Nonlinear Fusion of colors to face authentication

M.Fedias[1] , D.Saigaa[2]

Automatic Department, University Mohamed khider
B.P 145 RP Biskra (07000), Algeria,
Tél/Fax : +213-33-74-31-21
Email : [1]meriem_fedias@yahoo.fr, [2]saigaa_dj@yahoo.fr

Abstract--**In this paper, we propose to introduce the color information to authenticate face. To improve the performance of this system, many color spaces have been used for processing RGB color components of the original images. The results in different spaces or components colorimetric are combined by using a nonlinear fusion for classification with networks neurons simple type MLP (Multi layer perceptron). We have applied the method of principal components analysis (PCA) or (Eignenfaces) for the extraction of feature vectors. To validate this work we have tested this approach on front images of the database XM2VTS according to its Associated Protocol (Protocol of Lausanne).**

Keywords-- **Eigenfaces, principal components analysis (ACP), face authentication, color spaces.**

1.INTRODUCTION

In this article we concentrate on a particular mode of biometric that is the mode of face, she is important for a lot of application in our real life and the most important advantage is that it is accepted very well by the users because it is therefore without direct contact with the sensors without too to disturb the users, so the low cost of the sensor and the easiness of use. The recognition of the face is used mainly like system of surveillance or identification by the authorities or the police bodies in the public places, the airports, the borders, the automatic ticket windows and the laboratories.

The first theoretical studies of the facial recognition go back up in the beginning of the years 1970 [2]. In 1991, Turks and Pentlands [1] introduced the concept of EigenFaces to ends of recognition. Based on an analysis in main components (PCA), the method of the eigenfaces rests on use of the first clean vectors as clean faces, from where the term EigenFaces.

The stain is simple; the picture of the face is captured by a camera. The topic can present itself before this one and according to the used technique; the system extracts features of the face that are kept in a data base.

The organization of this article is as follows: The section 2 presents the problem of face authentication, the section 3 explains the PCA for the extraction of characteristic, in the section 4 we present the experimental results finally gotten us give the findings and perspectives.

2. FACE AUTHENTICATION

A system of authentication knows the user's identity a priori (for example by a password) and must verify this identity for more of security, if it is indeed the user or an impostor.
The principle of system of authentication of face of an individual is the extraction of a vector X of the features of this last, in order to compare it with a vector that contains the features of this same individual extracts from its pictures that are stocked in a data basis (where p is on the whole the number of pictures of this person of training). to estimate the difference between two pictures, it is necessary to introduce a measure of similarity, several metrics can be used as the L1 distances and L2 (Euclidian), Correlation, the distance of Mahalanobis,….

For example the technique of Correlation is based on a simple comparison between a picture test and the training faces. The one among them being to the weakest distance of the face test will be selected like first choice. but in the case where one uses a distance like L2 (Euclidian), if the difference is lower to a threshold, grant the face corresponds to this person, but another important problem exists that is the choice of the best threshold , Choosing the best threshold is an important part of the problem: a too small threshold will lead to a high False Rejection Rate (FRR), while a too high one will lead to a high False Acceptance Rate (FAR); FRR and FAR are defined as the proportion of feature vectors extracted from images in a validation set being wrongly classified, respectively wrongly authentified and wrongly rejected. The validation and test sets must be independent (though with faces of the same people) from the learning set, in order to get objective results. One way of setting the threshold is to choose the one leading to equal FRR and FAR. we will not investigate other ways of fixing thresholds, and use the global threshold leading to FRR = FAR in the remaining of this paper

3. Feature extraction

The Principal component analysis (PCA) is a linear mathematical method of data analysis, it search for the directions of the space (the axes) that maximizes the variance of the data and minimize the gap to the square in relation to the axes.
In the case of the face recognition we consider the set of the faces of a practice bank like a set of uncertain vectors (matrix of vectors) and the matrix of pictures so constituted is normalized then, therefore the PCA is applied to this matrix. it essentially consists in doing a reduction of dimensionality while coding the faces in a new basis formed by the first clean vectors (EigenFaces) coming from the calculation of the PCA.

