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A New Method for Recognizing People: Based on a Fusion of Face and Palm Print

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ABSTRACT

This study uses a new method of fusion of face and palm print to recognize a person. In biometrical aspect, three information phases are suggested for fusion plan: Feature Extraction phase, Result Match phase, and decision-making phase. This article deals with the fusion plan phases. The purpose of this study is to investigate whether the biometric fusion of face and print palm will be able to offer a more desirable performance than single biometric. Both Principle Component Analysis (PCA) and Independent Component Analysis (ICA) will be demonstrated in biometric vector. Then, the results of the combined biometric will be compared with the results of face and print palm. The operation showed a remarkable progress in both cases, especially for the biometric feature in ICA, where the remarkable result of 99.17 % was obtained for the accuracy of the recognition by a test carried out on 40 subjects.

KEY WORDS: Palm, Face Biometric, ORL Database, ICA Method, PCA Method

1. INTRODUCTION

Biometrics automatically deals with the recognition of people based on their specific physiology or behavioral characteristics. It widely states that biometrics is mostly concerned with the recognition of people rather than their particular wealth and knowledge [1]. Unlike the project of individual wealth and knowledge recognition, the biometric recognition is not forgotten, can't be guessed or easily forged. Despite these intrinsic advantages, the wide application of biometric-based individual recognition is impeded due to some reasons: first, it can't be satisfactorily used in some areas, e.g. face recognition. The accuracy of face recognition by light, face expression and gesture will intervene [2]. Second, the biometric system can't ignore fraud. Third, some people are not able to provide the required independent biometric related to illness, inability, etc.

Some of these problems can be solved to some extent by the fusion of several controversial biometric ways. A considerable deal of biometric system works has been reported in the literature. Rose and Jane [3] embodied the fusion information base in the biometrics and offered the results for the experiments of combining face, fingerprint, and palm print biometrics at the phase of result match. Hung and Jane [4] have integrated the image of fingerprint and face to recognize an individual. Wang et al combined iris and face for individual authentication [5]. Kommer et al suggested a new approach for individual authentication of palm and face biometric which is based on appearance biometric [6]. The results of the comparison is the fusion of ear and face shape based on biometrics.

The main purpose of this study was to suggest a new method of multiple biometric using faces and palm print to recognize people, which are assumed to be different by the authors at the decision-making phase of biometrics. To authenticate the user, we will use neural network. The recognition of face is good and non-invasive; however, today the validity of people recognition using their face is less than what the researchers are dealing with concerning the issues of expression, light, direction and gesture [2]. The recognition of palm is more or less a new branch in biometric technology for the operation results, compared to fingerprint recognition [8]. The interested person should be collaborative and should have specific learning tools. In this article, biometric operation deals with the analysis and comparison of feature extraction phase and face and the classification of palm print.

Researchers have found that the performance has improved in both areas, and especially in the phase of ICA application fusion feature. In a test carried out on 40 subjects, the remarkable results should 99.17% accuracy for the

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recognition. The acquired results strongly support the multiple biometrics (palm print and face) as having a better efficiency than single biometrics.

Later in this article, section 2 deals with the expression of details for extraction feature from PCA and ICA, both the features of face and those of palm print. Section 3 explains the fusion feature extraction phase in PCA and ICA. And section 4 explains the database and the performed tests as well as the research result.

2. Feature Extraction Using PCA and ICA

2-1- Feature Extraction Using PCA [9]

Assume that the educational samples of biometric images include $x_1, x_2,\ldots, x_M$, where M is the number of images in the educational collection. The average of the training images collection is defined by $\mu = \frac{1}{M}\sum_{i=1}^{N} x_i$ the difference between image and image average is expressed as $\mathbf{T_i = X_i \_ \mu}$ and Matrix $\{x_i\}$ is expressed as follows:

