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A Review on Palm Print Recognition Techniques

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Abstract*— Biometrics helps to identify individuals based on their physiological and behavioural characteristics, which can be used for their personal identifications. Various physical characteristics like retina patterns, iris patterns, fingerprint patterns, palmprint patterns, facial features etc. are utilized for such purposes. Palmprint recognition involves identifying an individual by matching the various principal lines, wrinkles and creases on the surface of the palm of the hand. The basis for using palmprint lies in the fact that since palmprint patterns are generated by random orientations of tissues and muscles of the hand during birth, no two individuals have exactly the same palmprint pattern. Advantages of using palmprint include the fact that such patterns remain more or less stable during one‘s lifetime and also that reliable images of the palm can be obtained quite easily using standard digital imaging techniques. Palmprint recognition uses the person's palm as a bio-metric for identifying or verifying person's identity. Palmprint patterns are a very reliable biometric and require minimum cooperation from the user for extraction. Palmprint is distinctive, easily captured by low resolution devices as well as contains additional features such as principal lines, wrinkles and ridges. Therefore it is suitable for everyone and it does not require any personal information of the user.

***Keywords*— Palmprint recognition, patterns, features**

I. INTRODUCTION

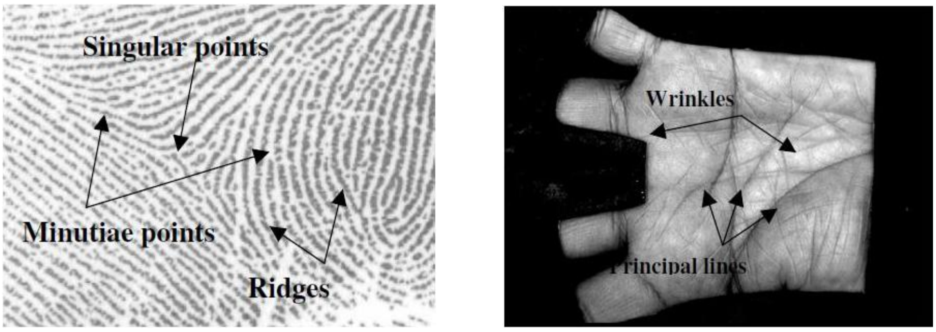
The development of accurate and reliable security systems is a matter of our convenience, and in this context biometrics system has seen as a highly effective automatic mechanism for personal authentication. Authentication by biometric verification is becoming increasingly common in corporate and public security systems, consumer products and point of sale applications. Biometrics is the science and technology of measuring and analysing biological data. In information technology, biometrics refers to technologies that measure and analyse human body characteristics, such as fingerprints, eye retinas and irises, voice patterns, facial patterns and hand measurements, for authentication purposes. Addition to security, the driving force behind biometric verification has been convenience.

Biometric devices consist of:

- A reader or scanning device
- A database that stores the biometric data for comparison

To prevent identity theft, biometric data is usually encrypted when it's gathered. Here's how biometric verification works on the back end: To convert the biometric input, a software application is used to identify specific points of data as match points. The match points in the database are processed using an algorithm that translates that information into a numeric value. The base value is compared with the biometric input the end user has entered into the scanner and authentication is either approved or denied.

The inner surface of palm normally contains three flexion creases, secondary creases and ridges. The flexion and secondary creases are also called principal lines and wrinkles, respectively. The flexion creases and the main creases are formed between the 3rd and 5th months after conception and petty lines appear after birth. These creases are not genetically settled. Even identical twins those are having the same DNA sequences have different palm prints. These complex patterns have rich information for personal authentication. Human beings were interested in the palm lines for fortune telling long time ago. Scientists and fortune tellers name the lines and the regions differently. There are two types of palmprint recognition research, high resolution and low resolution approaches. High resolution approach is suitable for forensic applications such as criminal investigation while low resolution is more suitable for civil and commercial applications such as access control. Generally speaking, high resolution refers to 400 dpi or more and low resolution refers to 150 dpi or less. Figure 2.2 illustrates a part of a high resolution palmprint image and a low resolution palmprint image. In high resolution images, researchers extract ridges, singular points and minutia points as features while in low resolution images, they generally use principal lines, wrinkles and texture. At the beginning of palmprint research, the high-resolution approach was the focus but almost all current research is focused on the low resolution approach because of the potential applications.



