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Texture based palmprint feature extraction and matching using lifting wavelets

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Abstract: Palmprint feature extraction and matching is the measurement of palm feature for identifying a user. Palmprint has geometry features, line features, statistical features, texture features etc. In this work texture features are used since they require only low-resolution images. Right hand images are captured using digital camera. In this work binary hand images are used for determining valley points. Lifting wavelet transform is used to extract the features of palmprint and to obtain the energy. The wavelet energies in different decomposition levels are combined to get the feature vector. The feature matching is performed using Euclidian distance. The proposed method gives an accuracy of 96.41 percent.

Keywords: palmprint features, lifting wavelet, delta points, energy feature, Euclidean distance

1 Introduction

The field of digital image processing deals with methods for processing digital images by means of a digital computer. One of the important areas in digital image processing is authentication using biometrics. Identities can be stolen; passwords can be forgotten or cracked. Two types of characteristics are measured in biometric technology namely, physiological characteristics and behavioral characteristics [1]. Physiological characteristics measure human body parts while behavioral characteristics measure the actions produced by human such as sound, signature, or posture. Behavioral characteristics are more vulnerable to change than the physiological characteristics. This includes features such as iris pattern, retina, palmprint, fingerprint, and face. Palmprint acquisition device costs lesser than the iris scanning device. It is also more acceptable than face recognition system that may cause privacy issues [2].

At present, fingerprint is the most widely used trait of biometrics. Some of the problems posed by its use for identification purposes are mentioned below:

1. The utilization of fingerprints, which are minute in detail, requires very high resolution image, complex imagery setup and increased system memory requirements. This complexity of fingerprint technology can be reduced by the use of palmprint.

2. Because of skin problems or the nature of their work, around 2% of the population is unable to provide clear fingerprint images.

3. Palmprint is harder to imitate than fingerprint.

4. It is quiet useful due to its richness in amount of features.

5. They can be utilized along with fingerprint in the identification of criminals.

This paper deals with utilization of wavelets in the field of palmprint identification.

The palmprint, the large inner surface of a hand, contains many geometry features, line features, statistical features and texture features. The palmprint geometry features are insufficient to identify individuals. This is because geometry features like palm size and palm width are relatively similar for adults. They are usually used in hierarchical palmprint biometric or combined with finger geometry features to form hand geometry biometric system [3].

The palmprint lines feature such things as principal lines, wrinkles, and ridges. The principal lines are major lines available on most of the palm (headline, lifeline and heart line). Wrinkles are coarse line of palmprint. Ridges are fine lines of palmprint. The separation of wrinkles and principal lines is difficult because some wrinkles are as thick as principal lines.

Palmprint features also contain minutiae points or delta points to identify an individual. Low resolution hand image does not have clear points location. Palmprint texture features are usually extracted using transform based methods like Fourier transform, Discrete Cosine Transform (DCT), Discrete Fourier Transform (DFT), and Discrete Wavelet Transform (Haar, Daubechies, etc.)[4-9].

Here we are using *lifting wavelet transforms* which give more accuracy than DWT. The block diagram giving the basic steps is in Figure 1.

2 Hand image acquisition

Hand images are captured using Canon Power Shot SD 780 IS digital camera. The hand images of different users can be taken in front of a uniform dark intensity background. Different hand images of the same user are being used in this work. Digital camera can be connected to computer as the real time acquisition device. Peg-less acquisition is used in

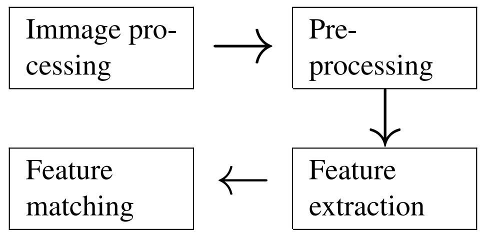

Figure 1: Steps in palmprint recognition

this work. The hand image is usually taken in front of a dark intensity background to ease the image segmentation process. The fingers are required to spread apart and the hand is lean against the background. Images are stored in JPEG format. The acquired hand image is shown in Figure 2.

Figure 2: Acquired hand image

3 Image pre-processing

The image preprocessing steps include obtaining binary hand image, valley point determination, cropping, image enhancement etc. They are described below.

A. **Binary Hand Image**

The hand image will be represented using Red-Green-Blue (RGB) format. Obtaining the binary hand image makes the segmentation between image and the background easy. Thresholding method is used. Thresholding is computationally inexpensive. The background will be represented by black colour and palm will be in white colour.

B. **Valley point determination**

The key points are to be determined. The key point may be the gaps between two fingers or the tips of the fingers. Here we are using the gap between the fingers as the key point. Depending on the row and column value the valley points are determined. The hand image is represented as one and the background as zero. The first valley is the gaps between little finger and ring finger, Key Point 1 (KP1). The third valley in the graph is the gaps between middle finger and index finger, Key Point 2 (KP2). To avoid the valley point between thumb and index finger, only half of the finger width is considered. Distance between two key points, D is calculated using following equation:

$$D = \sqrt{a^2 + b^2}, \quad a = x_1 - x_2, \quad b = y_1 - y_2 \tag{1}$$

where (x_1, y_1) is the key-point KP1 and (x_2, y_2) the key-point KP2 in the image.