(1) $$C = \frac{1}{M}\sum_{i=1}^{N}(x_i - \mu)(X_I - \mu)^T = \frac{1}{M} XX^T$$

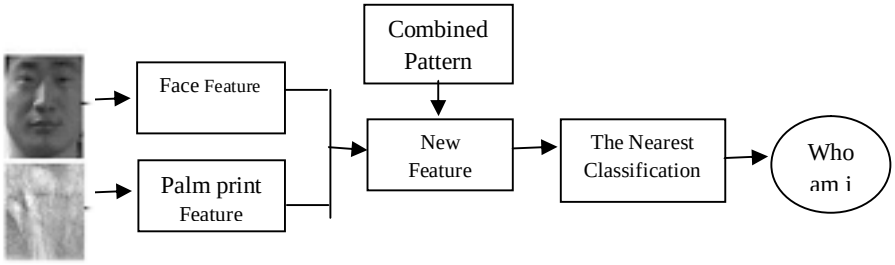

Figure1. Binary Biometric Fusion System in Feature Extraction Phase

And Matrix equals X = [T_1, T_2… T_M]. Matrix *C* includes algebraic descriptor space and provides approximation for educational samples in mean square error. The following relation is appropriated for Matrix *C*.

(2) $$C_{\mu K} = \lambda_{K\mu K}(K = 1,2,..., M)$$

μk refers to the descriptor Matrix *C*, and λ_K is related to value of the descriptor of Matrix *C*. PCA theory states that there is no need to select all the descriptor vector as a basic vector. The descriptor vector that matches the largest descriptor value can well be stated as the indicator of educational collection. Descriptor vector of **μk** that is linked with the largest descriptor value is selected as the page element or pal characteristic (U= {μk, k=1, 2… M ´}) The descriptor vector that may include the dimensional sub-space for all possible images for **M** ´. A new image with its descriptor space is changed to the following activity:

(3) $$P_i = U^T(X_i - \mu)(i = 1,2,..., M)$$

2-2- Feature Extraction Using ICA

After being vertically fused with the unknown matrix of X=AS, ICA was first meant to solve resource separation problems and to detect free resources signals (such as different sounds, music or resource interference).

In the biometric content, the educational images are illustrated by variable X. Assume the $X'i$ Is a biometric image, then the educational images collection can be expressed as $x_1', x_2', ..., x_m'$, where *m* is a random variable, a variable that is thought to be a linear combination of *n* unknown independent elements (IC_s) that refers to $S_1', S'x_2, ..., S_m'$ *i* is always shown as **i =1,2 .... M** And image $\mathbf{x'_i}$ and independent components of $\mathbf{s'_i}$ are converted to vector X_i and S_i like a chain, and they are expressed as $\mathbf{x=(\ x_1, x_2, \ldots, x_m\ )^T}$ and $\mathbf{S=(\ s_1, s_2, \ldots, s_n\ )^T}$ respectively. Note that the relations *X* and *S* are formed as X=AS. Then $\mathbf{S=(s_1, s_2, \ldots, s_n)^T}$ is drawn for the image of each palm print as a non-orthogonal linear and coordinated system. Row A illustrates the features.

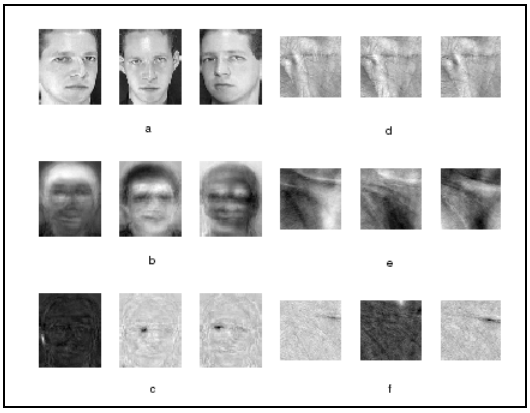

Figure2. (a) Three face images from the first person; (b) three descriptor values for face image; (c) three IC of face image; (d) three images matching the palm print; (e) three descriptor value from palm print image; (f) three IC of palm print images.

And s_i is i feature factor in an X data vector. And here the method of [8] is applied.
Unlikely, PCA and ICA does not provide the internal order for ICs. We adopted the minimization method of the relation $r = \sigma_{between} / \sigma_{within}$
In the variables of the between class to internal class [13] in order to achieve the ICs order, where $\sigma_{between}$ equals $\sigma_{between} = \sum_i (\bar{x}_j - \bar{x})^2$ that is the variance for the between class of *J*, internal σ equals $\sigma_{within} = \sum_j \sum_i (x_{ij} - \bar{x})^2$ in the set of the variances for every class.

