# A Survey on Security and Accuracy in Palmprint Recognition

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***Abstract***- *Biometrics is the study of automated methods for recognizing a person based on his physical or behavioral characteristic. Biometric systems can be divided into two categories- identication systems and verication systems. Biometric palmprint has received wide attention from researchers. It is well-known for several advantages such as stable line features, low-resolution imaging, low-cost capturing device, and user-friendly. In the area of personal authentication using the palmprint as a biometric trait has concentrated on enhancing accuracy yet resistance to attacks is also a centrally important feature of any biometric security system. This paper provides an overview of current palmprint research, describing in image acquisition, preprocessing, feature extraction, palmprint related fusion and security and accuracy about palmprint system. Finally some conclusion and suggestion is offered.*

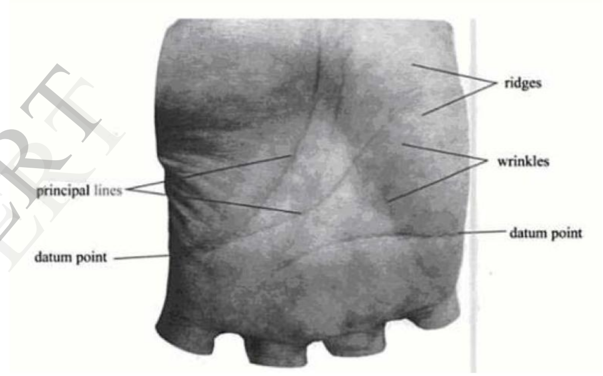
***Keywords:- Palmprint Recognition, Biometric Security.***

## "1. INTRODUCTION"

Palmprint is one of the most reliable features in personal identification because of its stability and uniqueness.
Although the use of palmprints for identity authentication has drawn interests from some researchers, the development of an effective and efficient approach to identify and verify palmprints remains a challenging research topic. The inner surface of the palm normally contains three flexion creases, secondary creases and ridges. The flexion creases are also called principal lines and secondary creases are called wrinkles. Many feature of a palmprint can be used to uniquely identify a person. Six major types of features can be observed on a palm (figure 1).
1. Geometry Feature: - According to the palm shape, we can easily get the corresponding geometry feature such as width, length and area.
2. Principal line feature: - Both location and form of principal lines in a palmprint are very important physiological characteristic for identifying individual because they very little over time

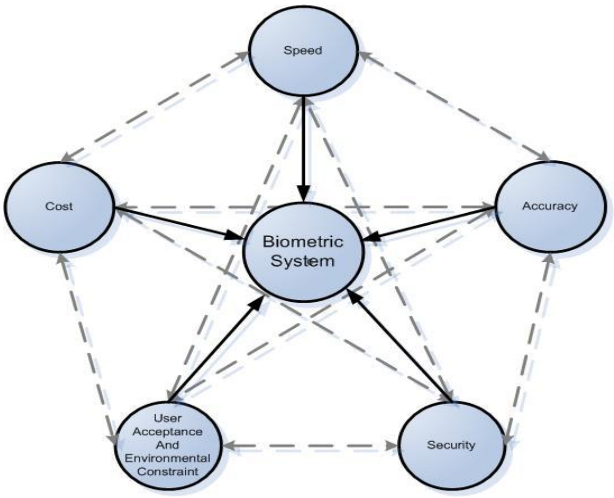
3. Wrinkles: - In a palmprint there are many wrinkles which are different from the principal lines in that they are thinner and more irregular. These are classified as coarse wrinkles and fine wrinkles so that more features in detail can be acquired.
4. Datum points: - Two end points called datum points are obtained by using the principal lines. These intersect on both sides of a palm and provide a stable way to resister palmprint.
5. Delta point feature: - The delta point is defined as the center of a delta like region in the palmprint
6. Minutiae: - A palmprint is basically composes of the rides, allowing the minutiae feature to be used as another significant measurement.






"Figure 1: Palmprint Image"

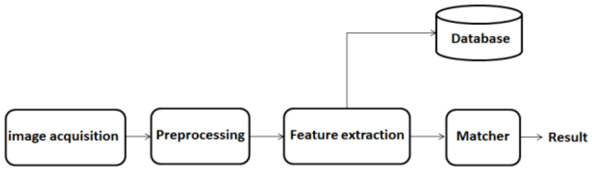
The design of a biometric system takes care of five objectives: cost, accuracy, computation speed, security and user acceptance and environment constraints (figure 2). Reducing accuracy can increase speed. Reducing user acceptance can improve accuracy. For instance, users are required to provide more samples for training. Increasing cost can enhance security. We can embed more sensors to collect different signals for liveness detection. In some applications, environmental constraints such as memory usage, power consumption, size of templates and size of devices have to be fulfilled. A biometric system installed in PDA (personal digital assistant) requires low power and memory consumption but these requirements may not be vital for biometric access control systems.