(a) (b)

Fig: Palmprint features in (a) a high resolution image and (b) a low resolution image

II. DESIGN OF AUTOMATIC BIOMETRIC SYSTEM

A **biometric system** is essentially a pattern recognition system that operates by acquiring biometric data from an individual, extracting a feature set from the acquired data, and comparing this feature set against the template set in the database. Depending on the application context, a biometric system may operate either in *verification* mode or *identification* mode. In the **verification mode,** the system validates a person's identity by comparing the captured biometric data with her own biometric template(s) stored system database. In such a system, an individual who desires to be recognized claims an identity, usually via a PIN (Personal Identification Number), a user name, a smart card, etc.In the **identification mode**, the system recognizes an individual by searching the templates of all the users in the database for a match. Therefore, the system conducts a one – to - many comparison to establish an individual's identity (or fails if the subject is not enrolled in the system database) without the subject having to claim an identity (e.g., "*Whose biometric data is this*?"). While traditional methods of personal recognition such as passwords, PINs, keys, and tokens may work for positive recognition, negative recognition can only established through biometrics. They are often referred to as the *three pillars of authentication*. Any combination of these approaches further heightens security. Requiring all three for an application provides the highest form of security. An example of airport has presented here for understanding the design of palmprint recognition system.

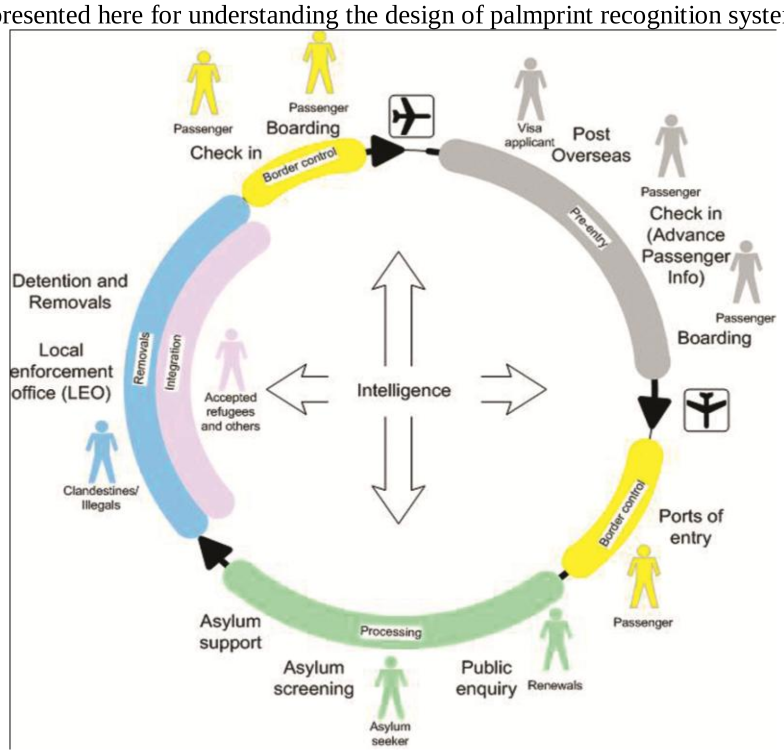


Fig: A Biometric System

Five objectives i.e. cost, user acceptance and environment constraints, accuracy, computation speed and security should be considered when designing a biometric system. They are inter-related. Reducing accuracy can increase speed. Typical examples are hierarchical approaches. Reducing user acceptance can improve accuracy. For instance, users are required to provide more samples for training the system. Increasing cost can enhance security. More sensors can be embedded to collect different signals for liveness detection. In some applications, some environmental constraints such as memory usage, power consumption, size of templates, and size of devices have to be factored into a design. A biometric system installed in a PDA (personal digital assistant) requires low power and memory usage, but these requirements are not essential for access control. A practical biometric system should balance all these aspects.