3. Extraction Feature Fusion Phase Using PCA and ICA

Out of different appearance-based face recognition algorithms, the operations of [5], [6], [9] are the most popular ones. The recognition of palm print is one of the relatively newest branches of biometric technology and the most popular operations based on algebraic characteristics in examples [8].

For more details of fusion in the feature extraction phase, see the explanation in [3]. Figure 1 shows bimodal biometric fusion system at feature extraction phase. First, PCA is analyzed and them ICA, so that we will be able to finish the fusion at extraction phase. Assume that $a_i = \{a_{i1}, a_{i2}, ..., a_{ik}\}$ is the feature of *i*s for an individual at the extracted PCA and $p_i = \{p_{i1}, p_{i2}, ..., p_{iL}\}$ is the feature of palm print of *i*s for an individual at the extracted PCA. Now, we combine face features vector and palm print feature vector to form the fusion feature vector of $f_i = \{a_{i1}, a_{i2}, ...a_{ik}, p_{i1}, p_{i2}, ...p_{iL}\}$ then, the recognition of an individual in the next feature (K+L) is done by the closest similar classification (concept of principle L2). The fusion of feature extraction phase can be easily summarized using ICA.

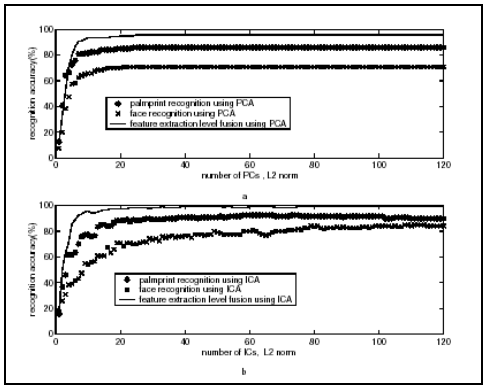

Figure3. (a) The comparison between the Fusion Feature Phase of individual's face and pal print classification using PCA; (b) and the comparison between the Fusion Feature Phase of individual's face and pal print classification using ICA

4- TEST RESULTS

4-1- Database

The face images used in this article were downloaded from ORL database (http://www.uk.research.att.com/facedatabase.html). This database includes 40 subjects and 400 images. Σ of the image was selected randomly in our experiments. Figure 2a illustrates 3 images from the first individual. Database of palm print images is not available to all. Palm print of 300 persons were collected using palm print capture tool that includes the sources of ring, CCD camera, Lens, image digitizer and A/D converter. Every individual should have prepared image σ from the left palm that matched ORL database. We selected only 40 images out of 240 different images. See the second image, for instance (for more details of main preprocessing procedure) [8].

Obviously, database of ORL for face is not like that of palm print. We allocated a group of arbitrary (but fused) palm prints for every face image. Then, we obtained the database for 40 persons by image σ of the palm print in every individual.

4-2- Experiments in the Analysis of Fusion Data Collection

All fusion databases are classified under two categories. Three face images are used based on the palm print image for every individual so that the data will be prepared for the tests. The recognition of face can be defined as the proportion between the numbers of the identified individuals to the whole number of individuals in the experiment collection. We will use PCA for the feature extraction for face image and palm print image and then we will use ICA. Figure 2b shows three features of face and figure 2c shows three ICs for the face image and figure 2e shows three features of palm print and figure 2f shows three ICs for three palm print images.

Figure 3a deals with the comparison between the fusion feature phase and independent classification of palm print ad face using PCA. It can be observed that independent face classification (PCA) obtains 70.83% (that is possible to be relatively obtained from the difference between educational faces and experimental faces because they are selected averagely from 6 to ten and they are randomly classified into two categories). Independent classification of palm print (PCA) is 85.83% and the fusion of feature extraction phase using PCA shows a 95.83% improvement of accuracy.

Figure 3b shows the comparison between fusion feature phase and independent classification of palm print and face using ICA. It can be observed that independent classification of face and palm print fusion yields 85.00% and 92.50%. Therefore, when fusion feature extraction phase is combined with the fusion system, an approximately complete result is yielded. The accurate recognition of 99.17% is promising. When the performance of system is comparable to that of individuals, the fusion system performance will be improved. When the performances are nearly the same, it will enjoy a remarkable improvement. Also, SVM classification was tested instead of the nearest similar classification, but the results were not as satisfactory as expected.

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