"Figure 2: Key Objective of a Biometric system design [1,2]"

A palmprint recognition system generally consists of five parts (fig.3): Image acquisition, preprocessing, feature extraction, matcher and a database. Palmprint recognition consists of images acquisition in which image is capture with the help of device. Preprocessing is to setup a coordinate system to align palmprint images and to segment a part of palmprint image for feature extraction. Feature extraction obtains effective features from the preprocessed palmprints. Finally, a matcher compares two palmprint features. All the images, templates generated are stored in a local or remote database.

The remaining section is organized as follows: Palmprint image acquisition and preprocessing are reviewed in Section 2. Feature extraction in Section 3. Various fusion approaches for enhancing verification accuracy are summarized in Section 4. Recognition/classification methods used in Section 5. Security and privacy approaches in Section 6.

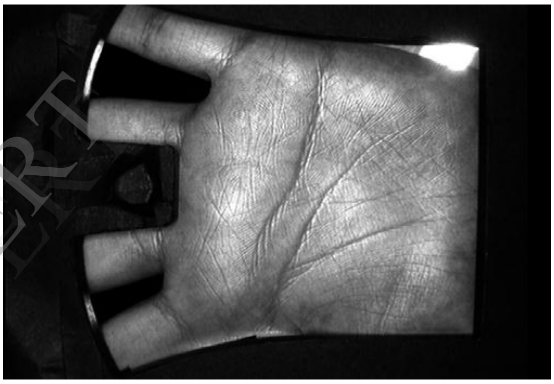



"Figure 3: System Block Diagram"

## "2. PALMPRINT IMAGE ACQUISITION AND PREPROCESSING"

### 2.1 Palmprint image acquisition

During image acquisition a palmprint image is captured by a palmprint scanner or camera and store in grayscale file. Then the AC signal is converted into a digital signal, which is transmitted to a computer for further processing. It is the first process in palmprint recognition systems. Researchers utilize four different types of sensors to collect palmprint images, CCD-based palmprint scanners, digital cameras, digital scanners and video cameras. A CCD-based palmprint scanner developed by the Hong Kong Polytechnic University. Generally speaking, CCD-based palmprint scanners capture high quality palmprint images and align palms accurately since the scanners have pegs for guiding placement of hands. Digital scanners are cost-effective to collect palmprint images. However, they cannot support real-time verication because of the scanning time. Digital cameras and video cameras are two ways to collect palmprint images without contact. Figure 4(a) is a palmprint image collected by a CCD-based palmprint scanner and Figure 4(b) is a palmprint image collected by a digital scanner. These digital scanners [3] capture high quality palmprint images and align palms accurately because the scanners have pegs for guiding the placement of hands. This acquired image is further sent for the preprocessing.

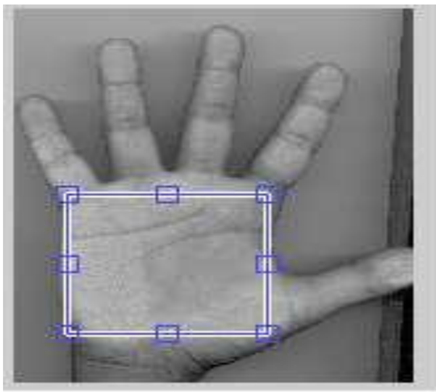


"Figure 4(a): Palmprint collected by a CCD-based palmprint scanner"

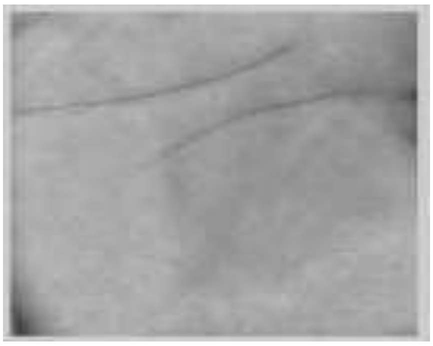
"Figure 4(b): Palmprint collected by a digital scanner"

### 2.2 Preprocessing

Preprocessing is used to align different palmprint images and to segment the center for feature extraction. Most of the preprocessing algorithms employ the key points between fingers to set up a coordinate system. Preprocessing involves five common 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. Fig. 4(a) illustrates the key points and Fig. 4(b) shows a preprocessed image.