The method of EigenFaces takes place as follows:
1. A middle face is calculated from the l pictures of Xi practice of measurements N ×H:

$$\overline{X} = \frac{1}{l}\sum_{1}^{l} X_i \tag{1}$$

2. This middle face is subtracted of the training pictures (one eliminates the resemblances therefore to concentrate on the differences), what generates the vectors of differences $\overline{X}_i$ associated to each of the pictures:

$$\overline{X}_i = X_i - \overline{X} \tag{2}$$

3. The matrix of covariance Ω is constructed
These last vectors are combined, side by side, to create a matrix of data of size trainings [(NxH)xl] (where NxH is the number of pixel of every picture)

$$\overline{X} = \left[\overline{x_1}\,\overline{x_2}\,........\,\overline{x_l}\right] \tag{3}$$

The matrix of data $\overline{X}$ is multiplied by its transposed to find the matrix of covariance

$$\Omega = \overline{X}\,\overline{X}^T \tag{4}$$

4 . Considering the raised measurements of Ω (NH ×NH), an inter-pictures approach are privileged. The calculation limits itself therefore to a matrix $\Psi = \overline{X}^T\,\overline{X}$ depending on the number of pictures in the bank of training (measurements l×l) [3].

5. Calculation of the values and clean vectors of the matrix ψ.

6. The face own *efi* associated to the i éme clean value is formed while using the vectors own Vi of the matrix ψ :

$$ef_i = \sum_{k=1}^{l} v_{ik}\Psi_k \tag{5}$$

7. The m first clean vectors (EigenFaces) (partners to the strongest clean values) are kept. They define the space of the faces thus.

8. The original pictures are projected in the space of the faces to form a continuation of adherence coefficients, what gives for a Xi picture,:

$$w_k = ef_k^{\ T}\Psi_k \tag{6}$$

And k = 1, ...,m .

9. These coefficients form a vector representing the Xi picture then:

$$\varphi_i = [w_1, w_2, w_3......., w_m] \tag{7}$$

Once the completed training, an individual's different representations can be regrouped in order to form a class.
Therefore after the application of the PCA, the vector of entry of the faces of l dimension is reduced to a characteristic vector in one under space of dimension m.

4. EXPERIMENTAL RESULTS

A. data base

Indeed, it is necessary to use a set of data voluminous, representative and standardized. The main choice of XM2VTS data base is its big size, with 295 people and 2360 pictures in total and its popularity since it became a norm in the community of biometric audio and visual of verification multimodal of identity [4].

For every person eight holds have been done in four sessions distributed during five months.
The protocol bound in XM2VTS divides the basis in 200 customers and 95 impostors, people are the two sexes and different ages. the photos in high-quality color and size (256x256).

The protocol of Lausanne shares the data base in three sets [5]:

1. The set of training: it contains information concerning people known of the system (only the customers)
2. The set of validation permits to fix the parameters of the system of face recognition.
3. The set of test permits to test the system while presenting him of people pictures being completely unknown to him.

For the class of the impostors, the 95 impostors are distributed in two wholes: 25 for the set of validation and 75 for the set of test. The schematic illustrates the distribution of the pictures.

Session	Shot	Clients	impostors	
1	1	Training	Evaluation	Test
	2	Evaluation		
2	1	Training		
	2	Evaluation		
3	1	Training		
	2	Evaluation		
4	1	Test		
	2			

Fig. 1. Configuration 1 of the XM2VTS basis

The table 01: show The sizes of the different wholes.

Sets	customers	impostors
training	600 (3 by people)	0
validation	600 (3 by people)	200 (8 by people)
Test	400 (2 by people)	560 (8 by people)

Tab. 1. sizes of the different sets

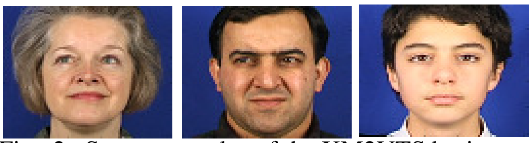


Fig. 2. Some examples of the XM2VTS basis

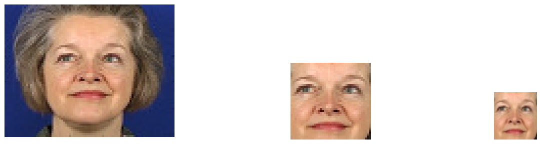
B.Pre_treatment

Every picture is constituted of several information as: the hair, the collars of shirt, ...

