Biometric Palmprint Recognition System: A Review
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Abstract-An easy-to-capture biometric modality that could work well even with a commodity camera is palmprint. It has coarse lines which can be easily detected using a low resolution camera and it is easy to present due to the free mobility of our palm. On most surveys, hand as a biometric modality rates high on user acceptance. It is very easy and convenient to integrate palmprint into an already existing Biometric Recognition System since it does not need a dedicated capture device. Because of the presence of coarse distinguishing lines, it is possible to capture palm lines even at a low resolution, using a digital camera. All this combined with a moderate recognition accuracy on large datasets makes palmprint the ideal choice as an add-on in a multi biometric system. All the factors defined above make palmprint a very useful biometric.

Keywords- Palmprint, Biometrics, Preprocessing, Feature extraction, matching.

1. INTRODUCTION
Palmprint is the inner part of a person’s hand. For centuries, the palm line patterns have popularly been believed to be able to predict a person’s future. But its uniqueness and capacity for distinguishing individuals has come to fore only recently. Palmprint is also one of the reliable modality since it possess more features than that of the other modality such as principal lines, orientation, minutiae, singular points etc. Also palmprint modality is unique for each individual, moreover it is universal. Palmprint recognition is used in civil applications, law enforcement and many such applications where access control is essential.

Palm has features like geometric features, delta point’s features, principal lines features, minutiae, ridges and creases. Principal lines are namely heart line, head line and life line. Figure 1 shows structure of palmprint. Palmprint contains three principal lines which divides palm into three regions: Interdigital, Hypothenar and Thenar. An Interdigital region lies above the Heart line. The Thenar lies below the Life line. And Hypothenar is between Heart and Life line. From palmprint principal lines, minutiae, ridges features can be extracted for identification.

Palmprint recognition techniques have been grouped into two main categories, first approach is based on low-resolution features and second approach is based on high-resolution features. First approach make use of low-resolution images (such as 75 or 150 ppi), where only principal lines, wrinkles, and texture are extracted. Second approach uses high resolution images (such as 450 or 500 ppi), where in addition to principal lines and wrinkles, more discriminant features like ridges, singular points, and minutiae can be extracted.

Fig. 1 Different Features of Palm.

2. LITERATURE SURVEY
Early researches on fast palmprint identification can be roughly classified into two categories, hierarchical matching and palmprint classification. Hierarchical matching approaches typically involve first extracting multiple kinds of features and then searching in a layered fashion. Simpler features which can be quickly extracted and matched are used at higher layers because they allow a large number of candidates to be discarded. The drawback is that the templates discarded at higher layers may contain the target. Classification strategies often make use of expert knowledge to design the classification rules. They proceed by dividing palmprints into several classes and matching the query only with the
templates in its class. The drawback here is that the initial classification may have put the query and its target template into different classes, making a successful match impossible. Therefore, while both strategies speed up the identification process, they do so at the expense of accuracy.

2.1 Existing system

A. Gyaourova and A. Ross[1] have proposed an indexing technique that can either employ the biometric matcher that is already present in the biometric system or use another independent matcher. Index codes are generated for each modality using the corresponding matcher. During retrieval, the index code of the probe is compared against those in the gallery using a similarity measure to retrieve a list of candidate identities for biometric matching, the proposed indexing technique on a chimeric multimodal database resulted in a reduction of the search space by an average of 84% at a 100% hit rate. The main factor for the amount of speedup during identification was the penetration rate of the indexing.

Dai and Zhou [2] introduces high resolution approach for palmprint recognition with multiple features extraction. Features like minutiae, density, orientation, and principal lines are taken for feature extraction. For orientation estimation the DFT and Radon-Transform-Based Orientation Estimation are used. For minutiae extraction Gabor filter is used for ridges enhancement according to the local ridge direction and density. Density map is calculated by using the composite algorithm, Gabor filter, Hough transform. And to extract the principal line features Hough transform is applied. SVM is used as the fusion method for the verification system and the proposed heuristic rule for the identification system.

