmprint scanner which is then converted into a digital imprint. This imprint is transmitted to a computer for pre-processing. In pre-processing a co-ordinate system is set up on basis of the boundaries of fingers so as to extract a central part called as ROI of a palmprint for feature extraction. Then apply Radon transform to extract textural information from the central part. These textural features are then compared with the features stored in the database as the templates of imprints during the enrolment phase. A distance measure is used to find the close match between the query palmprint and the template imprints stored in the database.

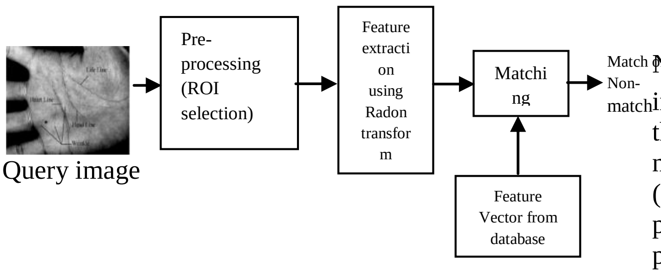


Figure 1 Block dia. of the palmprint recog. system.

Line property of Radon transform

Radon transform of a 2-D image $f(x,y)$, denoted as $P_\theta(t)$, is defined as its line integral along a line inclined at an angle θ from the y-axis and at a distance t from the origin (see Figure 2).

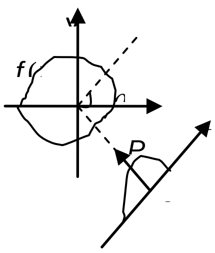


Figure 2 $P_\theta(t)$ is the Radon transform 1-D projection of $f(x,y)$ at an angle θ.

In other words $P_\theta(t)$ is the 1-D projection of $f(x,y)$ at an angle θ, and is given as

$$P_\theta(t) = \int\int f(x,y)\,\delta(x\cos\theta + y\sin\theta - t)\,dxdy \quad (1)$$

where,
δ is the dirac distribution.
The line property of Radon transform is an important property utilized for rotation estimation of the shapes in a palmprint image. Radon transform assumes a function that contains line, which is modeled with a delta function.

$$g(x,y) = \delta(y - p^* x - \tau^*) \quad (2)$$

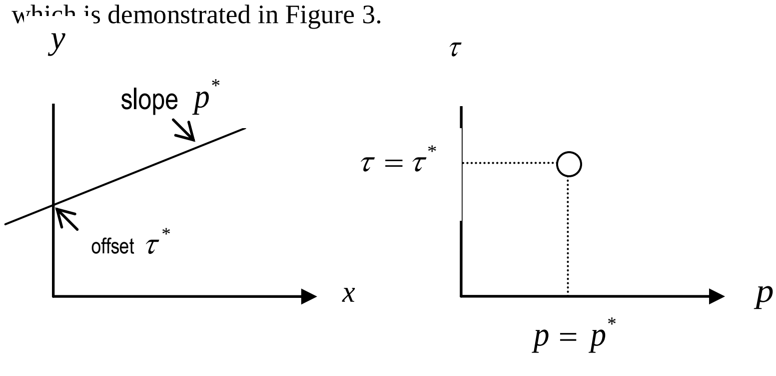
Hence, the function has non-zero values only if (x,y) lies on the line with certain fixed parameters (p^*, τ^*). In this case the Radon transform is given by

$$\check{g}(p,\tau) = \int\int_{-\infty}^{\infty} \delta(y - p^* x - \tau)\,\delta(y - px - \tau)\,dxdy \quad (3)$$

$$= \int_{-\infty}^{\infty} \delta((p - p^*)x + \tau - \tau^*)\,dx$$

$$= \begin{cases} \dfrac{1}{|p - p^*|} & for\, p \neq p^* \\ 0 & for\, p = p^* and\, \tau \neq \tau^* \\ \int_{-\infty}^{\infty} \delta(0)\,dx & for\, p = p^* and\, \tau = \tau^* \end{cases} \quad (4)$$

Note that for $p = p^*$ and $\tau = \tau^*$, the result is written as infinite function integrated over an infinite interval, hence the result is infinite at that point. If the finite terms are neglected, Radon transform of a line produces a peak (with infinite value) in the parameter domain, and the position of the peak matches the line parameters. This property has the basis of edge feature detection in images, which is demonstrated in Figure 3.



(a) (b)

Figure 3 Line property (a) A 2-D function $g(x,y)$, (b) Corresponding Radon transform $\check{g}(p,\tau)$.

