International Journal of Natural and Engineering Sciences 6 (3) : 7-10, 2012
ISSN: 1307-1149, E-ISSN: 2146-0086, www.nobel.gen.tr

An Authentication Method Based on The Hands Scheme

Sobhan ROSHANI[1]* Amir FARAMARZI[2] Saeed ROSHANI[1] Hossein ROSHANI[3] Farzin SHAMMA[4]

[1] Islamic Azad University, Kermanshah Branch, Kermanshah, IRAN

[2] Computer Dept, Eng. Faculty, RaziUniversity, Kermanshah, IRAN

[3] Amirkabir University of Technology, Tehran, IRAN

[4] Razi University, Kermanshah, IRAN

***Corresponding Author**

e-mail: sobhan_roshany@yahoo.ca

Received : February 04, 2012
Accepted : March 11, 2012

Abstract

Back of the hand scheme, fingers skin lines and nails structure can be used as new parameters of biometric features for human identification in high accuracy. In this paper, a new method for extracting unique features from back of the hand, fingers wrinkle and nails structure has been presented. At first fingers skin pattern and nails pattern which has been obtained by the edge operators are added to back of the hand scheme with multiplayer effect. Then basic data have been obtained from back of the hand's image according to characteristics of PCA filter. Identification and authentication in this method have been based on three main processes: separation, feature extraction and feature matching. Initially, we separate back of the hand area from the background completely by pre-processing of the image. In next step that is the most important step in the process, the appropriate features for identification are extracting. The results of the proposed method show the proper performance of this new method of extracting features for human identification.

Keywords: authentication, edge detection, image processing, PCA

INTRODUCTION

In recent years authentication with computer is significantly useful in many fields such as security, networks, electronic payment and, etc. recently, using the biometric features of people have become more important. Biometric authentication verifying systems include automatic methods for identifying people based on fingerprint, face, iris pattern, voice and behavioral characteristics [1].

Geometrical features of hands, back of the hands and fingers have many advantages compared with other biometric features such as voice and face that there is doubt to their Individuality [2, 3]. Also finger print and iris pattern technique need high resolution images (more than 400 dpi).

For capturing an image from back of the hand or fingers skin, there is no need to any extra equipment and low resolution image (100dpi) is sufficient for extracting data. In this paper a new method based on PCA filter, has been proposed to process the extracting data that is the main step in identifying systems based on the biometric features. Principal component analysis is a statistical technique that is suitable for searching pattern in a large scale of data. In this process called EAPCA, edge operators are used to increase the influence of fingers skin lines and nails pattern on the back of the hand's scheme [7, 8]. Identifying based on back of the hands scheme, fingers skin lines and nails pattern include three main processes that are listed below.

Extracting the back of the hand's scheme from the background

Extracting the features

Adapting the features

In the first step, initially a pre-processing is preformed to correct distortion and to eliminate noises in image, then the hands area is extracted from background by thresholding.

In second section, the used image database and pre-processing on image are briefly explained. In third section feature extracting using PCA method and it's optimizing, are described. Obtained results from the proposed method have been expressed in forth section. At last section results of this method and future ideas are propounded.

IMAGE DATABASE

The used image database includes 50 images of right hand; belong to 10 persons which are captured by a CCD[1] camera. Size of the captured images is 480×360 pixels with 100dpi resolution.

Initial Pre-Processing

In the initial pre-processing, background of the image is eliminated and back of the hands scheme is extracted from the background. The background without the existence of hand will subtract from the main image to eliminate the background. Then, by applying a thresholding process, back ground will be completely eliminated from the hands scheme. Median filter is used to increase the quality of image. So the hands area becomes more obvious and distortions are eliminated after thresholding.

[1] Charge coupled device

Features Extracting

A robust identifying system requisite is a feature vector that could express proper representation of input objects. Processing speed is a determinant parameter in automatic image processing, so we should have a simple and complete description of the desired objects.

