Hand Image Feature for Human Identification

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Abstract. This paper presents an algorithm for efficient personal identification using robust hand features. The feature is extracted from hand boundary points and print of hand palm. The centre of gravity of the edge map of the hand image is determined to serve as a reference point. Thereafter City block distances between the reference point and hand boundary points are found. These distance feature vectors are compared using Euclidean distance measure for effective image classification. The proposed algorithm will improve personal identification in access control and attendance record.

1. Introduction

Hand is one the physical parts of human body. Human hand has many parts; these include fingers, palm, dorsal and nails. The arrangement of fingers on the palm region of hand called hand geometry is a good biometric feature that can be used for human identification. Hand geometry is one of the physiological biometric trait commonly use. The usefulness of any biometric trait depends majorly on the area of application and user acceptability [1]. Among biometric traits, hand features are very rich and easy to acquire for different applications such as access control and attendance purpose. Human identification using hand geometry is a biometric technology that involves the analysis and processing of hand image for classification process.

Extraction of robust invariant features from biometric source poses serious challenges to researchers in this area of study. Many researchers have developed different feature extraction techniques for hand geometry recognition systems. In [2] twelve hand geometry features were extracted, four features are obtained using finger lengths, eight features are obtained from finger width. Also in [3] algorithm hand geometry system is proposed where three set of feature reference points from hand are established, the reference points are the tips of fingers, finger valley and centre life of the hand. Feature triangles are formed by obtaining the distances between these reference points.

Furthermore [4] presented a contact free hand biometric system for real environments, geometrical features are obtained from binary images, and three independent feature vectors are formed from the index, middle and ring fingers. Each finger is characterized as a triangle. The three vertexes of the triangle are the end and the two side valleys of the finger. Also in [5] feature vector is formed by finding the Euclidean distance between hand valleys points to the major axis of each of the finger. Kullback-Leibler distance is used to compare histogram distribution between a test finger and the template one. In [6] classification of users is done using the features extracted from hand contour and palm-print region of interest. Five valley points and four peak points are detected from the hand contour. These points serve as reference points to measure the length, width and height of the fingers. These points were also used to crop palm print area of interest. Fusion of hand and palm image processing was done at decision level. Lastly in [7] three features called eigenpalm, eigenfinger and eigenthub are extracted from hand image.

The feature extraction techniques used in many hand geometry recognition systems have some limitations that makes it difficult for them to recognize people effectively. Some of the previous techniques produce weak feature from hand contour only good for recognizing guided hand. In order to overcome the deficiencies arising from most previous systems a robust hand recognition system that incorporates feature from fingers and palm area of the hand is proposed. The robust feature is extracted from an unguided hand image. The features are the distances between hand boundary point and center of gravity of the preprocessed image.

This paper is organized into six sections. Following an introduction of the topic in section 1, section2 describes the proposed system, data acquisition procedure and image preprocessing. Section 3 introduces the feature extraction method; training strategy is discussed in section 4; section 5 describes verification process and finally, conclusion is presented in section 6.

2. System Description and Input Image

The hand geometry recognition algorithm proposed in this study is basically divided into five stages. The first stage deals with collection of hand images followed by preprocessing at the second stage. The robust feature extraction process is done in the third stage. The fourth stage describes the training process where the aim is to obtain the user's hand templates. And the final stage describes the hand classification process using the test hand image and the user's hand template.

2.1 Input Image

Hand images were collected from 10 people, each person contributed six hand image samples. Users freely placed their hand on the scanner surface for image collection. Hand images were obtained at 150 dpi.

2.2 Preprocessing

Hand image preprocessing is done by performed filtering and canny edge detection. Example of the output image from the filtering stage is as shown in Fig. 1 and Fig.2 shows output from canny edge detection method. The preprocessed hand image majorly captures the distinct principle lines and wrinkles on the foreground of the palm within the hand boundary.

Fig. 1 Filtered hand image Fig. 2 Edge detected hand image

2.3 Feature Extraction Technique

In this work a new feature extraction technique using hand boundary and palm-print pattern is presented. Our method is different and more robust than the previous methods. In [5] only the distances between finger valley points and finger major axis are used in each finger to form feature vector. In this work the centre of gravity of each edge detected hand image is calculated and used as the reference point. Robust distance feature is extracted from all pixel points in the hand boundary in respect to the reference point. The reference point for each image is unique and different from others and this point can be at any coordinate points with the image space. The extracted feature is able to capture invariant hand shape characteristics. The feature extraction algorithm is stated as follows:

i. Calculate the center of gravity of the preprocessed hand image using Eq.1.

$$\bar{x} = \frac{1}{N}\sum_{i=1}^{N} x(i),$$

$$\bar{y} = \frac{1}{N}\sum_{j=1}^{N} y(j). \quad (1)$$

ii. Calculate the distance between the reference point (center of gravity) and all the pixel points of hand boundary using city block distance

The city-block distance (d_c) between reference point p and pixel q is defined as:

$$d_c\,(p,q) = |\, x_p - x_q \,| + |\, y_p - y_q \,| \quad (2)$$

Fig.3 illustrates the method used to obtain the distance between the two points.

