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Palm-Print Based Biometric Authentication Systems - A Review

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Abstract: ***Palmprint is widely used in personal identification and authentication for a precise and robust recognition. Palmprint recognition has been reconnoitered over numerous years. During this instance of time, several different glitches related to palmprint recognition have been addressed. Furthermost of the studies has been done in palmprint recognition due to its stability, reliability and exclusivity. Furthermore it has been used for law enforcement, civil applications and access control applications. Researchers have proposed a variety of palmprint preprocessing, feature extraction and matching approaches. This paper deliberates about the number of investigation works introduced to overcome the difficulties confronted in each stage of palm print verification. Our study on palm print recognition focuses on verifying the palm print in different types of schemes involved.***

Keywords: Palm Print Recognition, biometric authentication system, person verification, Biometrics, security

1. Introduction

Biometric authentication has been receiving much interest over the past decade with rising demands in automated personal identification. Among many biometric techniques, palmprint recognition is one of the most trustworthy approaches

Palmprints are assumed to have the critical properties of universality, exclusivity, permanence and collectability for individual authentication [1]. What's more, palmprints have several advantages over other hand-based biometric technologies, for instance fingerprints and hand geometry. Faking a palmprint is more complicated than faking a fingerprint since the palmprint texture is more complicated; and one rarely leaves his/her complete palmprint somewhere unintentionally. Palm usually contains three flexion creases (principal lines), secondary creases (wrinkles) and ridges.

The three main flexions are genetically dependent; the majority of other creases are not [2]. Even identical twins have dissimilar palmprints [2].These non-genetically deterministic and complex patterns are very helpful in personal identification. Palm is the inner surface of the hand amid the wrist and fingers. Palm area contains huge number of features such as principal lines, wrinkles, minutiae, datum point features and texture [3]. Palmprint recognition system utilizes high or low resolution images. Most of the system employs the low resolution image [4].

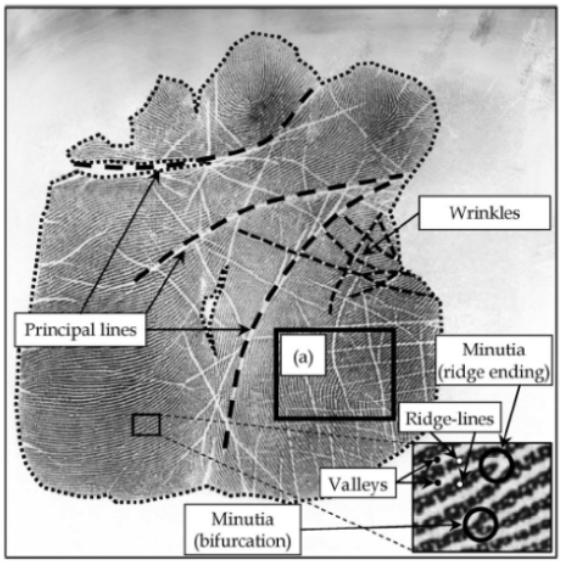

Figure 1: Palmprint with the important features

2. Architecture of Palm Print Recognition System

A palmprint recognition system normally consists of four parts: palmprint scanner, pre-processing, feature extraction and matcher. The palmprint scanner is to gather palmprint images. Pre-processing is an arrangement of a coordinate system to align the palmprint images, and to segment a fraction of the palmprint image for feature extraction. Feature extraction is to acquire effective features from the pre-processed palmprints. Finally, a matcher evaluates the two palmprint features.

Palmprint based recognition can operate in either identification or verification mode. Palmprint identification refers to one-to-many match, means input palmprint of an individual is matched with all templates present in database. It conform the identity of an individual. Palmprint recognition system basically follows four steps that are image acquisition, pre-processing, feature extraction and

matching. Figure 2 shows general block diagram of palmprint recognition system.