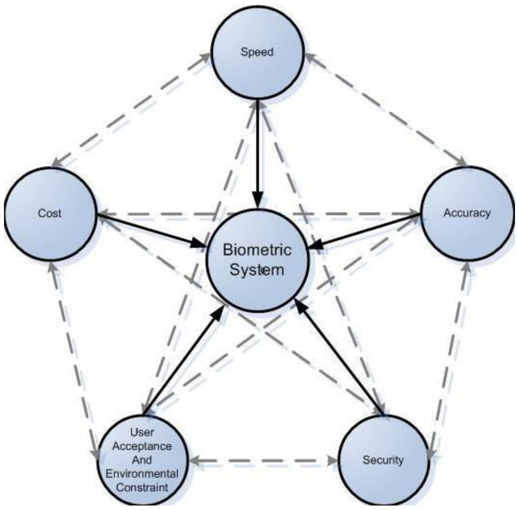


Fig: The inter relationships between different objectives for designing a biometric system

Palmprint recognition came into existence in year of 2000, but the main work in this area, has been performed since 2009. In this chapter, an effort has been made to present a survey of different Palmprint recognition technique in chronological order. A palmprint recognition system generally consists of four modules: palmprint scanner, pre-processing, feature extraction and matcher. Palmprint scanner is used to collect palmprint images. Pre-processing is to setup a coordinate system to align palmprint images and to segment a part of palmprint image for feature extraction. Feature extraction step is used to obtain effective features from the pre-processed palmprint images.

III. PALMPRINT RECOGNITION TECHNIQUES

Palmprint Scanners

Different types of sensors have been used by the researchers to collect palmprint images. CCD-based palmprint scanners, digital cameras, digital scanners, video cameras etc., are the main sensors. So far, only two research teams have CCD based palmprint scanners. Fig shows a CCD-based palmprint scanner developed by the Hong Kong Polytechnic University and it shows a digital scanner developed by Hewlett Packard (HP). 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 verification because of the scanning time. Digital cameras and video cameras are two other ways to collect palmprint images without contact

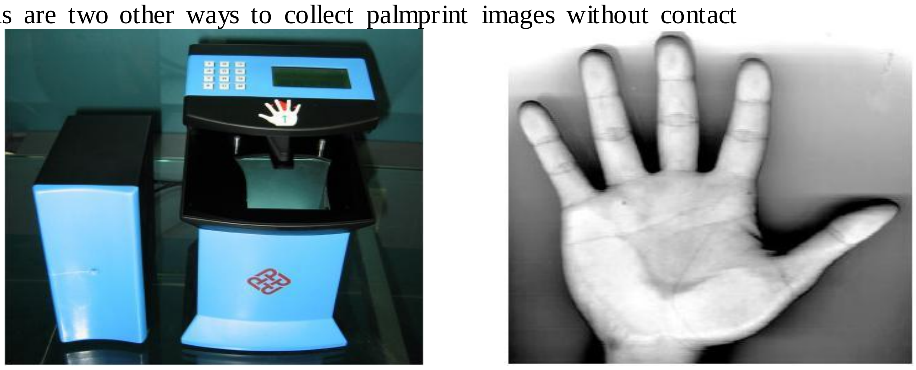


Fig: A CCD-based palmprint scanner

Pre-processing Methods

Pre-processing is used to align different palmprint images and to segment the central parts for feature extraction. Most of the pre-processing algorithms use the key points between fingers to set up a coordinate system. Pre-processing involves generally five common steps, 1) Binarizing the palm images, 2) extracting the shape 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 pre-processing algorithms are similar. However, the third step has several different implementations including tangent-based, wavelet-based, bisector-based etc. to detect the key points between fingers. Furthermore, Han detects points in the middle of fingers and constructs lines passing through fingertips and the points to setup a coordinate system. All these approaches utilize only the information on the boundaries of fingers, while Kumar et al. propose to use all information in palms. They fit an ellipse to a binary palmprint image. According to the orientation of the ellipse, a coordinate system is established. After obtaining the coordinate systems, central parts of palmprint are segmented. Most of the pre-processing algorithms segment square regions for feature extraction, but some of them segment circular and half elliptical regions. Image pre-processing is usually the, first and essential step in pattern recognition. In order to recognize a palm, four steps are devised in the pre-processing module.

Step 1: Image thresholding. The hand images of 256 gray levels are acquired from a platform scanner. The image-thresholding operation is to Binarized the gray images to obtain the binary hand-shape images. In this step, the histogram of gray images is analyzed to determine a threshold value. This value is automatically set at the local minimal value between 50 and 100. Since the capturing environment is stable and controlled, the threshold value is conveniently fixed in the experiments. Thus, the Binarized image can be obtained.