“Figure 4(a): Keypoints on figure boundary”



“Figure 4(b): The central parts for feature extraction”

The first and second steps in all the preprocessing algorithms are similar. However, the third step has several different implementations including tangent, bisector and finger-based 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. They depend on a very short boundary around the bottom of fingers. Therefore, it is robust to incomplete and the presence of rings. 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 and the other based on the point, middle and ring fingers. 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. 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. After obtaining the coordinate systems, the central parts of palmprints are segmented. Most of the preprocessing algorithms segment square regions for feature extraction but some of them segment circular and half elliptical regions. The square region is easier for handling translation variation, while the circular and half elliptical regions may be easier for handling rotation variation.

## “3. FEATURE EXTRACTION”

Once the central part is segmented, features can be extracted for matching. The features defined possess the stable and unique properties of low intra-class difference and high inter-class difference. These features are used to create a master template which is stored in the system database. While in Feature matching a matching score is obtained by matching the identification template against the master templates. If the score is less than a given threshold, the user is authenticated. Features from Palmprints are shown in Fig. 1. Many features of a palmprint can be used to uniquely identify a person. Various algorithms have been developed to be used in palmprint recognition. Developed algorithms mainly include different methods for feature extraction and distance matching. From now on, some of the methods developed for palmprint recognition will be mentioned. Fang Li et al [7] proposed an approach utilizing Line Edge Map (LEM) of palmprint as the feature and Hausdorff distance as the distance matching algorithm. In this study, Line segment Hausdorff distance (LHD) and Curve segment Hausdorff distance (CHD) are explored to match two sets of lines and two sets of curves. They carried out an identification experiment on The Hong Kong Polytechnic University Palmprint Database. 200 palm images, i.e. 2 palm images for each person, have been randomly selected in order to test the system performance. They reserved one palm image for each individual as a template, and used remaining palm images as test images to be identified. Fang Li et al [8] later proposed the utilization of Modified Line segment Hausdorff distance (MLHD) as the distance matching algorithm. In this study, 2-D low pass filter is applied to sub-image extracted from the captured hand image. The result is subtracted from the image in order to decrease the non-uniform illumination effect resulting from the projection of a 3-D object onto a 2-D image. After line detection, contour and line segment generation steps, each line on a palm is represented using

several straight line elements. Finally, MLHD is used in order to measure the similarity between two palm images.
Algorithms employing neural networks have also been developed. Li Shang et al. suggested the usage of radial basis probabilistic neural network (RBPNN). The RPBNN is trained by the orthogonal least square algorithm (OLS) and its structure is optimized by the recursive OLS algorithm (ROLSA). A fast fixed-point algorithm is used for independent component analysis. In transform-based feature extraction methods Discrete Cosine Transform (DCT) [9], Discrete Fourier Transform [10], Wavelet Transform, contourlet transform are used. In DFT by Li et al. [10] the palmprint image is first converted into the frequency domain image. These different features are used to lead a layered fashion searching for the best matching with the templates in the database. But in FT only the global variations are captured. In the proposed DCT-based palm-print recognition scheme by Jing et al. [9], instead of operating on the entire palmprint image at a time the dominant spectral features are extracted separately from each of the narrow-width band obtained by image segmentation. It has been found that the proposed feature extraction scheme offers two-fold advantages. First, it can precisely capture local variations that exist in the palm-print images, which plays an important role in discriminating different persons. Second, it utilizes a very low dimensional feature space for the recognition task, which ensures lower computational burden. In DCT, the palmprint image is analyzed in single resolution. Since the palm lines, such as principal lines, wrinkles and ridges can only be acquire in different resolution, multi resolution analysis using Wavelet Transform is proposed by Lu et al. as it has better space-frequency localization.

## "4. FUSION"

Fusion is a promising approach that may increase the accuracy of systems. Many biometric traits including fingerprint, palm vein, finger surface, face, iris, and hand shape have been combined with palmprints at score level or at representation level. Combining other hand features such as hand geometry and finger surface with palmprints allows these features and palmprints to be extracted from a single hand image. Only one sensor is needed. Researchers have examined various fusion rules including sum, maximum, average, minimum, SVM and neural networks. Researchers also fuse features including appearance-based, line and texture features from palmprints. Although fusion increases accuracy, it generally increases computation costs and template sizes and reduces user acceptance.