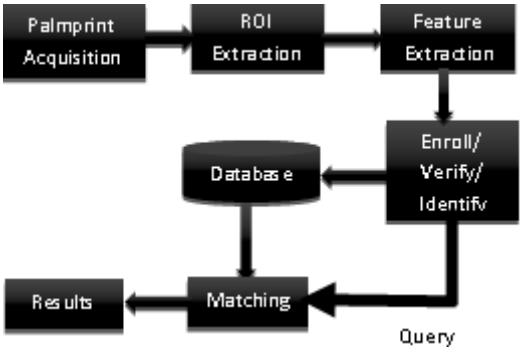

Figure 3: General block diagram of palmprint recognition system

The Architecture of palmprint recognition system can be divided into four sub-sections as:

a) Image Acquisition
In this phase, image of palmprint is first capture with the help of different types of digital cameras. Acquired image may be blurred or it may have noise, which decreases the quality of an image and affects the performance rate of palmprint recognition system directly [13]. A basic database is shown in figures below:

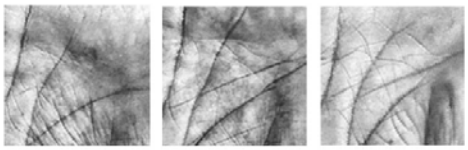

Figure 4: Example images from the IIT Delhi dataset (left hand samples)

b) Pre-processing
After capturing the data or image of the palmprint, pre-processing is formed on image. Sometimes noise is present in the captured image, noise can be remove with help of filters in processing phase.

c) Feature Extraction
Feature extraction is followed by pre-processing. In feature extraction phase features of palm are extracted like principal lines, orientation field, minutiae, density map, texture, singular points etc.

d) Matching
Matching is next to the feature extraction phase. Feature matching determines the degree of similarity of recognition template with master template [13]. Different approaches are used for matching. Input provided by individual is matched with templates present in database.

e) Structure of thisAssessment
The edifice step of this paper is as follows. The Introductory Section ends with a brief introduction of palmprint authentication systems and basic principles. In Section II, we address the characteristics and design architecture of palmprint recognition system. Section III gives a detailed analysis of transformation based approaches especially spatial domain transformation of palmprint images. In Section IV, we analyse the artificial intelligence based approaches including the supervised learning principles, neural network, SVM and fuzzy logic based approaches falls under this category. Section V and VI explains palm stroke or palm line base approaches and appearance or subspace based approaches used in palmprint authentication system. Finally Section VII illustrates the Numerical statistical approaches. General conclusion and discussion is mentioned in IX.

3. Transformation Based Approaches

In the last few years, a large amount of research has been done in the palmprint recognition field, where researchers have proposed numerous method for palmprint recognition. G. Lu, D. Zhang and K. Wang [5] has proposed palmprint recognition by means of Eigen palms features, where original image of palmprint is altered into the feature space i.e. Eigen palm with the aid of K-L transform. Euclidean distances classifier is used for harmonizing of recognition template and master template.

Cappelli, Ferrara, and Maio [6] proposed high resolution palmprint recognition scheme which is based on minutiae extraction. Pre-processing is done by segmentation of an image from its background. To improve the quality of image, local frequencies and local orientations are evaluated. Local orientation is estimated via fingerprint orientation extraction approach and local frequencies are anticipated by counting the number of pixels amid two consecutive peaks of Gray level along the direction normal to local ridge orientation. Minutiae feature is taken out in feature extraction phase. To extract the minutiae attributes contextual filtering with Gabor filters approach is applied. Minutiae cylinder code has been exercised for matching the minutiae features.

Kong, Zhang and Li [7] have proposed palmprint verification by means of 2-DGabor filter for feature extraction from palmprint. In the pre-processing of the image low pass filter as well as boundary tracking algorithm is applied. Texture feature is extracted via the texture-based feature extraction technique which uses the 2-D Gabor Filter. Palmprint matching is based on the principle of normalized hamming distance.