Fig: Binarized Image

Step 2: Border tracing. After the image-thresholding step, the binary images are traced to obtain the contours of hand shape by making use of the border tracing algorithm. The main purpose of this step is to find the boundary of a hand image and then locate the positions of five fingers for the determination of palm contour. A square region in the palm called ROI will be generated. At the beginning, the first point of hand shape is set at the upper-left point of a hand-shape image. The contour of hand shape is then traced in counter clockwise direction.
Step 3: Wavelet-based segmentation.
Step 4: ROI generation. In this step, we will find the region of interest (abbreviated as ROI) in the palm image which is the operating region both in the enrolment and verification process.

Feature Extraction and Classification Technique

Comparing with image collection and pre-processing, the research of feature extraction and matching is more diverse. Feature extraction algorithms can be classified into five categories, line-based, subspace based, local statistical-based, global statistical-based and coding-based approaches.

Statistical Approach

Statistical approach can be further divided into local and global statistical approaches. Local statistical approach transforms images into another domain and then divides the transformed images into small regions. Local statistics such as means and variances of each small region are calculated and regarded as features. Gabor filters, wavelets and Fourier transforms have been examined. The small regions are commonly square but some of them are elliptical and circular. According to the collected papers, so far, no one investigates high order statistics for this approach. In addition to local statistics, researchers also use global statistics, which are computed from whole transformed images. Moments, centres of gravity and density are considered as the global statistical features.

Subspace-Based Approach

Subspace-based approach involves generally in principal component analysis (PCA), linear discriminant analysis (LDA) and independent component analysis (ICA). The subspace coefficients are considered as features. Various distance measures and classifiers are used to compare the features. In addition to applying PCA, 2D-PCA, $2D^2$-PCA, Kernel PCA, LDA and ICA directly to palmprint images, researchers embed wavelets, discrete cosine transform (DCT) and kernels in their methods. Researchers also develop new subspace algorithms and examine them on palm prints. Generally speaking, subspace-based approach does not make use of any prior knowledge of palm prints.

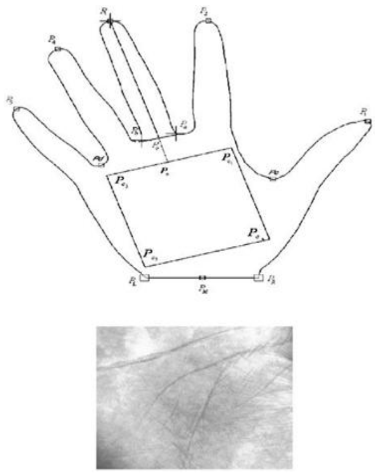


Fig: Illustration of pre-processing. (a) The key points based on finger boundary and (b) the central parts for feature extraction.

Line-Based Approach

A human palm has mainly three principal lines i.e. life line, head line and heart line. Palm lines are obvious features in palm prints. Researchers employ existing edge detection methods and develop edge detectors to extract the palm lines. The extracted palm lines are either matched directly or represented in other formats for effective matching. Although at the beginning of palmprint research, some researchers concentrate on line-based approach, it is not the focus of current palmprint research since it is difficult to accurately extract palm lines from low-resolution palmprint images. There are a number of distinguishable features of the human hand. These features are the size and form of the lines on the palm, the lengths of the fingers in proportion to the palm, the length and mobility of the thumb, the hollowness of the palm, the spread of the digits and the general size and shape of the hand. In particular, the lines on a person's hand, *the palm print,* are unique to every individual; even our own two hands are never quite alike. There are a number of attributes which make the lines on a person's hand distinguishable from the lines on another. These include: color, clarity, and length, position within the palm, continuity and variations in thickness. The starting point of the proposed palm identification system is to extract the main lines of the palm from gray scale images. While the major lines on the palm, known as the life line, head line, and the heart line are the primary target for identification, any significant lines will be used by the system. These lines are then detected (using Hough transform). The lengths of the detected lines as well as the angles between them are then calculated and recorded. In the learning phase of the system, the above information is gathered from authorized users of the system. In the identification phase, images of the palms of all persons wishing to use the system (legitimate and possibly unauthorized) are captured and processed the same way. The extracted lines‟ lengths and inter-angles are compared with those in the data base of the system. Persons with recognized palms are accepted by the system otherwise they are rejected.