Different steps of making this simple and complete feature vector will be explained.

PCA filter and its performance method

The main idea of PCA is reducing data dimensions in a collection of data. The main components of this filter are called PC's that obtained from linear transformations of the main series of variables. PC's are Non-correlated. Geometric interpretation of the first PC can be considered as a new coordinate's axis that data changes are maximum on it.

PCA AND SPECIAL IMAGES

Assume a N×N grayscale image with intensity of I(x, y). Each element in this picture is presented with a value of 8-bit, which indicates the intensity at this point. In this case, we can consider I(x, y) as a vector with length of N^2, or as a point in N^2 dimensional space. So the 480×360 image can be shown as a single point in 172800 dimensional space. Generally back of the hands scheme, occupy only a small part of this big space, and thus they aren't shown appropriately in this coordinate space.

An optimal coordinate system performed with basic component analysis for this image. A method is needed to assessment variances in the series of back of the hands images and this is the same case that could be archived with special vectors. By having a matrix C, special vector of u_i and eigenvalues λ_i related to C satisfy the Equation (1).

$$cu_i = \lambda u_i \qquad \forall i \tag{1}$$

Special vectors are perpendicular and can be shown in a normalized mode as following.

$$\mu_i^T \mu = \begin{cases} 1 & i = j \\ 0 & i \neq j \end{cases} \tag{2}$$

The matrix I_k is defined such that its elements correspond to gray-level intensity of hands image. Assume that this matrix is the k'th element of a set of hands image in the database that contains M elements. Now consider that I_k is a vector that has been made by columniation of I_k. Also we define Φ_k as a normalized column vector for the k'th image.

$$\psi = \frac{1}{M}\sum_{k=1}^{M} \tau_i \tag{3}$$

We define C as The covariance matrix of average normalized images.

$$C = \frac{1}{M}\sum_{k=1}^{M} \phi_k \phi_k^T \tag{4}$$

In the above equation, M is the number of the back of the hands images in Database. These images can help us to build a subspace that indexes the images excellently. Since, we call this subspace, the back of the hands subspace.

According to this subspace and conditions for the eigenvectors:

$$\begin{aligned} &Cu_i = \lambda_i u_i \\ &u_i^T Cu_i = u_i^T \lambda_i u_i = \lambda_i u_i^T u_i \end{aligned} \tag{5}$$

$U_i \times U^t_i = 1$, then we have:

Eigenvalue of i, is the variance between back of the hands' images along the axis which is described by eigenvector of i. So by choosing particular eigenvectors corresponding to the largest amount of eigenvalues, a dimensional selection has been performed to represent the largest variances in back of the hands' images [9, 10].

$$\begin{aligned} &Cu_i = \lambda_i u_i \\ &u_i^T Cu_i = u_i^T \lambda_i u_i = \lambda_i u_i^T u_i \\ &u_i^T Cu_i = \lambda_i \\ &\lambda_i = \frac{1}{M} u_i \sum_{k=1}^{M} \phi_k \phi_k^T u_i \end{aligned} \tag{6}$$

$$\begin{aligned} &= \frac{1}{M}\sum_{k=1}^{M} u_i^T \phi_k \phi_k^T u_i \\ &= \frac{1}{M}\sum_{k=1}^{M} \left(u_i^T \phi_k\right)^T \left(u_i^T \phi_k\right) \\ &= \frac{1}{M}\sum_{k=1}^{M} \left(u_i^T \phi_k\right)^2 \\ &= \frac{1}{M}\sum_{k=1}^{M} \left(u_i^T \tau_k - mean\left(u_i^T \tau_k\right)\right)^2 \\ &= \mathrm{var}_k\left(u_i^T \tau_k\right) \end{aligned} \tag{7}$$

Using EAPCA to Improve PCA

As described in the previous section, PCA based on the most changes in back of the hand's images, chooses its eigenvectors according to the highest eigenvalues. This process was the main idea to reduce data size without significant loss of details in order to speed up feature extraction. Thus a feature vector is made, that maintenance the changes in the hand image as possible. Now, the Edge Adaptive PCA method is used to improve results of PCA method.

