A Single-Sensor Hand Geometry and Palmprint Verification System

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Abstract - Several contributions have shown that fusion of decisions or scores obtained from various single-modal biometrics often enhances the overall system performance. Biometric system is becoming increasingly important, since they provide more reliable and efficient means of identity verification. The physical dimensions of a human hand contain information that is capable of authenticating the identity of an individual. The proposed system is a verification system which utilizes these hand geometry features for user authentication and also uses a scanner as sole sensor to obtain the hands images. The hand geometry verification system performs the feature extraction to obtain the fingers and palm. The region of interest (ROI) is detected and cropped which is uses by palmprint. This ROI acts as the base for palmprint feature extraction by using Linear Discriminant Analysis (LDA). The matching scores use in the algorithms namely sum rule, weighted sum rule and Support Vector Machine (SVM). The results of the fusion algorithms of palm and hand geometry classifiers. Fusion using SVM with Radial Basis Function (RBF) kernel .Biometric user recognition system based on hand geometry. The goal of a biometric verification system consists in deciding whether two characteristics belong to the same person or not.

Index Terms - Biometrics system, retrieval, identification, Multimodal biometric, fusion, palmprint, hand geometry.

1. INTRODUCTION

The advances in biometric technology have led to the very rapid growth in identity authentication presents an approach to personal identification using hand geometry. Hand geometry based biometric systems are gaining acceptance in low to medium security applications Here we attempts to scientifically develop a comprehensive set of hand geometry features and develop an original algorithm from a fundamental level to robustly compute a selected set of features so as to minimize palm placement effect. These systems are only capable to provide that the low to middle range of security feature is provided. So for higher security feature, the combination of two or more single-modal biometrics is also known as multimodal biometrics is required in the system. In addition, the industry is currently exploring the multimodal biometric which is reliable and able to provide high security features, non-intrusive and widely accepted. Multimodal biometrics has significant functional advantages through over the single biometrics, we consider the example, elimination of False Acceptance Rate (FAR) means that (by adjusting FAR=0%) without suffering from increase occurrence of FRR. It is difficult to obtain both FAR and FRR to be equal to zero in a single-modal for the measurement space. The biometrics industry are security issues relating to choosing the lowest FAR with the FRR. They causes high FRR and results in the increase of rejection of valid users. In the usability and public acceptance of the biometrics system and also both aspects are significant obstacles to the wide deployment of the biometric technology. Wang et al. [1] uses both the combination of face biometrics and iris biometrics for identity verification using RBF neural network fusion has produced higher verification accuracy. The hybrid biometric authentication system [2] using vector abstraction scheme which is the VAS and learning-based classifiers to fuse voice and face vectors has significantly reduced the FAR and FRR. Work in [3] has integration of palm print and hand geometry by using fusion. A multimodal person verification system proposed by Kittler et. al. [4] using three experts which are the frontal face profile, and voice. The best results are obtained by applying in the sum rule. A bi-modal biometric verification system based on hand geometry and palmprint modalities. This system uses natural fusion approach as both of the biometric features from the same part. Unlike the other multimodal biometric system that required in the multiple input devices [5],

only a image capturing device is needed in system. With this, the users do not need to go through the inconvenience. They can be shielded completely from the complexity of multimodal system.

In this Paper, an optical scanner is selected instead of a CCD camera as the input single sensor model. This is due to the reason that the scanner is able to provide the better quality images, than the CCD camera. And also it is not easily affected by lighting factors. In the word of cost, the scanner is much cheaper than a high resolution of the CCD camera. Another advantage of the scanner is that, it is appeared with a flat glass which enables the user to flatten their palm properly on the glass. To reduce bended palm ridges and wrinkles errors.