A. Kong and D. Zhang [3] have presented a novel feature extraction method, the Competitive Coding Scheme for palmprint identification. This scheme extracts the orientation information from the palm lines and stores it in the Competitive Code. An angular match with an effective implementation is developed for comparing Competitive Codes. Total execution time for verification is about 1s, which is fast enough for real-time applications. The proposed coding scheme has been evaluated using a database with 7,752 palmprint images from 386 different palms. For verification, the proposed method can operate at a high genuine acceptance rate of 98.4% and a low false acceptance rate of 3*10^{-6}.

Jia, Huang and Zhang [4] have proposed palmprint verification based on robust line orientation code. Modified finite Radon transform has been used for feature extraction, which extracts orientation feature. For matching of test image with a training image the line matching technique has been used which is based on pixel-to-area algorithm.

D. Huang, W. Jia, and D. Zhang[5] proposed a novel algorithm for the automatic classification of low-resolution palmprints. First the principal lines of the palm are defined using their position and thickness. Principal lines are defined and characterized by their position and thickness. A set of directional line detectors is devised for principal line extraction. By using these detectors, the potential line initials of the principal lines are extracted and then, based on the extracted potential line initials, the principal lines are extracted in their entirety using a recursive process. The local information about the extracted part of the principal line is used to decide a ROI and then a suitable line detector is chosen to extract the next part of the principal line in this ROI. After extracting the principal lines, some rules are presented for palmprint classification. The palmprints are classified into six categories considering the number of the principal lines and their intersections. From the statistical results in the database containing 13,800 palmprints, the distributions of categories 1–6 are 0.36%, 1.23%, 2.83%, 11.81%, 78.12% and 5.65%, respectively. The proposed algorithm classified these palmprints with 96.03% accuracy.

Zhang, Kong, You and Wong [6] have proposed Online Palmprint Identification. The proposed system takes online palmprints, and uses low resolution images. Low pass filter and boundary tracking algorithm is used in pre-processing phase. Circular Gabor filter used for feature extraction and 2-D Gabor phase coding is used for feature representation. A normalized hamming distance is applied for matching.

J. You, W. Kong, D. Zhang, and K. Cheung[7] proposed a dynamic selection scheme by introducing global texture feature measurement and the detection of local interesting points. Our comparative study of palmprint feature extraction shows that palmprint patterns can be well described by textures, and the texture energy measurement possesses a large variance between different classes while retaining high compactness within the class. The coarse-level classification by global texture features is effective and essential to reduce the number of samples for further processing at fine level. The guided searching for the best matching based on interesting points improves the system efficiency further.

W. Li, J. You, and D. Zhang[8], have proposed an effective indexing and searching scheme for an image database to facilitate fast retrieval when the size of a palmprint database is large. There are three key issues to be considered: feature extraction, indexing, and matching . In general, in an image database, the extracted features are often associated to the original images as indices. A search for the best matching is conducted in a layered fashion, where one feature is first selected to lead the search by reducing the set of candidates. Then other features are used to reduce the candidate set further. Such a process will be repeated until the final output is determined based on the given matching criteria. The selection of features plays an important role for efficient search. An effective feature selection scheme should exclude the most impossible candidates, compare easily, require small size of space for storage.

Prasad, Govindan and Sathidevi[9], have proposed Palmprint Authentication Using Fusion of Wavelet Based Representations. Features extracted are Texture feature and line features. In proposed system pre-processing includes low pass filtering, segmentation, location of invariant points, and alignment and extraction of ROI. OWE used for feature extraction. The match scores are generated for texture and line features individually and in combined modes. Weighted sum rule and product rule is used for score level matching.
Cappelli, Ferrara, and Maio [10] proposed high resolution palmprint recognition system which is based on minutiae extraction. Pre-processing is formed by segmentation of an image from its background. To enhance the quality of image, local frequencies and local orientations are estimated. Local orientation is estimated using fingerprint orientation extraction approach and local frequencies are estimated by counting the number of pixels between two consecutive peaks of gray level along the direction normal to local ridge orientation. Minutiae feature is extracted in feature extraction phase. To extract the minutiae features contextual filtering with Gabor filters approach is applied. Minutiae cylinder code has been used for matching the minutiae features.