## "5.RECOGNITION AND CLASSIFICATION METHOD USED"

In palmprint verification mode the input palmprint image is matched with the palmprint image in the available database. For matching palmprint image many distances are defined. In the [3] Palmprint matching is based on a normalized hamming distance. It is bitwise operation and uses the XOR operator. The distance is in between range 0 to 1. The hamming distance for perfect matching is zero. To implement a real-time palmprint identification system requires a simple and powerful palmprint matching algorithm. So for the Competitive Code an angular distance is designed for comparing two codes. The distance is between 0 and 1. For perfect matching, the angular distance is zero. In the current systems firstly, the user's palmprint is captured by the system. Then, it is compared to every single image in the database, and a result is produced. An accurate and consistent classification can greatly reduce palmprint matching time for a large database. Wu et al. [11] proposed the classification of palmprints using principle lines. The algorithm has the ability to classify low-resolution palmprint into six categories according to the number of principal lines and the number of their intersections. These are mainly palms with one principal line, two principal lines without intersection, two principal lines with intersection, three principal lines without intersection, three principal lines of which two intersects and three principal lines of which all lines intersects each other. In [14] Kumar et al. uses the nearest neighbour (NN) classifier for the classification of extracted feature vectors. The NN classifier is a nonparametric classifier which computes the minimum distance between the feature vector of unknown sample g and that of for gm in the mth class. The class label corresponding to closet training sample is assigned to feature vector g. Three distance measures i.e. L1, L2, Lcos are used in [14] to evaluate the performance of feature sets of gabor, line, PCA. Each of the three feature sets obtained from the three different palmprint representations were experimented with each of the above three distance measures. The distance measure that achieved best performance was finally selected for the classification of feature sets from the corresponding palmprint representation. K-nearest neighbour (KNN) is a supervised learning algorithm. The new instance of palmprint is classified on the basis of the majority of K-nearest neighbour category. To find out closest neighbour, calculate angular or hamming distance [12] to each training sample and then sort it in ascending order and then find K nearest training sample. The purpose of this algorithm is to classify a query palmprint image based on attributes and training samples. Given a palmprint image, we find K number of training palmprints closest to the query palm. KNN classifier can be breaking any tie at random. KNN classifier is robust to noisy training data and effective also if data is large. Verification of a query palmprint image is determined by the class of its K-nearest neighbours if class of a query palmprint image is same as output of the K-nearest neighbour classifier, then palmprint is matched with training samples otherwise not matched. In [13] results using the combination HMAX model and support vector machine (SVM) classifier obtains higher recognition rate than those obtained with HMAX model and K-nearest neighbours (KNN) classifier in identity verification system based on palmprint, and also demonstrated that the HMAX model, compared with PCA method, not only obtains higher recognition rate, but also this method is scale and rotate invariant, whereas PCA method provide high recognition rate only in closely controlled conditions. SVM operates on the principle of Structural Risk Minimization (SRM). It constructs a hyper-plane or a set of hyper-planes on a high dimensional space for the classification of input features. The data to be classified by the SVM may not be linearly separable in the original feature space. In the linearly non-separable case the data is projected onto a higher dimensional feature space using Kernel function. Then SVM generates a hyper-plane in H with the decision boundary. SVMs have two basic advantages: First, the kernel techniques can be used to convert nonlinearly separable densities into a pair of linearly separable ones and second SVMs minimize the maximum expected generalization error, leading to good generalization ability. The following table gives the summary of the palmprint recognition system [3].