The proposed system does not need any pegs on the scanner to fix the position of the user's hand system. In that there is another special feature about the system which is that the size of the image captured is not fixed. But we have to vary proportionally to the actual size of the user's hands. In [6, 7, 8, 9], each captured image must adhere to the predetermine size, and also this has few limitations. When there is a small predetermined size is used, then some hand information will be lost; when a large predetermined size is used, some of them is use the much space will be wasted thus increase the computational load in system. The later problem is that particularly apparent in the case of acquiring children's hand is also vary. Therefore, the proposed system is overcomes some problem by allowing the image acquired to varies according to the actual user hand's size system.

This paper is organized as follows: In the proposed system introduces the framework. The extraction of individual hand geometry and palmprint system is image extraction and feature extraction respectively.

2. PROPOSED SYSTEM

The proposed system combines two biometric modalities, as palmprint verification system and hand geometry verification system both are used. Only one hand image is captured during the image acquiring process. The system of palmprint and hand geometry features are equally extracted using the same hand image. The Euclidean distance classifier is used to classify both individual hand geometry images and palmprint features extraction. Sum rule, weighted sum rule and SVM are used as decision level fusions to the matching scores obtained from the hand geometry image and palmprint extraction individual classifiers.

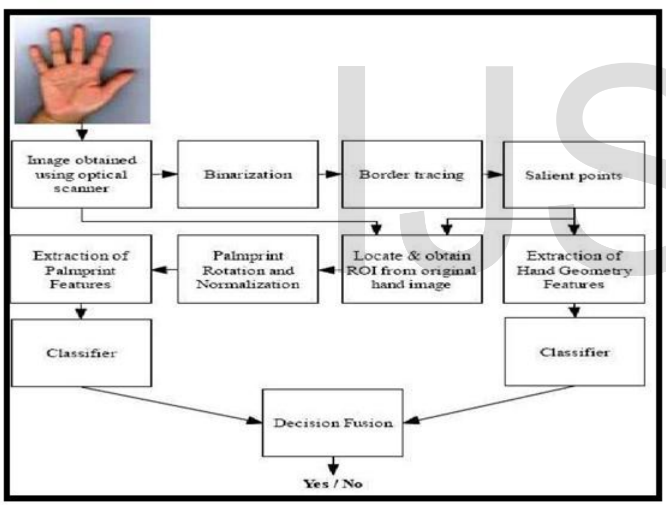

Figure 1:- Automated Hand Geometry and Palmprint Verification System framework

3. IMAGE EXTRACTION

During the image acquiring process, the users or a person are required to stretch their fingers and put their palm straight on the platform of the single- model scanner. The hand images acquired is in 256 RGB colors (8 bits per channel) format. The three color components are important in the pre-processing of the automated stage as it can distinguish the background, finger nails, rings and shadow from the hand image. This clear the distinction helps to trace the hand image more accurately and reliably.

3.1 Extraction of salient points

The hand image acquired from the optical scanner is binarized by using thresholding method [10] to filter the background of the hand or palm and shadow from the image. The border tracing algorithm [11] is used to obtain all the vertical coordinates of the border pixels that represent the signature of the hand contour, $f(i)$ where i is the array index. The hand contour signature is then blocked into no overlapping frames of 10 samples to check for existence of stationary points in each frame, a predefined threshold, Ts = 25. There are nine salient points with five valleys and four peaks which are see Figure. 2 which represent the tips and roots of the fingers are detected respectively. So these nine salient points serves as the reference points to measure the length, width and height of the fingers and palm, and also used to detect ROI. IT-based services in terms of a typical value chain, as shown in

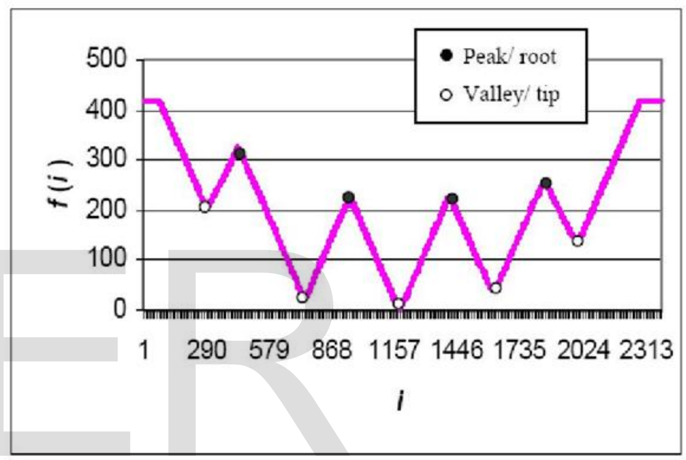

Figure 2:- Hand contour signature plot against index.