C. **ROI selection and cropping**

Region-of-interest (ROI) is determined for cropping of palmprint image from the hand image. Square ROI mask is used in our work. A variable size of mask is created to crop the Region-of-Interest (ROI). By referring to the distance between the two key points, the location of the palmprint area is estimated. The width of the fingers is approximately 0.5 times of D. The length for each side of the square is calculated using equation, length, $L = 1.4 \times D$. Thus the cropped palmprint is extracted. The extracted palmprint image is shown in Figure 3.

Figure 3: Extracted palmprint image

D. **Palmprint enhancement**

Gray scale image and histogram equalized palmprint images are used in this work. Histogram Equalized Palmprint, image gives a better accuracy than gray scale image.

4 Feature extractions

Palmprint image contains various types of features. Since texture features and line features required low resolution image and can distinguish people effectively, these features are utilized in our study. The extracted features are represented in feature vector for easy comparison in later stage. The feature representation must be short but contains vital information that can differentiate different individuals.

Since the palm lines, such as principal lines, wrinkles and ridges can only be acquired in different resolution, multi resolution analysis using Wavelet Transform is proposed. Multi resolution wavelet transform can extract different types of line in different resolution level. First level decomposition allows the extraction of ridges information. When the decomposition level increases, larger palm lines such as wrinkles and principal lines are extracted. Here we are using lifting Haar wavelet transform for feature extraction. Figure 4 and 5 gives the feature extracted image using histogram equalized image and gray scale image respectively. Compared to discrete Haar wavelet transform the lifting method provides better accuracy. One of the features of wavelets that is critical in areas like signal processing and compression is perfect reconstruction. The inverse transform is immediately clear. The wavelet lifting scheme divides the wavelet transform into a set of steps. In classical transforms, including the non-lifted wavelet transforms, the wavelet coefficients are assumed to be floating point numbers. In the lifting scheme it is however rather easy to maintain integer data, although the dynamic range of the data might increase.

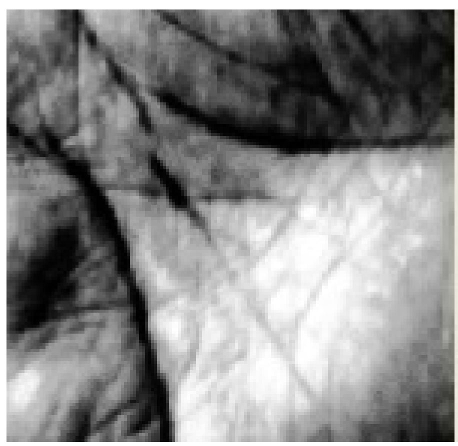

Figure 4: Feature Extraction using histogram equalized method

The enhanced image is decomposed into six level of Haar Wavelet decomposition. They are horizontal (H), vertical (V), diagonal (D) or approximation(A) details coefficients. For every set, the wavelet coefficient image is separated into 4×4 blocks. We are using only the detail coefficients to find out the energy feature. The frequency components give the energy information. For every coefficient blocks, the wavelet coefficients are squared and

Figure 5: Feature Extraction using gray scale image

summed to obtain its energy value.

The energy feature is obtained by the equation

$$\text{Energy} = \sum_{x=1}^{X}\sum_{y=1}^{Y}(\text{Coeff}_{xy})^2 \tag{2}$$

where $X \times Y$ is size of the block. This can be determined for different levels of decomposition.

The wavelet energies in different decomposition levels are combined to get the feature vector.

5 Feature matching

For feature matching, similarity measurement is used in this work. In similarity measurement, the likeliness between two feature vectors is calculated. One of the similarity measurements are Euclidean distance. Euclidean distance calculates the summation of squared differences between two feature vectors. The general equation for Euclidean distance is given by

$$\text{Euclidean distance} = \sqrt{\sum_{i=0}^{L}(\text{FV}_{1,l} - \text{FV}_{2,l})^2}. \tag{3}$$

Here, FV shows the feature vectors of different individuals and L is length of feature vector.

6 Results

The acquired hand images are False Acceptance Rate (FAR) which is the percentage of wrongly accepted individuals over the total number of wrong matching. False Rejection Rate (FRR) is the percentage for number of wrongly rejected individuals over the total number of correct matching. The accuracy is calculated as follows:

$$\text{Accuracy} = \left(1 - \left(\frac{\text{FAR} + \text{FRR}}{2}\right)\right) \times 100\% \quad (4)$$

From our experiments we got the following results. The accuracy of different methods are shown in Table 1.

Feature extraction method	**Gray scale image**	**Histogram equalised image**
Haar Wavelet	93.4	95.2
Lifting Wavelet	94.5	96.41

Table 1: Accuracy for different methods

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