Huanga, Jiaa and Zhang [8] have proposed the palmprint authentication system based on principal line extraction. Modified finite Radon transform has been employed for feature extraction. The feature which is considered is principal lines. For comparing of test image with a training image the line matching technique has been used which is based on the pixel-to-area algorithm.

Zhang, Kong, You and Wong [9] had proposed Online Palmprint Identification. The proposed scheme takes online palmprints, and utilizes low resolution images. Low pass filter in addition to boundary tracking algorithm is used in the pre-processing phase. Circular Gabor filter is used for feature extraction and 2-D Gabor phase coding is applied for feature representation. A normalized hamming distance is used for matching.

Konga, Zhanga, and Kamel [10] have introduced palmprint identification using feature level fusion. Multiple elliptical Gabor filters with diverse orientations are used to extract the phase information. Phase information is then amalgamated according to a fusion rule to produce a single feature called

the Fusion Code. Matching of two Fusion Codes is measured by means of the normalized hamming distance.

Jiaa, Huanga and Zhang [11] have projected palmprint verification based on the robust line orientation code. Modified finite Radon transform has been utilized for feature extraction, which extracts the orientation features. For matching of test image with the training image the line matching scheme has been used which is based on the pixel-to-area algorithm.

Prasad, Govindan and Sathidevi [12] have proposed Palmprint Authentication via Fusion of Wavelet Based Representations. Features extracted are Texture feature as well as line features. In proposed system pre-processing comprises of low pass filtering, classification, location of invariant points, in addition to alignment and extraction of ROI. OWE is used for the feature extraction. The match scores are generated for texture and line features separately and in combined modes as well. Weighted sum rule along with product rule is used for score level matching.

Dai and Zhou [13] has introduced high resolution approach for palmprint recognition by means of multiple features extraction. Features similar to minutiae, density, and orientation with principal lines are taken for feature extraction. For orientation assessment the DFT and Radon-Transform-Based Orientation Estimation are used. For minutiae extraction Gabor filter is used for ridges improvement according to the local ridge direction and density. Density map is evaluated by using the composite algorithm, Gabor filter, Hough transform. In addition to extract the principal line features Hough transform is applied. SVM is used as the fusion technique for the authentication system and the anticipated heuristic rule for the identification system.

As the problem of deformation due to many creases on palmprint and discrimination strength of different regions of palmprint Dai, Feng, Zhou [14] introduced a segment-based palmprint matching and fusion algorithm, where whole palmprint image is separated into different regions and then every region is separately matched to deal with the distortion. The similarity of two palmprints is computed by fusing the similarity scores of dissimilar segments using a Bayesian framework. Dai, Feng, Zhou [10] also introduced an orientation field-based registration algorithm which is used to reduce the computational complexity. P.S. Sanjekar [15] has used Haar wavelet for the palmprint identification which is an image based technique. For matching difference vector formula is employed and features extracted are in the form of standard deviation and mean.

4. Artificial Intelligence Based Approaches for Palm-Print Recognition

Artificial intelligence has been used in a wide range of fields including medical diagnosis, stock trading, robot control, law, remote sensing, scientific discovery and toys. However, many AI applications are not perceived as AI: "A lot of cutting edge AI has filtered into general applications, often without being called AI because once something becomes useful enough and common enough it's not labelled AI anymore.

Jiwen Lu et al proposes an efficient palmprint recognition method using locality preserving projections (LPP) and extreme learning machine (ELM) neural network. Firstly, two-dimensional discrete wavelet transformation (DWT) is applied in the region of interest (ROI) of each palmprint image and then principal component analysis (PCA) and LPP are used for dimensionality reduction [16].