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The steps involved in Radon transform based palmprint feature extraction are as follows:

***Step* 1 Acquire the palmprint image.**

***Step* 2 Extract ROI from the palmprint image.**

In order to make the proposed algorithm rotation and translation invariant, it is necessary to obtain a ROI from the captured palmprint image, prior to feature extraction. Five major steps of palmprint image pre-processing to extract the ROI are as follows and illustrated in Figure 4:

Step 1: Convolve the captured palmprint image with a low-pass filter. Convert this convolved imprint into a binary, as shown in Figure 4(b) by using a threshold value. This transformation can be represented as,

$$B(x,y) = \begin{cases} 1, & if\ O(x,y) * L(x,y) \geq T \\ 0, & if\ O(x,y) * L(x,y) < T \end{cases} \tag{5}$$

where, $B(x,y)$ and $O(x,y)$ are the binary image and the original image, respectively;
$L(x,y)$ is a lowpass filter, such as Gaussian, and
"*" represents an operator of convolution.

Step 2: Extract the boundaries of the holes, (F_ix_j,F_iy_j) $(i=1,2)$, between fingers using a boundary-tracking algorithm. The start points, (Sx_i,Sy_i), and end points, (Ex_i,Ey_i) of the holes are then marked in the process (see Figure 4(c)).

Step 3: Compute the center of gravity, (Cx_i,Cy_i), of each hole with the following equations:

$$C_{x_i} = \frac{\sum_{j=1}^{M(i)} F_i\, x_j}{M(i)}\ , \qquad C_{y_i} = \frac{\sum_{j=1}^{M(i)} F_i\, y_j}{M(i)} \tag{6}$$

where, $M(i)$ represents the number of boundary points in the hole, i.

Then construct a line that passes through (Cx_i, Cy_i) and the midpoint of (Sx_i, Sy_i) and (Ex_i, Ey_i). The line equation is defined as,

$$y = x\frac{(C\,y_i - M\ y_i)}{(C\,x_i - M\ x_i)} + \frac{(M\ y_i\,C\,x_i - M\ x_i\,C\,y_i)}{(C\,x_i - M\ x_i)} \tag{7}$$

where, (Mx_i, My_i) is the midpoint of (Sx_i, Sy_i) and (Ex_i, Ey_i).

Based on these lines, two key points, (k_1, k_2), can easily be detected (see Figure 4(d)).

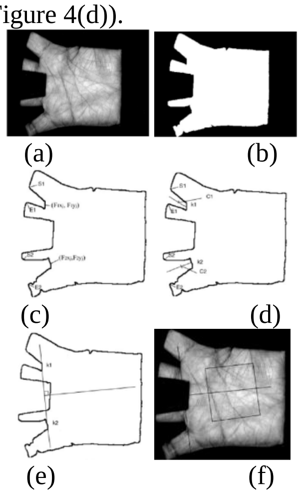

Figure 4 Steps illustrating pre-processing: (a) original image, (b) binary image, (c) boundary tracking, (d) key points (k_1 and k_3) detecting, (e) the coordinatsystem and (f) The central part of a palmprint.

Step 4: Line up k_1 and k_2 to get the *Y*-axis of the palmprint coordinate system and make a line through their midpoint which is perpendicular to the *Y*-axis, to determine the origin of the coordinate system (see Figure 4(e)). This coordinate system can align different palmprint images.

Step 5: Extract a sub-image with the fixed size on the basis of coordinate system, which is located at the certain part of the palmprint for feature extraction (see Figure 4(f)).

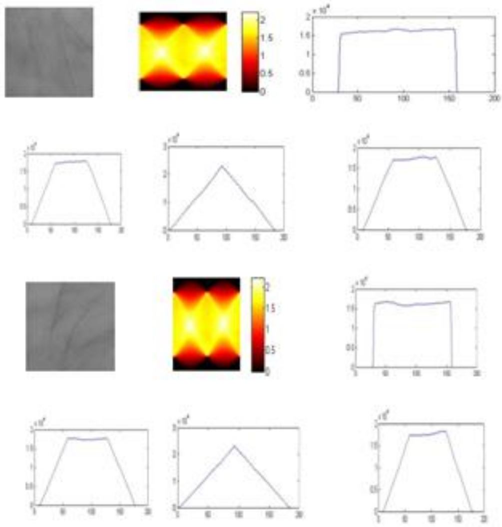

Figure 5 Radon projections at 0, 22.5, 45, 67.5 and 90 degree for two different palmprint and their respective hotplot.