Indeed, all these information don't serve to anything, but inflates the size of the data uselessly. Therefore a reduction of picture is necessary whose operation is to extract the essential parameters only for the identifier and that changes very little with time.

It is for that, one cuts the picture by an oblong window centered around the steadiest features bound to the eyes, to the eyebrows, to the nose and to the mouth of size 132x120. Then one filters the pictures by a filter passes low uniform (2x2) in order to do a decimation of factor 2. then we make the photonormalisation to the pictures it means that for every picture, we subtract to every pixel the middle value of these on the picture, and that we divide these by their standard deviation.

The photonormalisation to a double effect: on the one hand she/it suppresses for all vector a possible shift in relation to the origin, and then all effect of amplification. Finally one applies the normalization and that acts on a group of pictures (for every component, one withdraws the average of this component for all pictures and one divides by the standard deviation) [6].



(a) (b) (c)

Fig. 3. Picture of entry (a) picture after carving (b) and picture after decimation (c)

After all this operation of pre-treatment on the pictures, one can used it for the stage of the extraction of the features by the based eigenfaces method on the analysis in component main PCA, and the method takes place as we already itemized to the section 3.

C. Classification

In the problem of verification of identity, we seek to define, for each person, or in a comprehensive manner, threshold.This threshold will determine the minimum resemblance between two images to admit that this is the same person. This minimum resemblance will speak as a maximum distance between the characteristics of two images. In determining threshold we are going to use all evaluation set to determine the weight of the neurons network.

4. COMPARAISON

The question arises: what color space choose?. To answer this question we made our experiments on several areas colors [7] [11] [12] [13]. To make a comparison of results, we presented them with a basic method the EigenFaces, which has the parameters:

- Pretreatment with photonormalisation
- Coefficients: coefficients projection sorted following values decreasing.

Measure similarity: correlation.

Threshold: Global.

We apply a nonlinear classification with a simple neural networks type MLP (Multi layer perceptron). The network consists of three layers: input layer, hidden layer and layer exit. Each layer contains a finite number of units called neurons that receive signals Activation of other neurons, treating them and then forwarded the output signal to all units of the next layer. Each neuron layer (i-1) is connected to all neuron layer (i). There is no connection between units of a single layer [9][10]. Figure 3 shows the block diagram of a network of MLP neuron to a hidden layer.

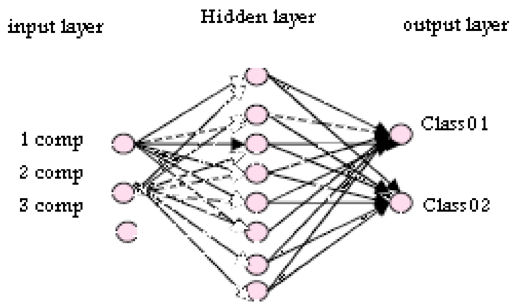


Fig 3: MLP network neurons.

In our work we have used the network MLP as a binary classifier (client where impostor).

We train the MLP with pairs element (distances intra clients, distances extra impostors) of the total validation set to determine the parameters of the network MLP. To assess the performance of the system authentication using a classifier MLP. It calculates the success rate of this classifier in the entire test.

The parameters chosen for our MLP are:
- A hidden layer with nine neurons
-Three neurons in the input layer
-Two neurons in the out layer

The input parameters of the network MLP are:
-The distance using the first component color of the PCA.
- The distance using the second component color of the PCA.
-The distance using the third component color of the PCA.