Followed by the same author Leqing Zhu, proposed a novel palmprint recognition algorithm based on principal lines: a new irregular geometrical shape was employed to get valid palmprint region, which decreased the influence of large noises; not only structure feature, but also intension information were included in the final extracted principal lines, which provides much sufficient clues for palmprint recognition; the probability feature image (PFI) was used in order to suppress random noises in feature image; features from several training samples were merged into one template, which guaranteed the integrity of feature; fuzzy logic was employed in matching algorithm [17].
As mentioned in [18], different neural network based approaches are evolved for palmprint recognition by using some other domain method like wavelet transform etc. for training purpose. Different stage classification can also be useful in such cases for optimum classification of appropriate features [19, 20, and 21]. As in [19] proposed system is based on geometrical features and texture features extracted using kernel principal components analysis (K-PCA). In the coarse-level stage, the hand geometrical features are applied in the SOMNN to select a small set for further matching, and in the fine-level matching, texture features are input into the BPNN for final identification.

Since, Palmprint-based personal identification, as a new member in the biometrics family, has become an active research topic in recent years. The rich texture information of palmprint offers one of the powerful means in the field of personal recognition. Hence, many researches proposed, a novel approach for handprint identification.

5. Approaches Based On Palm Strokes

Palm Strokes based approaches either develop edge detectors or use existing edge detection methods to extract palm lines [22, 23, and 24]. These lines are either matched directly or represented in other formats for matching. Wu et al. use Sobel masks to compute the magnitude of the palm lines [25]. The magnitude are projected along the x and y directions to form histograms. They designed two masks to compute the first order derivative and second order derivative of palm print images. The first order and second order derivatives can be obtained by rotating the two masks. The Zero crossing of the first order derivative is used to identify the edge points and corresponding directions. Second order derivative is used to identify the magnitude of the lines.

Kung et al. formed a feature vector based on a low-resolution edge map. The feature vector is passed into decision-based neural networks [26]. This was the first paper

to report an on-line palmprint recognition method. Pedro et al. employ Sobel masks to enhance edge information and the statistical information in the processed images is used to estimate an optimal threshold for extracting the edges [27]. The authors then utilize a thinning algorithm to further process the edges. Several descriptors of the edges are computed as features for matching.

Also, Image alignment is an important step in various biometric authentication applications such as palmprint recognition. Most of the existing palmprint alignment methods make use of some key points between fingers or in palm boundary to establish the local coordinate system for region of interest (ROI) extraction. The ROI is consequently used for feature extraction and matching. Such alignment methods usually yield a coarse alignment of the palmprint images, while many missed and false matches are actually caused by inaccurate image alignments. To improve the palmprint verification accuracy, some researches mentioned present an efficient palmprint alignment refinement method. In such cases after extracting the principal lines from the palmprint image, we apply the iterative closest point method to them to estimate the translation and rotation parameters between two images. The estimated parameters are then used to refine the alignment of palmprint feature maps for a more accurate palmprint matching.

6. Appearance Based Approaches

Appearance based method is also called Sub-spacing based approach, generally involve principal component analysis (PCA), Linear discriminate analysis (LDA) and independent component analysis (ICA).The subspace coefficient are considered as features .In addition to applying PCA, LDA and ICA directly to palm print images, researchers also employ wavelets, Discrete cosine transform and kernel in their method [28], [29], [30], [31].

Dale et al. proposed discrete cosine transform (DCT) based feature vector for palmprint representation and matching compared with DFT and wavelet transform [32].

Such approaches contain two interesting components. Firstly, the directional representation for appearance based approaches. In it, the new representation is robust to drastic illumination changes and preserves important discriminative information for classification. We then generate virtual samples to enlarge the training set to compensate for matching errors caused by large rotations and translations. Based on these two strategies, the recognition performance of representative appearance based approaches can be improved significantly.