***Step* 3 Compute the Radon Transform of ROI to generate feature vector.**

In this step we have extracted features of palmprint using Radon transform. The local features from the ROI of a palmprint represent the texture information present in the palmprint image in better sense.

The Radon transform of a square integrable function $f(x_1, x_2)$ is defined as,

$$RA(t,\theta) = \int f(x_1,x_2)\delta(x_1\cos\theta + x_2\sin\theta - t)\,dx_1dx_2 \tag{8}$$

where,
δ is the Dirac distribution.

Radon transform computes the line integral along parallel paths in a certain direction. Here we have computed line integrals of the palmprint image at 60 different directions. The 60 directions (orientations) from 0-180 degree with the interval of 3 degree have been selected empirically. Thus the feature vector size becomes 185×60 that has been used as the feature map. These feature maps are used to represent and match a query palmprint image. Figure 5 illustrates the significant variation in Radon projections of two different palmprint images at few sample orientations.

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Results and Discussions

The algorithm has been implemented and tested on Pentium-IV processor with 2.6 GHz, 512 MB RAM under MATLAB environment. The performance analysis of the algorithm has been evaluated using the palmprint images from the standard PolyU database available on the Hongkong polytechnic website and in-house generated database. The PolyU palmprint is a standard Database (file size 429MB) contains 7752 grayscale images corresponding to 386 different palms in BMP image format. Around twenty samples from each of these palms were collected in two sessions, where around 10 samples were captured in the first session and the second session, respectively. The average interval between the first and the second collection was two months. The layout of palm images are as follows: fingers are on the left side, wrist on the right, thumb is up and little finger down for right hand and thumb down, little finger up for the left hand. The resolution of those images is 384 × 284 with 256 grayscales.

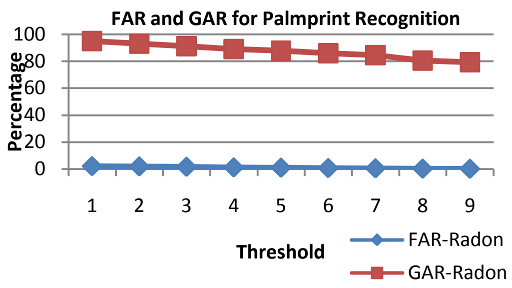

Figure 6 Percentage FAR and GAR plotted at various thresholds.

Initially the ROI of size 128×128 is extracted from the captured palmprint images and images from PolyU database. Then Radon transformed images have been obtained from these localized palmprint images. As the local features represent the texture information present in the palmprint image in better sense, the Radon transformed palmprint image is used as the feature map. The feature maps of all the palmprint images have been stored in the database. When a query palmprint image of the person is applied, its feature vector is generated and matched with the feature vectors available in the database. The Euclidian distance classifier will give the minimum distance for the stored template image that best matches with the query image. We have got a maximum recognition accuracy of 95.60% for PolyU palmprint database and that of 97.20% for the in-house generated palmprint images.