3. THE PROPOSED SYSTEM

3.1 Palmprint acquisition

There are various ways to capture palmprint image. Researchers utilize CCD-based scanners, digital scanners, video camera and tripod to collect palmprint images. Fig.2 shows a CCD-based scanner developed by Hong Kong Polytechnic University. A CCD-based scanner captures high resolution images and aligns palms accurately because it has pegs for guiding the placement of hand. Digital scanners produces low quality image and requires large time for scanning, therefore it cannot be used for real time applications. Digital and video cameras can also captured palm images but can cause recognition problems.

![Fig. 2 CCD Based Scanner](image)

The palmprint recognition system includes preprocessing followed by ROI extraction. After ROI extraction, features are extracted using the feature extraction algorithms. The palmprint is then accepted or rejected on the basis of matching the extracted features. All these processes have been studied and reviewed. On the basis of the review, the proposed system has been described. Each step has been studied in detail. The proposed palmprint recognition system has been depicted in figure 4 which is a flowchart of the palmprint recognition system. Each step is further described below in detail.

3.2 Preprocessing

Preprocessing is used to correct distortions, align different palmprints, and to crop the region of interest for feature extraction. Research on preprocessing commonly focuses on five steps 1.Binarizing the palm images 2.Boundary tracking 3.Identification of key points 4.Establishing a coordination system and 5.Extracting the central part.

The third step can be accomplished by two approaches, tangent based and finger based. The tangent based approach is preferred. This approach considers the edges of the 2 finger holes on the binary image to be traced. The common tangent of the two finger holes is considered to be the axis. The key points for the coordination system are calculated as the midpoint of the two tangent points.

![Fig.3 (a) key points and coordinate system, (b) ROI extraction](image)
3.3 ROI extraction

The central part of the palm image is segmented after the preprocessing. Different algorithms segment circular, half elliptical or square regions for feature extraction. The square region is the easiest and widely used. The cropped image is then passed through a low pass filter (LPF), which blurs the image. In this blurred image, the minor lines get suppressed. The major lines are also affected, but they are prominent. These are then used for feature extraction.

3.4 Feature extraction and matching

The aim of this section is to recognize a correct person to authenticate and to prevent multiple people from using the same identity. In identification, the system recognizes an individual by searching the templates of all users in the database for matching. Research on feature extraction and matching algorithms are classified as follows: line based, subspace based, statistical based and coding based.

![Flowchart of Palmprint Recognition Algorithm](image)

3.4.1 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.

3.4.2 Subspace Based Approaches:

Subspace based method is also called appearance based approach, generally involve principal component analysis (PCA), Linear discriminant 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.

3.4.3 Statistical Approaches:

There are two types local and global. The local approaches transform images into another domain and divide the transform into several regions such as mean and variance of each small region. Researchers compute global statistical features like moments, centre of gravity and density directly from the whole transformed images. 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 [11].

3.4.4 Coding Approaches:

Palm code uses a single Gabor filter to extract the local phase information of palm print. Kong et al. 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) reduces 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.

3.4.5 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 capable 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.

3.4.6 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 complex transform on preprocessed palmprint to decompose the images, phase only correlations etc.

4. CONCLUSION

Several existing methods have been reviewed for palmprint recognition. Palm print acquisition using CCD based scanner is recommended. Palm code, fusion code, competitive code and the theory of coding method are recommended. 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 extended to apply gaussianization, the feature normalization method on the high resolution images where multiple features can be extracted.

REFERENCES