ASSESSMENT OF THE EFFICIENCY OF CORRELATION COEFFICIENT FOR FACE AUTHENTICATION

[1]Sheela Shankar, [2]V.R Udupi

[1]Department of Electronics & Communication Engg,
KLE Dr. M. S. Sheshgiri CET, Udyambag, Belgaum, (India)
[2]Department of Electronics and Communication Engg,
Gogte Institute of Technology, Belgaum, (India)

ABSTRACT

Face recognition being a robust method of authentication has seen tremendous growth in the recent decades. Face authentication being an instance of face recognition involves one-to one mapping of probe face images with the gallery images. The aim of this paper is to test the effectiveness of correlation coefficient for use in face authentication. The images under test were selected from various standard face databases and the results obtained were in good agreement with respect to one-to-onematching of faces, although the hypothesis need not be true in case of one-to-many.

Keywords: Authentication, Correlation coefficient, Face recognition.

I INTRODUCTION

Face recognition is currently gaining wide acceptance as a powerful tool to identify faces uniquely for security related issues [1]. There are many techniques used to deploy this. However the techniques are well suited for recognizing faces with considerable amount of variations with respect to illumination, occlusions, skin tone, facial expressions, poses [2], etc. The techniques used in this regard are artificial neural networks [3,4,5,6,7],principal component analysis (PCA) [8], eigenface method [9], support vector machines (SVM) [10], etc. Though these techniques are robust, they are complex in terms of implementation. The proposed technique focusses on the scenarios of authentication rather than recognition, where one-to-one matching of face image is concerned.

The proposed technique focuses on an easy to use method which can serve as an alternative to the above discussed methods. It uses correlation coefficient to distinguish between like and unlike images. Also, the effectiveness of using correlation coefficient in this regard, is assessed.

The rest of the paper is organized as follows. Face recognition and authentication are briefed in Section 2. A detailed description of correlation coefficient is discussed in Section 3. The implementation of the testing paradigm is given in Section 4. Section 5 deals with the obtained results. Sections 6 and 7 deals with the conclusion and future scope of the study, respectively.

II FACE RECOGNITION AND AUTHENTICATION

2.1. Face recognition

Face recognition generally refers to different application scenarios. It can be either identification or authentication. In either case, the images of faces are used in the system. The stored set of faces is usually called the training set or the galley. The face images used in the later stages are called the testing images or the probes. The latter is matched against the former. The block diagram of face recognition is shown in Fig.1. The first face deals with detecting the presence of a face in the given image. If a face is found, then specific features are extracted and later subjected to classification, which yields in proper recognition of a face.

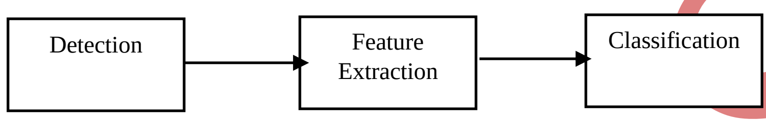

Fig.1. The basic architecture of the face recognition system

2.2. Classification of authentication

Authentication techniques can be broadly classified into three classes [11]:

1) *Something-you-are:* deals with the bodily characteristics that are unique identification of a person. Such techniques are called biometric based and are discussed in detail, throughout the paper.

2) *Something-you-know*: as the name implies, it is secret information known only to the user. Passwords and PIN numbers are better examples to substantiate this.

3) *Something-you-have*: can be objects or items to authenticate, for instance, ATM cards, passport, keys, etc.

2.3. Face authentication v/s recognition

In case of authentication, there is one-to-one matching, i.e. the face under test is matched against the training database for a claimed identity. The claimed identity is considered to be authenticated if the extent of the match exceeds some fixed threshold. In other words, if a subject stands in front of a face authentication system and claims to be a particular user, the system will only check if the subject is the claimed user or not. In recognition scenario, one-to-many matching is done and the face under test is matched against all the faces in the training dataset to find the best match. Recognition is more difficult than authentication because the large set of data in the training database is more prone to incorrect recognition. Secondly, the entire training database is to be parsed on each recognition attempt. Fig.2a,b gives a pictorial view of the differences in face recognition and authentication.