REFERENCES

[1] D. D. Zhang, Palmprint Authentication (International Series on Biometrics), Springer-Verlag New York, Inc., Secaucus, NJ, USA, 2004.
[2] R. Wildes, Iris recognition: an emerging biometric technology, Proceedings of the IEEE 85 (9) (1997) pp.1348 -1363.
[3] A. Jain, R. Bolle, S. Pankanti, Biometrics: Personal Identification in Networked Society, Kluwer Academic, 1999.
[4] International biometric groups consumer response to biometrics, http://www.ibgweb.com/reports/public/reports/facial scan perceptions.html (2002).
[5] A. Kong, D. Zhang, G. Lu, A study of identical twins' palmprints for personal authentication, Pattern Recognition 39 (11) (2006) pp.2149-2156.
[6] C. Han, H. Cheng, C. Lin, K. Fan, Personal authentication using palmprint features, Pattern Recognition 36 (2) (2003) pp.371-381.
[7] N. Duta, A. Jain, K. Mardia, Matching of palmprints, Pattern Recognition Letters 23 (4) (2002),pp. 477-485.
[8] J. Funada, N. Ohta, M. Mizoguchi, T. Temma, K. Nakanishi, A. Murai, T. Sugiuchi, T. Wakabayashi, Y. Yamada, Feature extraction method for palmprint considering elimination of creases, in: International Conference on Pattern Recognition, Vol. 2, 1998, pp. 1849-1854.
[9] D. Zhang, W. Shu, Two novel characteristics in palmprint verification: datum point invariance and line feature matching, Pattern Recognition 32 (4) (1999) pp.691-702.
[10] J. Chen, C. Zhang, G. Rong, Palmprint recognition using creases, in: International Conference on Information Processing, 2001, pp. 234-237.
[11] X. Wu, K. Wang, D. Zhang, Fuzzy directional element energy feature based palmprint identification, in: International Conference on Pattern Recognition, Vol. 1, 2002.
[12] A. K. Jain, J. Feng, Latent palmprint matching, IEEE Transaction on Pattern Analysis and Machine Intelligence (To appear).
[13] G. Lu, D. Zhang, K. Wang, Palmprint recognition using eigenpalms features, Pattern Recognition Letters 24 (9-10) (2003) pp.1463-1467.
[14] X. Wu, D. Zhang, W. K., Fisherpalms based palmprint recognition, Pattern Recognition Letters 24 (2003) pp.2829-2938.
[15] L. Shang, D.-S. Huang, J.-X. Du, C.-H. Zheng, Letters: Palmprint recognition using fastica algorithm and radial basis probabilistic neural network, Neurocomputing 69 (13-15) (2006) pp.1782-1786.
[16] L. Wenxin, D. Zhang, X. Zhuoqun, Palmprint identification by fourier transform, International Journal of Pattern Recognition and Artificial Intelligence 16 (4) (2002) pp.417-432.
[17] D. Zhang, A. W. Kong, J. You, M. Wong, Online palmprint identification, IEEE Transactions on Pattern Analysis and Machine Intelligence 25 (9) (2003) pp.1041-1050.
[18] A. W. K. Kong, D. Zhang, Feature-level fusion for effective palmprint authentication, in: International Conference on Biometric Authentication (ICBA), 2004, pp. 761-767.
[19] A. Kong, D. Zhang, Competitive coding scheme for palmprint verification, in: International Conference on Pattern Recognition, 2004, pp. 520-523.
[20] Z. Sun, T. Tan, Y. Wang, Z. Li, S., Ordinal palmprint representation for personal identification, in: Computer Vision and Pattern Recognition, 2005, pp. 279-284.
[21] Wei Jia, De-Shuang Huang, and David Zhang, "Palmprint verification based on robust line orientation code," *Pattern Recognition*, vol. 41, no. 5, pp. 1504-1513, May 2008.
[22] T. Cook, R. Sutton, and K. Buckley, "Automated flexion crease identification using internal image seams," *Pattern Recognition*, vol. 43, no. 3, pp. 630-635, March 2010.
[23] G. S. Badrinath, P. Gupta, An efficient multi-algorithmic fusion system based on palmprint for personnel identification, in: International Conference on Advanced Computing and Communications, 2007, pp. 759-764.
[24] T. Connie, A. Teoh, M. Ong, D. Ngo, An automated palmprint recognition system, Image and Vision Computing 23 (5) (2005) pp.501-515.
[25] M. Aykut, M. Ekinci, Kernel principal component analysis of gabor features for palmprint recognition, in: International Conference on Biometrics, 2009, pp. 685-694.
[26] M. Ekinci, M. Aykut, Palmprint recognition by applying wavelet subband representation and kernel pca, in: Machine Learning and Data Mining in Pattern Recognition, 2007, pp. 628-642.
[27] S. Ribaric, I. Fratric, A biometric identification system based on eigenpalm and eigenfinger features, IEEE Trans. on Pattern Analysis and Machine Intelligence 27 (11) (2005) pp.1698-1709.
[28] J. Wang, W. Yau, A. Suwandy, E. Sung, Person recognition by fusing palmprint and palm vein images based on 'laplacianpalm' representation, Pattern Recognition 41 (5) (2008) pp.1531-1544.
[29] A. Kumar, D. Zhang, Personal recognition using hand shape and texture, IEEE Transactions on Image Processing 15 (8) (2006) pp.2454-2461.

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[30] X. Jing, Y. Yao, D. Zhang, J. Yang, M. Li, Face and palmprint pixel level fusion and kernel dcv-rbf classi_er for small sample biometric recognition, Pattern recognition 40 (11) (2007) pp.3209-3224.
[31] X.Wu, D. Zhang, W. K., N. Qi, Fusion of palmprint and iris for personal authentication, in: Advanced Data mining Applications, 2007, pp. 466-475.