In this method before using the PCA filter in three stages, we increase shrinkage influence of the fingers and nails pattern that are important in Authentication, in the back of the hands scheme image, using edge operators. This edge detecting operation is performed to enhance the PCA filter and magnifies the effect of shrinking area on skin. At first edge detecting step, The Sobel operator is applied in horizontal direction. This operator uses deriving properties to find horizontal edges. This filter applied to image by masking. Figure 1 shows the masks that used in Sobel operator.

Using a horizontal Sobel mask, all of horizontal edges (shrinkage of fingers skin) in the back of the hand's image will be determined. By multiplying this pixels intensity in a constant gain and adding them to original image of hand, shrinkage of finger's skin will be highly intensified.

In the second step, the Sobel's operator will be applied to image in the vertical direction (Figure 1b). By applying this mask, vertical edge (nail pattern) will be separated from the image.

+1	+2	+1
0	0	0
-1	-2	-1

(a)

-1	0	+1
-2	0	+2
-1	0	+1

(b)

Fig.1. (a) Horizontal Sobel mask for edge detection. (b) Vertical Sobel mask for edge detection.

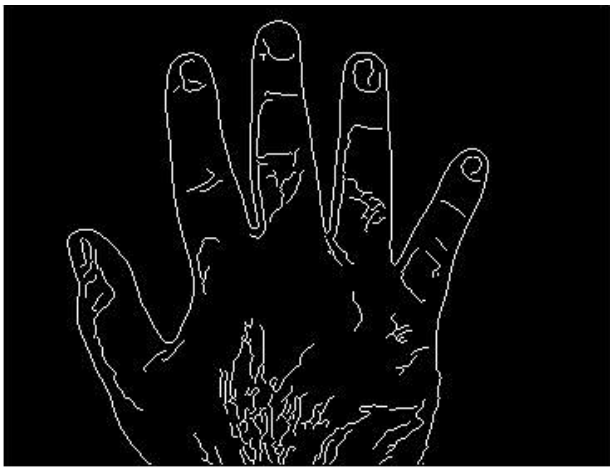

Fig.2. Canny operator output.

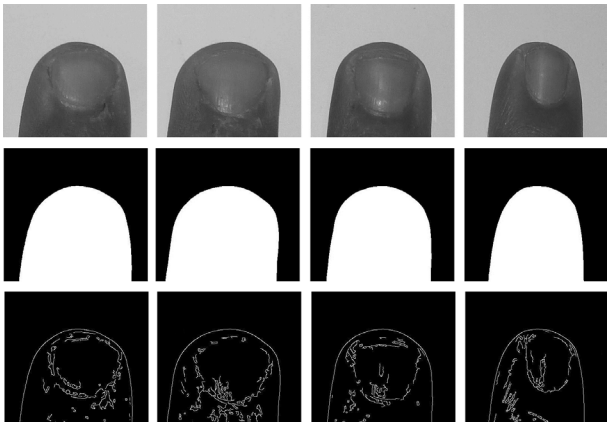

Fig.3. Finger boundary and shrinkage extracted by EAPCA.

At the last step in this approach that is the complement of previous two stages, the Canny operator that is one of the most common and accurate edge detector is used to add details such as shrinkage fingers skin and nails (the nails areola). Canny filter determines useful detail for this process, with a detection threshold of 0.12 (this threshold has been obtained from experimental results) [11, 12].

Canny operator output is shown in Figure 2.

The EAPCA method extracted the finger shrinkage and its boundaries from the hand picture (Figure 3). This method has valuable information for authentication purposes.

After performing the above steps using PCA filter the feature vector which includes all details such as shrinkage skin of fingers and pattern with hand's scheme data, will be extracted from the image. Superiority of this new method is obvious in simulation result section.

