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2D Palmprint Recognition: A Survey

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Abstract: *In this paper we have used palm print recognition system as it is unique as compared to face recognition and rigid as compare to fingerprint recognition system. Different recognition algorithms are consists of four processing parts 1 Preprocessing, 2 Region of interest, 3 Feature Extraction and 4 Classification. We have discussed different standard databases which are used to validate recognition algorithm and also focused on various preprocessing techniques used by many researchers. We have also looked upon various feature extraction techniques like PCA, LDA, ICA, 2DPCA, 2DDFT, Wavelet, Gabor and classification techniques like Euclidean Distance, Neural Network, Support Vector Machine. In this paper different combination of above three techniques are reviewed.*

Keywords: *Palmprint, Biometric, Feature extraction, Classifier*

I. INTRODUCTION

The most and foremost way of human identification is by their characteristics or using biometrics traits. Biometric traits of humans are a measurable biological (anatomical and physiological) and behavioral characteristics, which can used for automated recognition of an individual. The identification of humans by their characteristics or traits is also known as biometric authentication. The biometric authentication has been find application in forensic, government, commercial, health-care and traveling and immigration.

In recent years several state-of-the-art biometric techniques have been developed which used a varieties of human biological characteristics for identification and recognition. These include fingerprint, palm print, iris, face, retina, facial thermogram and many more. The biometrics traits are classified as physiological and behavioral traits [1].The physiological traits are fingerprint, palm print, hand geometry, iris and face while the behavioral traits are speech, gaits, signature, key strokes etc. All these type of information are unique and vary from person to person. Each biometric trait has its strengths and weaknesses. Also the biometric traits are classified as soft and hard biometric. The soft biometric traits are gender, age, height, weight, ethnicity and eye color, which can be either continuous or discrete. Traits such as gender, eye color, and ethnicity are discrete in nature while height and weight are continuous variable. The hard biometric are finger print, face, speech, palm print, iris, retinal scan etc. The soft traits cannot provide reliable user recognition because they are not distinctive and permanent. Hard biometric traits are sufficient for human identification and recognition.

There are other methods available for human identification like password, pin-codes, smart-cards, etc. Compare to well establish methods of person identification using Pin-code, password, smart card the biometric identification offers many advantages like no need to remember password, no chance of card or pin-code theft, and no one can misuse it. Hence, biometric based human identification is preferred and it's secured. The problem with fingerprint is over a period of time the figure print may lost or not properly readable so it cannot used for every age group of people. The problem with the face recognition is again with age, different facial expression, and different face accessories and in the case of sibling it is difficult to recognize securely, while in speech recognition system one may copy some ones speech and in the case of retinal and iris recognition one may have to look at the sensor and it is not as convenient as one expect so palm print is preferable over the other biometrics. The palm print consists of lines and it remains same and without damaged throughout lifetime so its highly preferable biometrics.

Palmprint is nothing but the inner surface of the hand. The palm, the inner surface of the hand between the wrist and the fingers, consists of three parts: the finger-root region, inside region and outside region. There are three principle lines made by flexing the hand and wrist in the palm, which are usually defined as life line, heart line, and head line (Shu and Zhang, 1998) [2]. The previous work on palmprint recognition focused on two aspects: (1) extracting the principle lines and creases in the spatial domain (Zhang and Shu, 1999[3]; Duta et al., 2002[4]; You et al., 2002[5]) and (2) transforming the palmprint images into the frequency domain to obtain the energy distribution feature (Li and Zhang, 2002[5]). In the first approach, the lines and creases of a palm are sometimes difficult to extract directly from a given palmprint image with low resolution. The recognition rates and the computational efficiency are also not sufficient. In the second approach, the abundant textural details of a palm are ignored and the extracted features are greatly affected by the lighting conditions. The problems with these two approaches suggest that new methods are required for palmprint recognition. The pattern generated by the inner surface is unique for every individual so can be used for identification of human being. The palmprint recognition consists of three major steps preprocessing, feature extraction and recognition.

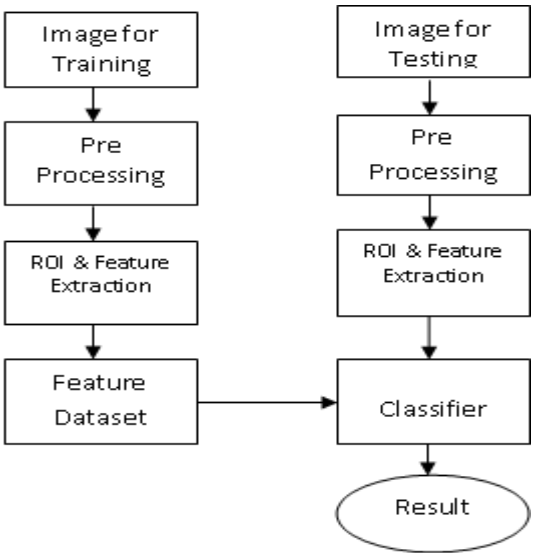

Figure 1. Architecture of palmprint

The system architecture of palmprint recognition is shown in the figure 1. The acquired image is may be of good quality or low quality, so initial stage is to preprocess the image so that they can be processed efficiently. The second stage is to get region of interest and features from the image. The extracted feature is stored in the feature dataset. When image of palmprint is comes for testing than then same dataset is used by the classifier to recognize that palmprint with the exciting palmprint of the registered user. The classifier gives the result of recognition whether that person belongs to the registered user or not and it gives the identification. We have discussed the work done in the field of palm print recognition.