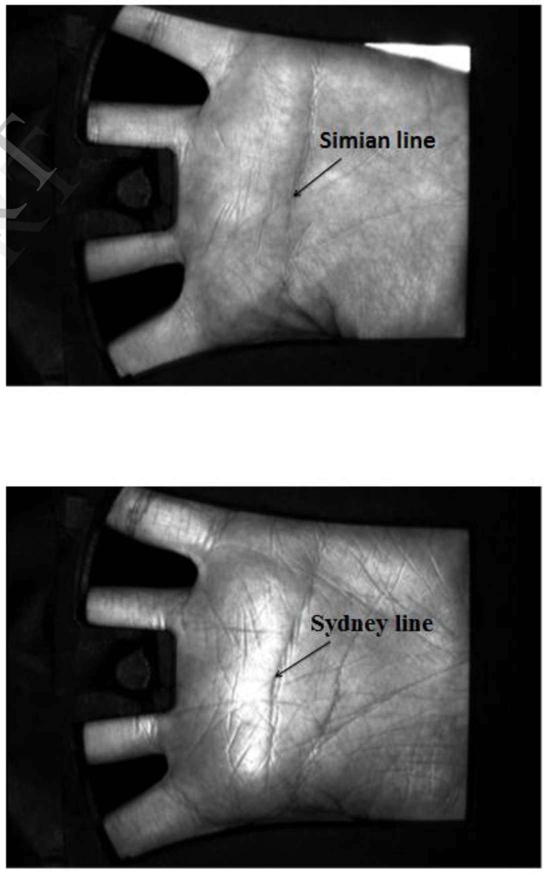
Table 1: Summary Of Palmprint Recognition

| Method | Feature | Classifier | Data Set | Accuracy (%) |
|---|---|---|---|---|
| Gabor | Phase information | Hamming Distance | 4647 | 97.59 |
| DCT | Spectral features | Distance based | 7752 | 99.97 |
| GB(2D)2LDA | Gabor feature vector | Nearest neighbor | 7752 | 99 |
| Wavelet Transform | Wavelet energy features | Neural network | 1000 | 98 |
| DFT | Statistic feature | Hamming Distance | 2500 | 95.48 |
| DLBP | LBP statistic feature vector | Euclidian distance | 1460 | 98.95 |
| Palm Code | Feature vectors | Hamming Distance | 800 | 97.50 |

## "6. SECURITY AND PRIVACY"

Biometric systems are vulnerable to many attacks including re-play, database and brute-force attacks. Compared with verification, fusion and identification, there has been little research on palmprint security. We have analyzed the probability of successfully using brute-force attack to break in a palmprint identification system [15] and proposed cancelable palmprints for template re-issuance to defend replay attacks and database attacks [16]. Connie et al. combined pseudo-random keys and palmprint features to generate cancelable palmprint representations [17]. They claim that their method can achieve zero equal error rates. However, they assume [6] that the pseudo-random keys are never lost and shared and based on this assumption report zero equal error rates for different biometric traits [18]. Sun et al. apply watermarking techniques to hide finger features in palmprint images for secure identification [19]. Wu et al. use palmprint for cryptosystem [21]. Although some security issues have been addressed, it is still not enough. For example, liveness detection has not been well studied. A fake palmprint can be found in [20]. Potential solutions of liveness detection include infrared and multiple spectrum approaches [22,23]. Biometric traits contain information not only for personal identification but also for other applications. For example, deoxyribonucleic acid (DNA) and retina can be used to diagnose diseases. Palmprints can also indicate genetic disorders. Most previous medical research related to the palm has concentrated on abnormal flexion creases, the Simian line and the Sydney line (Fig. 10) [24]. About 3% of nor- mal population has abnormal flexion creases. Medical researchers also discover the association between density of secondary creases and schizophrenia [25]. To protect private information in palmprints, databases store encrypted templates because the line features can be reconstructed from raw templates. Both traditional encryption techniques and cancelable biometrics can be used for encryption.






"Figure.6: Abnormal Palmprints"

Cancelable biometrics match in the transform domain while traditional encryption techniques require decryption before matching. In other words, decryption is not necessary for cancelable biometrics. When matching speed is an issue, e.g. identification in a large database, cancelable biometrics can hide private information.

## "7. DISCUSSION AND CONCLUSION"

In this paper, we discussed about various methods and technique about image acquisition, preprocessing, feature extraction, fusion, recognition and classification, and security and privacy. Palmprint recognition has considerable potential as a personal identification technique as it shares most of the discriminative features with fingerprints and in addition possesses a much larger skin area and other discriminative features such as principal lines, ridges and wrinkles. Biometric fusion is in fact an application of information fusion and combined classifiers. Many excellent papers have been published in these two fields security, we also do not emphasize on any paper because the literature of palmprint security is very small. In face recognition literature, many researchers design algorithms based on prior knowledge of the face. To optimize the recognition performance in terms of speed and accuracy, we expect that more algorithms are designed based on the prior knowledge of palmprints. Different template formats may require different measures for template protection. More research should be put into security and privacy issues. Some issues in using palmprints for personal identification have not been well addressed. For instance, we know that ridges in palmprints are stable for a person's whole life but the stability of principal lines and wrinkles has not been systemically investigated.

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