Table.1. *Evaluated results for purposed scheme*

Method	Correct Detection Ratio
PCA	77.6%
ICA	79 %
LDA	86%
EAPCA	81.5%

EVALUATION RESULTS

As already mentioned, to check and improve the presented approach, 50 right hand images belonging to 10 persons were used. In this paper, 50 first columns are selected because the main features of PCA are in the first few rows or columns. Then all of the features are extracted. The obtained results are shown and compared with other methods in Table 1. These results show the PCA filter is very efficient to extract biometric features from the images, and can make a low memory database. In the fourth row of Table, results of optimizing method of PCA in identifying process have been presented. It is seen that EAPCA method is better than PCA, due to accentuation of unique features of the hand scheme (shrinkage and patterns).

LDA method has better ratio than the other methods, but due the performance overhead, this method not suitable for authentication purposes.

Also to get the reconstruction error of the images, the PCA coefficients and equation (5) can be used as following:

$$\varepsilon = \left|\Phi - \Phi_r\right|^2 \tag{8}$$

In this equation, Φ_r is original image and Φ_r is reconstructed image. ε is the error value due to reconstruction of image from PCA coefficients.

CONCLUSION

In this paper, methods were explained about the identification, based on the back of the hand's scheme geometric, fingers skin shrinkage lines and nails patterns. Also a new method was proposed to improve the previous methods. Using PCA Filter it can be possible to achieve correct recognition of 77.6%. For improving this rate, new EAPCA method was proposed. In this procedure despite the volume of the data that are extracted from image is low, but by doing some image processing techniques and performing some process to improve the PCA filters, Extracted vectors will be appropriated for identifying. With this new method, correct recognition rate increased to 81.5%.

Authentications field can be extended on other biometric characteristic by using expressed methods and techniques.

REFERENCES

[1] Kumar, Ajay and Ravikanth, Ch. 2009. Personal Authentication Using Finger Knuckle Surface. IEEE Trans. Info. Forensics & Security, **4**(1) 98-110.

[2] Jain, A.K, Ross, A and Pankati, S. 1999. A Prototype Hand Geometry-Based Verification System. In 2nd Intel Conference On Audio And Video-based Biometric person Authentication, Washington D.C.

[3] Pankati, S, Bolle, R.M and Jain, A. 2000. Biometrics: The Future of Identification. IEEE Compute, **33**(2) 46-49.

[4] Chang-Yu, W, Shang-Ling, S, Feng-Rong, S and Liang-Mo, M (2006). A Novel Biometrics Technology-Finger-back Articular Skin Texture Recognition, ACTA Automatica Sinica, 32(3) 1-22.

[5] Woodard, D.L and Flynn, P.J. 2005. Finger surface as a biometric identifier. Computer Vision and Image Understanding, **23**(100) 357-384.

[6] Gao, Y and Leung, M.K. 2002. Human Profile Recognition Using Attributed String. Pattern Recognition, **33**(1) 335-360..

[7] Liu, Xia and Fujimura, Kikuo. 2004. Hand Gesture Recognition using Depth Data. Proc. of the Sixth IEEE International conference on automatic Face and Gesture Recognition, 529-534.

[8] Stergiopoulou, E and Papamarkos, A. 2006. A New Technique on Hand Gesture Recognition. Proc of the IEEE International Conference on Image Processing, 2657-2660.

[9] Vaseghi, S and Jetelova, H. 2005. Principle And Independent Component Analysis In Image Processing. Proceedings of the 14th ACM International Conference on Mobile Computing and Networking (MOBICOM ‘06), 1-5.

[10] James V. Stone. 2004. Independent Component Analysis. The MIT Press.

[11] Barret, H. 2004. Foundations of Image Science. John Wiley & Sons, New Jersey, U.K., third edition.

[12] Gonzales, R.C and Woods, R.E. 2002. Digital Image Processing. Prentice Hall, second edition.