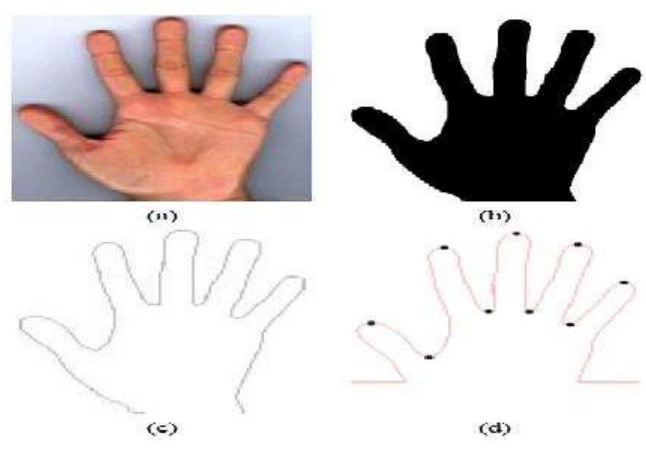

Figure 3:- Salient point detection process, (a) Original hand image acquired scanner (b) binarized image (c) hand contour (d) nine salient point that represents the tips and roots of the fingers.

3.2 Extraction of ROI

For the palmprint verification system, the ROI is located based on the salient points by using right-angle side coordination system [12]. After the obtaining the outline of the ROI, the image is cropped and rotated which are see Figure 4. As the size of ROI varies from hand to hand (depending on the width of the hand), there is a need to resize all of them to a fixed size. In this paper, the ROIs are resized to200 x 200 pixels.

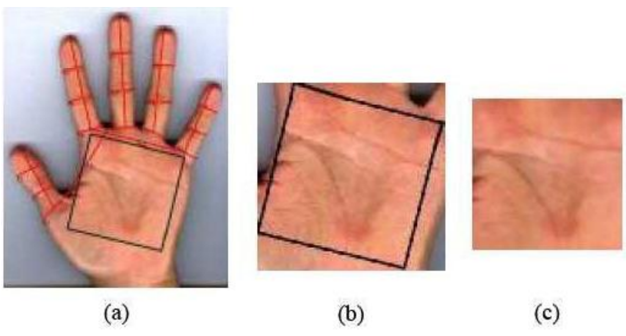

Figure 4:- ROI extraction process (a) ROI detection based on salient points (b) ROI crop (c) rotation and normalization.

4. FEATURE EXTRACTION

4.1 The extraction of hand geometry features

Figure 5:- Hand geometry features.

Based on the salient points obtained, a automated hand geometry features measurement in the technique proposed in [10] is used to extract the finger lengths, widths and the relative location of the crucial features in the hand like knuckles and other joints which are as shown in Figure 5. These hand geometric features are important in order to construct a unique pattern for each person. The measuring process generates some of the feature vector that is an array consists of *N* feature of the hand and the palm values as shown in equation 1.

$N=5g+7$ (1)

Where g is the number of segment that is set for each finger and in the equation 7 there is the number of features that are obtained from the height of the fingers and width of the palm. Illustration for the, Figure 5 depicts the case where $g = 3$ yield $N = 22$ features.