We have covered the available standard database in palmprint, different preprocessing methods, feature extraction method and classification method used by the researchers. The next sections discuss database, pre-processing, feature extraction methods and classification methods.

The database may be of two type locally generated and standard database. Some researcher may use their own locally generated database for standardize their algorithms while some may use standard available database.

II. STANDARD DATABASE IN PALMPRINT

A. CASIA Palmprint Image Database:

CASIA Palmprint Image Database (or CASIA-Palmprint for short) contains 5,502 palmprint images captured from 312 subjects. For each subject, we collect palmprint images from both left and right palms. All palmprint images are 8 bit gray-level JPEG files.

B. CASIA Multi-Spectral Palmprint Database:

CASIA Multi-Spectral Palmprint Image Database contains 7,200 palm images captured from 100different people using a self-designed multiple spectral imaging devices. All palm images are 8 bit gray-level JPEG files. The time interval between the two sessions is more than one month. In each session, there are three samples. Each sample contains six palm images which are captured at the same time with six different electromagnetic spectrums. Wavelengths of the illuminator corresponding to the six spectrums are 460nm, 630nm, 700nm, 850nm, 940nm and white light respectively.

C. IIT Delhi Touchless Palmprint Database:

The IIT Delhi palmprint image database consists of the hand images collected from the students and staff at IIT Delhi, New Delhi, India. This database has been acquired in the IIT Delhi campus during July 2006 - Jun 2007 using a simple and Touchless imaging setup. All the images are collected in the indoor environment and employ circular fluorescent illumination around the camera lens. The currently available database is from 235 users, all the images are in bitmap (*.bmp) format. All

the subjects in the database are in the age group 12-57 years. Seven images from each subject, from each of the left and right hand, are acquired in varying hand pose variations. The resolution of these images is 800*600 pixels.

D. PolyU multispectral palmprint Database:

Multispectral palmprint images were collected from 250 volunteers, including 195 males and 55 females. The age distribution is from 20 to 60 years old. The samples collected in two separate sessions. In each session, the subject was asked to provide 6 images for each palm. Therefore, 24 images of each illumination from 2 palms were collected from each subject. In total, the database contains 6,000 images from 500 different palms for one illumination. The average time interval between the first and the second sessions was about 9 days.

III. PREPROCESSING

Preprocessing is used to align different palm print image and to segment the center for feature extraction. Preprocessing involves generally five steps, 1) binarizing the palm images, 2) extracting the contour of hand and/or fingers, 3) detecting the key points, 4) establishing a coordination system and 5) extracting the central parts. The first and second steps in all the preprocessing algorithms are similar. However, the third step has several different implementations including tangent-based [6], bisector based [7] and finger-based [8, 9] to detect the key points between fingers. The tangent-based approach considers the two boundaries — one from point finger and middle finger and the other from ring finger and last finger — as two convex curves and computes the tangent of these two curves. The two intersections are considered as two key points for establishing the coordinate system. Tangent-based approaches have several advantages like they depend on a very short boundary around the bottom of fingers. Bisector-based approach constructs a line using two points, the center of gravity of a finger boundary and the midpoint of its start and end points. The intersection of the line and the finger boundary is considered a key point. Han and his team propose two approaches to establish the coordinate system, one based on the middle finger [10] and the other based on the point, middle and ring fingers [8]. The middle finger approach uses a wavelet to detect the fingertip and the middle point in the finger bottom and construct a line passing through these two points [10]. The multiple finger approach uses a wavelet and a set of predefined boundary points on the three fingers to construct three lines in the middle of the three fingers.

The two lines from point and ring fingers are used to set the orientation of the coordinate system and the line from the middle finger is used to set its position. These approaches use only the information on the boundaries of fingers while Kumar et al. proposed using all information in palms [11]. They fit an ellipse to a binary palmprint image and set up the coordinate system according to the orientation of the ellipse. After obtaining the coordinate systems, the central parts of palm prints are segmented. Most of the preprocessing algorithms segment square regions for feature extraction but some of them segment circular [12] and half elliptical regions [13]. The square region is easier for handling translation variation, while the circular and half elliptical regions may be easier for handling rotation variation.