Coding Approach

Coding approach encodes filter responses as features. Gabor filters, Sobel filters are commonly applied in this approach. Phase and orientation features have been encoded. The encoding process is to construct a bitwise representation for high speed matching. The high speed matching is performed by bitwise hamming distance or bitwise angular distance. These two bitwise distances are equivalent. Although Wu et al. use the term, *code* to describe their methods

Other Approaches

In addition to the previous approaches, some algorithms are difficult to be classified. These algorithms combine several image-processing methods to extract palmprint features and employ standard classifiers such as neural networks to make the final decision. In addition, Kumar and his co-workers apply correlation filter for palmprint recognition.

Classification

Many existing classifiers including neural networks, hidden Markov models and correlation filters and various measures including cosine measure, weight Euclidean distance, Euclidean distance and hamming distance have been examined. Only limited researchers try to develop special distances or classifiers for palmprint recognition. Bitwise angular distance may be the only one.

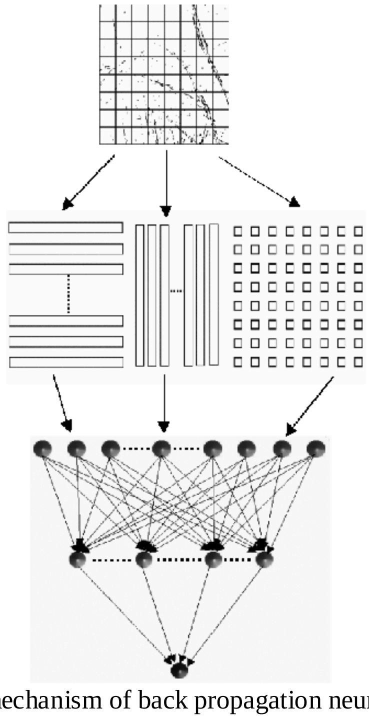


Fig: The mechanism of back propagation neural network

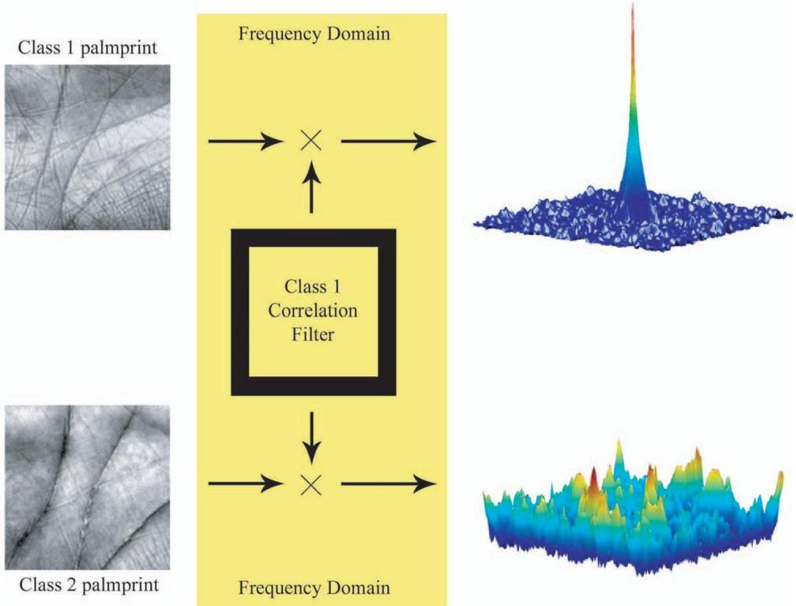


Fig. Applying an advanced correlation filter. The palmprint on top is an authentic exemplar

When filtered with the correlation filter of its class, yields a sharp peak. In contrast, the palmprint below belongs to an imposter, and it yields a plane with lower energy and no unique apparent peak.

IV. CONCLUSIONS

In this, a novel approach is presented to authenticate individuals by using their palm-print features. The hand images are captured from a HP scanner and a camera without any fixed peg. This mechanism is very suitable and comfortable for all users. The proposed system is reliable and user friendly as satisfactory recognition result is provided and convenient acquiring process is offered. The Palm print recognition system has been implemented using subspace methodology. The position and scaling of the palmprint is critical to the success of palmprint template-based approach, and the alignment of the training images is determinant. It has been stressed that the good performance of the palmprint verification method depends on alignment of the palmprint image. The image is first pre-processed (histogram equalized, resized, and thresholded) and Gauss and Sobel filters are used to extract the palm feature like principle lines, ridges, edges etc. so make fit to given to developed algorithm. In the template-matching method, the linear correlation function is adopted as the metric measurement. Using this method, nearly 80% accuracy rate has been achieved.

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