4.2 Extraction of palmprint features

In that the palmprint extraction module in this system, Linear Discriminant Analysis, and also known as Fisher Discriminant Analysis (FDA), the equation [13] is used to extract the important palmprint feature from the hand images. FDA maximizes the ratio of between the class scatter to that of within the class scatter. In other words, the images of the same class are close to each other while images of different classes are far apart in that. The basis vectors calculated by Fisher Discriminant analysis to create the Fisher Discriminant subspace, which is also called Fisherpalms. More formally, consider a set of M palmprint images having c classes of images, with each class containing n set images, i_1, i_2 , i_n. The mean of images in each class and the total mean of all images be represented by mc and m, respectively, the images in each class are centered as

$$\phi_n^c = i_n^c - \widetilde{m}_c \quad (2)$$

and the class mean is centered as

$$\omega_c = \widetilde{m}_c - m \quad (3)$$

The centered images are then combined side by side into a data matrix. When by using some data matrix, an orthonormal basis U is
obtained by calculating the full sets of eigenvectors of the
covariance matrix $\phi_n^{cT}\tilde{\phi}_n^c$ the centered images are then projected into this orthonormal basis as follow

$$\widehat{\phi_n^c} = U^T \phi_n^c \quad (4)$$

The centered means are also projected into the
orthonormal basis As

$$\widehat{\omega}_c = U^T \omega_c \quad (5)$$

Based on this information, the within class scatter
matrix S_w is calculated as

$$S_W = \sum_{j=1}^{c} \sum_{k=1}^{n_j} \widehat{\phi_k^j} \widehat{\phi_k^j}^T \quad (6)$$

and the between class scatter matrix S_B is calculated as

$$S_B = \sum_{j=1}^{C} n_j \widetilde{\omega}_j \widetilde{\omega}_j^T \quad (7)$$

The generalized eigenvectors v and eigenvalues of
the within class and between class scatter matrix are
solved as follow:

$$S_B V = \lambda S_W V \quad (8)$$

The eigenvectors are sorted according to their associated eigenvalues. The first *M-1* eigenvectors are kept as the Fisher basis

vectors. The rotated images, $_M$where $_M$ $T\,M = U^{\,T} i_M$ is projected into the orthonormal basis by

$$\varpi_{nj} = U^T \alpha_j \qquad (9)$$

Where $n = 1, \ldots, M$ and $j=1, \ldots, M-1$.

The weight obtained forms a vector $\Omega_n = [\varpi_{n1}, \varpi_{n2}, \ldots, \varpi_{nM-1}]$ that describes the contribution of each fisherpalm in representing the input palmprint image, treating fisherpalms as a basis set for palm images.

5. FUSION STRATEGIES

In that the fusion strategies to decision level fusion is selected over feature fusion because matching scores has the lowest data complexity and fusion at decisions level often achieves better overall authentication performance. In the proposed system, when we adopt the SVM as it is a type of machine learning technique that learns the decision surface to separate the two classes of genuine and imposters through the process of discrimination. It also has good generalization characteristics and to proved to be a successful classifier on several classical pattern recognition problems. Two other combined classifiers, such that the sum rule and weighted sum rule are used to compare with the proposed fusion method.

5.1 Sum Rule

The summation of both single-modals and also multi-model metrics are classifiers matching score or distance is calculated as

$$S = P_{ms} + H_{ms} \qquad \textbf{(10)}$$

Where P_{ms} and H_{ms} represents the matching score of palmprint extraction and hand geometry images respectively and output the class with the smallest value of the S.

5.2 Weighted Sum Rule

There exists different classifiers with different performance, thus weights can be formed to combines the individual to classifiers. So there is only two single-modal biometrics used in our system, the weighted sum S_w can be formed as

$$S_w = wP_{ms} + (1-w)H_{ms} \qquad \textbf{(11)}$$

Where w is the weight that fall within 0 to 1.

5.3 Support Vector Machine

The vector machine of classification problems in the proposed system can be restricted to two class problem some are genuine and imposter without losses of generality. The goal of using SVM is to separate those two classes by hyper planes, which gives the maximum margin [18]. To support the vectors are determined through numerical optimization during the training phase.

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