IV. FEATURE EXTRACTION

Image representation and feature extraction are pervasive techniques that are commonly used for Palm recognition process. When the input data to an algorithm is too large to be processed and it is suspected to be notoriously redundant then the input data will be transformed into a reduced representation set of features. Transforming the input data into the set of features is called feature extraction. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size input. There are so many feature extraction techniques available. In the case of palm print recognition different approaches can be employed for feature extraction.

A. Subspace based approach:

This approach is also called appearance based approach in the literature of face recognition. They used Principal Component Analysis,(PCA), Linear Discrimination Analysis(LDA) and Independent Component Analysis(ICA).[7,8,9,10,11,12] Some researcher also used directly 2D image without converting them into 1D. They used technique like 2DPCA, 2DLDA etc [14]. The outcome coefficient of the process is called the feature.

B. Statistical Approach:

The statistical approach is either local or global statistics. The local statistical approach transforms image into other domain and then it into small regions [10, 15, 16, 17, 18]. The mean, median and variance are calculated for these small regions and then these statistics are considered as features. Gabor, wavelets and Fourier transforms have been applied. The small regions are commonly square but some are elliptical and circular [19, 11].

C. Line based approaches:

This approach develops edge detectors and makes use of the magnitude of the palm lines. The magnitudes of the palm lines are projected in x and y coordinates forming histograms. After this, the first and second order derivatives of the palm images are calculated. The first order derivative is used to identify the edge points and corresponding directions. The second order derivative is used to identify the magnitude of lines. Then the Euclidian distance is used for matching.

D. Coding Approaches:

Palm code uses a single Gabor filter to extract the local phase information of palm print. Kong et al.[20,21] introduced a fusion code method to encode the phase of the filter responses from a bank of Gabor filters with different orientations. A practical palmprint recognition algorithm using 2D phase information (i) reduce the registered data size by registering quantized phase information and (ii) deals with nonlinear distortion between palmprint images by local block matching using Phase-Only Correlation.

E. Fusion:

Fusion of multiple traits of an individual can improve the matching accuracy of a biometric system. Some of the limitations such as noisy data, intra-class variations, spoof attacks and unacceptable error rates of a unibiometric system can be addressed by designing a system that consolidates multiple sources of biometric information. Multimodal biometric systems are those which utilize, or are capability of utilizing, more than one physiological or behavioral characteristic for enrollment, verification, or identification. The multimodal biometrics has drawn more and more attention in recent years due to its promising applications and theoretical challenges.

F. Other Approaches:

Some approaches are difficult to classify because they combine several image processing methods to extract palmprint features such as neural network to make final decision, two dimensional dual-tree complexes transform on preprocessed palmprint to decompose the images, phase only correlations etc.

V. CLASSIFICATION OR RECOGNITION

A classification or recognition is an ordered set of related categories used to group data according to its similarities. Classification means to put things into groups according to their characteristics.

Table 1. Subspace based Approach

Feature Extraction	Classifiers	Ref
PCA,LDA, ICA	L1 Measure L2 Measure Cosine Measure Probabilistic Neural network	8
LDA	Euclidean Distance	22
PCA	Weighted Euclidean distance	23
Kernel PCA	Maximum a Posterior Classifiers	25

Table 2. Statistical based

Feature Extraction	Statistics Feature	Shape of small regions	Classifiers	Ref
Sobel Filter	Mean	Square and Rectangle	Back Propagation NN	10
Direction Marks	Standard Deviation	Square	Cosine Similarity	21
Gabor Filter	Mean & Std. Deviation	Circular	Cosine Similarity	20

Gabor, Haar Wavelet	Mean Energy	Rectangle	L1 norm	26
Wavelet	Center of gravity, density	Global statistics	Sum of individual percentage error	24

In Palmprint recognition after feature extraction steps palmprint classification steps has been performed. Various classifiers have been used by the researchers. The classifiers used in palmprint recognition are L1 measure, L2 measure, Cosine Measure, Probabilistic Neural Network, Back propagation Neural Network, Modular Neural Network, L1 Norm, Cosine similarity, Euclidean Distance, Weighted Euclidean Distance, Cosine Distance, Maximum posterior Classifiers and Support Vector Machine[8, 10, 12, 22, 23, 24, 25, 19].

In latest work in palm print recognition [27,28,29] the reasercher has used direct cosine transform, 2DDFT and local binary pattern for feature extraction and Euclidean distance, correlation value and chi square statistics for recognition.

VI. CONCLUSION

Biometric pattern recognition is one of the trends used now days to identify human being by using their biometric traits. Several databases available have been discussed. Several existing methods used for feature extraction and classification by reasercher have been discussed. Palm print recognition is an emerging field and only limited works were carried out which paves way for the researchers to invent new methods to reduce the error rates and to improve the accuracy and speed of the system. The future work can be done in the field by using image directly and applying 2d image algorithm like 2DPCA. Classifier can be used like neural network, fuzzy logic, Neuro fuzzy, Adaptive Neuro fuzzy inference System. In this paper, we have covered almost all techniques used. We have tried to explore that one can make and use combination of above techniques to do palm printing which is not combine and used yet.

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