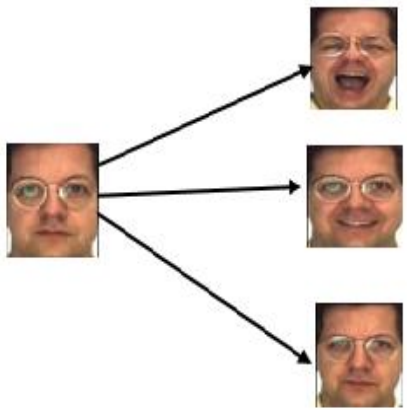

Fig. 2a. Face Recognition

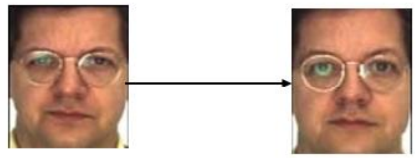

Fig. 2b. Face Authentication

III CORRELATION COEFFICIENT

It is a technique for assessing the amount of linear relationship that exists between two quantities under test. It was designed in 1895 by Karl Pearson. It is widely used in pattern recognition, statistical analysis and image processing. The Pearson's correlation coefficient is given by [12]:

$$r = \frac{\sum_i (x_i - x_m)(y_i - y_m)}{\sqrt{\sum_i (x_i - x_m)^2}\sqrt{\sum_i (y_i - y_m)^2}}$$

where x_i and y_i represent the intensity values of the i^{th} pixel in 1^{st} and 2^{nd} images respectively; x_m and y_m correspond to the mean intensity values of the 1^{st} and 2^{nd} image respectively. If the two images are absolutely identical, then the value returned by the correlation coefficient is 1, the value of r=0 signifies that the two images are completely uncorrelated. When the two images are anti-correlated, the value of r =-1 [13].

The main benefit derived from the correlation coefficient is that it condenses the comparison of two 2D images down to a single scalar value, r. Also, it is invariant to linear transformation of x and y. Hence, r is insensitive to uniform variations in contrast and brightness in an image. The major shortcoming here is that it is computationally intensive. It also goes undefined in some cases due to division by zero error (when images has uniform, constant intensity).

IV IMPLEMENTATION

To check the effectiveness of the correlation coefficient, the testing schema involved constructing a database of faces by selecting 4 faces each from 5 different standard face databases, like AR face database [14], Japanese Female Facial Expression Database [15], AT & T Face Database [16], etc. To lessen the intricacy level, the selected face images were of the front view, but a little of side movements were allowed. The first face image from each of the database was taken as a pivot. Fig. 3 shows a set of pivot images used for the study. Each pivot image was tested for correlation against all the other images in the database, including itself. Both, one-to-one and one-to-many matching of face images was undertaken. Before subjecting the images to the test, they were all normalized. The graphical analysis of the obtained results is given in the results and discussion section.

Fig. 3. Images taken as pivot for testing.

V RESULTS AND DISCUSSION

Fig.4 shows the bubble graph of the testing schema employed. X axis represents the pivot images. Y axis represents all the 20 face images under test. The diameter of the bubbles depicts the correlation coefficient values. Each image of a particular person was selected as a pivot image (represented along X-axis) and was compared against all the other images for correlation coefficient values. 4 images, each of 5 people, totaling to 20 were taken. It is evident from the figure that the diameter of the bubbles is comparatively higher (above 0.5) for the images of the same persons, and lesser otherwise. For instance, in case of pivot 1, the correlation coefficient values are higher for the first 4 images on the Y axis and lesser for the rest. In similar fashion, the testing was carried on for a wide assortment of face images and similar results were obtained.

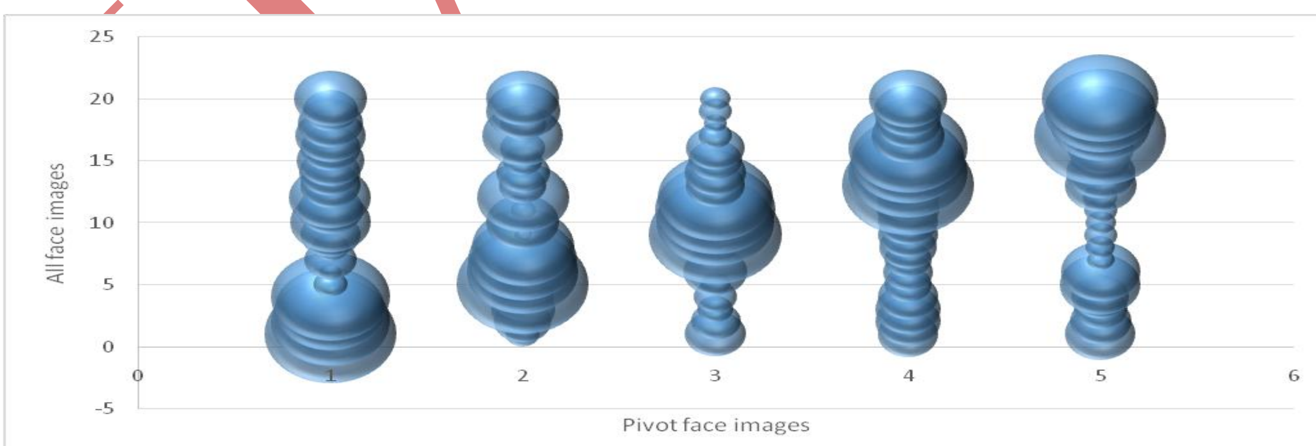

Fig. 4. Correlation Coefficient values of pivot face images taken with respect to all the face images in the database.