3D palmprint authentications systems also developed using appearance based approaches, as a significant biometric technique, 3D palmprint authentication is better than 2D palmprint authentication in several aspects. Previous work on 3D palmprint recognition has concentrated on two aspects: Extracting the texture and line features using the binary image of 3D palmprint, second is Extracting the orientation features using the Gabor filter and competitive code. Histogram based methods and higher versions of wavelet transform like dual-tree wavelet transform double density wavelet transform etc. also included in this section. Subspace learning methods are very sensitive to the illumination, translation, and rotation variances in image recognition.

7. Approaches Based on Numerical Statistics

Statistical approaches are categorized into local and global statistical approaches. Local Statistical approaches transforms images into another domain and divide the transform into several small regions. Local statistics such as means and variances of each small region are calculated and regarded as features [33], [34], and [35].

Yong et al. method for feature extraction divides the palm print image into a set of n small regions and then calculates the mean and S.D of sub regions. Euclidian square norm is employed for matching [36]. Researchers compute global statistical features like moments, centre of gravity and density directly from the whole transformed images [37], [38]. Some recent researches prefer to combine these Statistical approaches with supervised learning environment as State-of-the-art algorithms of palmprint recognition describe appearances of palmprints efficiently through local texture analysis.
Also, in on-line palmprint recognition tasks, texture based feature extraction methods are widely adopted for palmprint representation, owing to their high performance. Gabor filter bank is among the most promising texture information extraction tool because of its multi-scale and multi-orientational characteristics. However, it is both time and memory intensive to convolve palm images with a bank of filters to extract features.

Generally, there are two types of features in palmprint: structural features and statistical features. Structural features, such as lines, can characterize a palm exactly, but are difficult to be extracted and represented; while statistical features can be extracted and represented easily, but are unable to reflect the structural information of a palmprint. It is also concluded that, since the principal features of both Chinese characters and palmprint are lines hence we can also try to use methods of Chinese character recognition to identify palmprint.

8. Conclusion& Discussion

The increase of terrorism and other sorts of criminal actions, such as fraud in e-commerce, increased the curiosity for more powerful and reliable ways to recognize the identity of a person. To this end, the utilization of behavioural or physiological characteristics, named biometrics, is proposed. Biometrics is best defined as quantifiable physiological and or behavioural traits that can be utilized to verify the distinctiveness of an individual. Many physiological characteristics of humans, i.e., biometrics, are classically invariant over time, easy to acquire, and unique to each individual. Therefore the biometrics traits are increasingly adopted for civilian use and no longer restricted to forensic identification. The Palmprint is a vital biometric due to the following reasons:

1. Stable structure that is preserved since birth and is quite exclusive to individuals.
2. Invariable to the variation in expression.
3. Immune from anxiety, privacy along with hygiene problems.

Due to the above mentioned causes, automated personal identification using Palmprint images has been increasingly studied for probable commercial applications recently. A typical biometric system usually consists of that precise biometric detection method followed by an extraction methodology (which shrinks the dimensionality of valuable information) and then a classifier to make the suitable decision.

Literature regards two approaches towards palm print recognition – one associated to structural and the other associated to statistical. In the structural approach, the creases, best lines etc. are measured as features and are analyzed. On the other hand, some authors determined the datum points derived from principal lines by using the directional projection algorithm. It has been said that, the structural based approaches could extract ridges mostly correctly. The dominant approach is in the direction of palmprint recognition is based on the statistical features. For statistical based palmprint recognition approach, the works that appear in the literature include Eigen palm (where the original palm print images were projected to a relatively lower dimensional space called Eigen palms), fisher palms (which uses fisher linear discriminant to reduce the dimension), Gabor filters, Fourier Transform, and local texture energy (Out of these approaches, Eigen palm and fisher palm are used for comparing with our approach). We also conclude that the introduction of artificial intelligence in palmprint recognition provide a supervision to all other previous approaches, the methods like neural network, support vector machine, fuzzy logic and other learning paradigm had already increase the efficiency, accuracy and recognition rate of such system. However, it should be noted that appropriate use of such artificial intelligence can increase the recognition rate up to 100%.

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