iii. The feature vector for each image is obtained using 200 quantified values as in Eq.3.

$$H = h_1, h_2, h_3, h_4, h_5 \text{ -------------}, h_{198}, h_{199}, h_{200}\ . \quad (3)$$

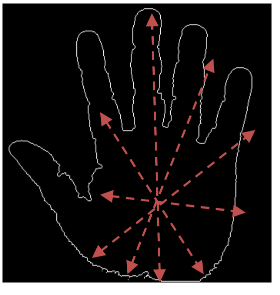

Fig. 3 Distance measurement

2.4 Hand Image Model

In the training stage, each subject feature template is established independently based on feature vectors of four images from each of the subjects. Given that four training samples are represented as H_1, H_2, H_3 and H_4 the corresponding feature vector element of each is represented as h_1, h_2, h_3 h_{200}. As given in Eq. 4.

$$H_1 = [h_{1,1}, h_{1,2}, h_{1,3}, \ldots\ldots\ldots, h_{1,200}]$$

$$H_2 = [h_{2,1}, h_{2,2}, h_{2,3}, \ldots\ldots\ldots, h_{2,200}]$$

$$H_3 = [h_{3,1}, h_{3,2}, h_{3,3}, \ldots\ldots\ldots, h_{3,200}]$$

$$H_4 = [h_{4,1}, h_{4,2}, h_{4,3}, \ldots\ldots\ldots, h_{4,200}] \quad (4)$$

The template feature vector of each of the subject is obtained by finding the mean values (h_{mean}) of each corresponding feature vector elements. Therefore the feature model for each of the subject is represented by Eq. 5.

$$H_f = [h_{mean,1}, h_{mean,2}, \ldots\ldots\ldots\ldots h_{mean,200}] \quad (5)$$

2.5 Verification Result

Euclidean distance measure is an effective classifier used to obtain minimum distance between the test subject feature vector and all the subject template feature vectors of equal dimension [8, 9 10]. In this work the minimum distance (d) between the test image feature vector and each of the template feature vector (H_f) of the all subjects in the database is calculated using Euclidean distance measure as in Eq. 6.

$$(d) = \sqrt{\sum_{f=1}^{200}(H_f - T_f)} \qquad (6)$$

The best similarity score between the test feature (T_f) and template feature (H_f) is based on the lowest minimum distance. High similarity score is obtained between the test feature and template feature belong to the same subject. Fig. 4, 5 and 6 show the examples of stem feature plot of some tested hand images.

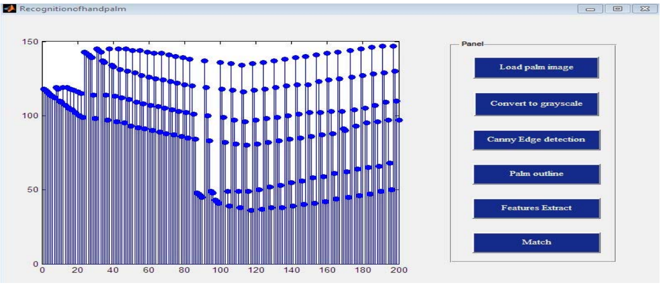

Fig. 4 First test feature plot

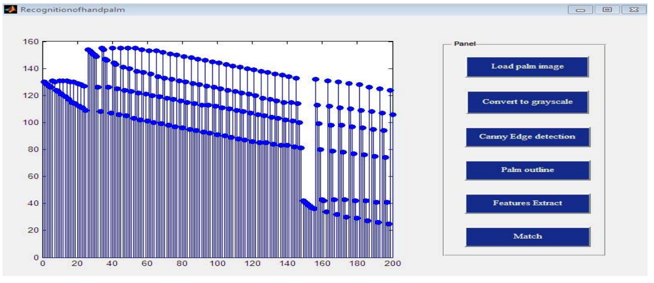

Fig. 5 Second test feature plot

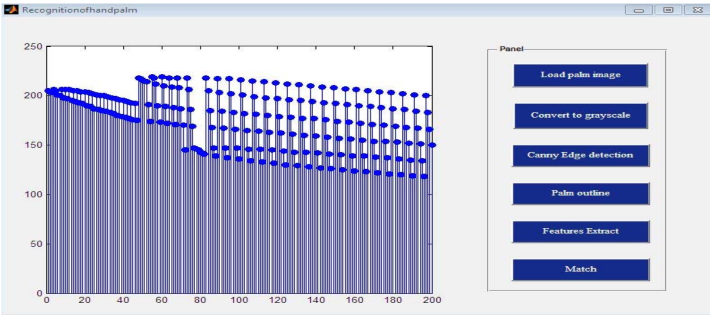

Fig. 6 Third test feature plot

3. Conclusion

Efficient personal identification technique is needed in order to increase security in access control and attendance record. Invariant hand feature is extracted from all accessible hand patterns. The extracted hand features are tested using Euclidean distance classifier. The proposed human identification method is robust enough to reduce the effect of impostor for different applications.

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