VI CONCLUSION

The paper dealt with testing the effectiveness of correlation coefficient for one-to-one and one-to-many matching of face images for authentication. It was observed that the obtained results were in good agreement of using the correlation coefficient for authentication specific to one-to-one matching. Hence the proposed technique can be used in scenarios where the authentication is restricted to one-to-one matching of face images.

VII FUTURE SCOPE

Techniques to enhance the efficiency of correlation coefficient with respect to one-to-many matching should be undertaken. Major concern should also be laid on optimizing the time complexity of the correlation coefficient.

VIII ACKNOWLEDGEMENTS

The authors are immensely grateful to the valuable suggestions and help provided by the Department of Electronics and Communication Engineering, KLE Dr. M.S. Sheshagiri College of Engineering and Technology, Udyambag, Belgaum, Karnataka.

REFERENCES

[1] Zhao, Wenyi, Rama Chellappa, P. Jonathon Phillips, and Azriel Rosenfeld. "Face recognition: A literature survey." *Acm Computing Surveys (CSUR)* 35, no. 4 (2003): 399-458.

[2] Xiaozheng Zhang, Yongsheng Gao, "Face recognition across pose: A review", Pattern Recognition 42 (2009) 2876 – 2896, Elsevier.doi: 10.1016/j.patcog.2009.04.017

[3] Réda, Adjoudj, and Boukelif Aoued. "Artificial neural network-based face recognition." In *Control, Communications and Signal Processing, 2004. First International Symposium on*, pp. 439-442. IEEE, 2004.

[4] Zhang ZhenQiu, Zhu Long, S.Z. Li, Zhang Hong Jiang, "Real-time Multi-View Face Detection", Proceeding of the Fifth IEEE International Face Conference on Automatic Faceand Gesture Recognition, pp 142-147, 20-21 May 2002.

[5] Rolf F. Molz, Paulo M. Engel, Fernando G. Moraes, Lionel Torres, Michel Robert,"System Prototyping Dedicated to Neural Network Real-Time Image Processing", ACM/SIGDA Ninth International Symposium on Field Programmable Gate Arrays(FPGA 2001).

[6] Gavrila, D.M; Philomin, V., "Real-Time Object detection for Smart Vehicles". International Conference on Computer Vision (ICCV99), Vol. 1, 20-25 September 1999.

[7] H. A. Rowley, S. Baluja, T. Kanade, "Neural Network-Based Face Detection", IEEE Transactiono n Pattern Analysis and Machine Intelligence, Vol.20, pp. 39-51, 1998.

[8] Yang, Jian, David Zhang, Alejandro F. Frangi, and Jing-yu Yang. "Two-dimensional PCA: a new approach to appearance-based face representation and recognition." *Pattern Analysis and Machine Intelligence, IEEE Transactions on* 26, no. 1 (2004): 131-137.

[9] Turk, Matthew A., and Alex P. Pentland. "Face recognition using eigenfaces." In *Computer Vision and Pattern Recognition, 1991. Proceedings CVPR'91., IEEE Computer Society Conference on*, pp. 586-591. IEEE, 1991.

[10] Guo, Guodong, Stan Z. Li, and Kap Luk Chan. "Face recognition by support vector machines." In *Automatic Face and Gesture Recognition, 2000. Proceedings. Fourth IEEE International Conference on*, pp. 196-201. IEEE, 2000.

[11] Merkow, M. & Breithaupt, J. 2006. Information Security: Principles and Practices.Pearson Prentice Hall.

[12] J.L.Rodgers, W.A. Nicewander, "Thirteen Ways to Look at the Correlation Coefficient", *The American Statistician, February 1988, Vol. 42, No. 1, pp.59-66*

[13] Eugene K . Jen, Roger G.Johnston, "The Ineffectiveness of Correlation Coefficient for Image Comparisons", *Research Paper prepared by Vulnerability Assessment Team, Los Alamos National Laboratory, New Mexico*

[14] Available at: http://www2.ece.ohio-state.edu/~aleix/ARdatabase.html

[15] Available at: http://kasrl.org/jaffe.html

[16] Available at: http://www.cl.cam.ac.uk/research/dtg/attarchive/facedatabase.html