The different rates of errors and success in two sets evaluation and test using a classifier MLP are shown in the table. II.

component color		Nb/ Crt	**évaluation set**	**testset**		
			TEE	**TFA**	**TFR**	**TS%**
Lab	L	87	0.0125	0.0251	0.0275	94.74
	a	83				
	b	160				
YUV	Y	108	0.0253	0.0344	0.0200	94.56
	U	108				
	V	61				
YCrCb	**Y**	**138**	**0.0148**	**0.0149**	**0.0300**	**95.51**
	Cr	**168**				
	Cb	**120**				
YIQ	Y	72	0.0149	0.0135	0.0425	94.4
	I	70				
	Q	88				
HSV	H	150	0.0231	0.0542	0.0250	92.08
	S	102				
	V	73				
I1I2I3	I1	120	0.0178	0.0145	0.0375	94.8
	I2	120				
	I3	71				
RGB	R	80	0.0422	0.0501	0.0500	89.99
	G	120				
	B	120				
XYZ	X	160	0.0412	0.0512	0.01475	93.40
	Y	160				
	Z	160				

Table II: error rates by the nonlinear fusion with MLP.

It is observed that the results of the three color components of the color space YCrCb gives the best rate succée TS 95.51%. We have already found a rate of succée TS 89.16% Using images to greyscale as characteristic of the entry system face authentication, and a rate of succeed TS 92.27% with the use of component {a}of the Lab color space [11]. This means that the use of color information by non-linear network neurons color pace YCrCb, as characteristic of entry in a face authentication system, represents an improvement in the rate of succeed about 3.24% compared to the use of images represented with a single color component (the {a}component Of the Lab color space). And an improvement about 6.35% in the rate of succeed compared to the use of images represented in greyscale.

CONCLUSION

We found that the use of Nonlinear fusion with a network MLP of the components colorimetric as characteristic of entry to the face authentication system , improves the performance of this system especially with the color space YCrCb that gives the best rate succeed TS = **95.51%.**
And if we are comparing the results with those obtained in greyscale we found that there is a significant improvement in the succession rate about **6.35%.**
In future work we propose the fusion of different components of colors with a methods such as: linear discriminant analysis (LDA) The independent component analysis (ICA).

REFERENCES

[1] TURK M. A. et PENTLAND A. P.: *Face recognition using eigenfaces*. IEEE Comput. Sco.
Press, p. 586-591, June 1991.
[2]CHELLAPPA R., WILSON C. L., and SIROHEY S.: *Human and machine recognition of faces*: A survey. Proceedings of the IEEE, p. 705-740, 1995.
[3] Matthew Turk et Alex Pentland : Eigenfaces for recognition. Journal of cognitive neuroscience, 3(1):71–86, 1991
[4] K. Messer, J. Matas, J. Kittler et K. Jonsson : Xm2vtsdb : The extended m2vts database. Audio- and Video-based Biometric Person Authentication (AVBPA), pages 72–77, Mars 1999.
[5] J. Luettin and G. Maitre. "Evaluation protocol for the extended M2VTS database". IDIAP, available at: http://www.ee.surrey.ac.uk/Research/VSSP/xm2vtsdb/face- avbpa2001/protocol.ps, 1998.
[6]:D.Saigaa, N.Benoudjit, K.Benmahamed, S.Leland-ais: Authentification d'individus par reconnaissance de visage, courier de savoir-N°6, juin 2005, Biskra, Algerie.
[7] Jon Yngve Hardenberg, Acquisition et reproduction d'images couleur : approches colorimétrique et multispectrale, thèse de doctorat de l'Ecole Nationale Supérieure des Télécommunications Specialité : Signal et Images 1999.
[8] C. Havran, L. Hupet, J. Czyz, J. Lee, L. Vandendorpe, M. Verleysen "Independent Component Analysis for face authentication" KES'2002 proceedings – Knowledge- Based Intelligent Information and Engineering Systems, Crema (Italy),16- 18 September 2002
[9] Claude TOUZET, cours : Les réseaux de neurones artificiels, introduction au connexionnisme,1992.
[10] Nadine St-Amand, cours : Réseaux neuronaux et classification (Fonctionnement, structure, initialisation et entraînement).
[11] M. Fedias, D. Saigaa , L'apport de la couleur à l'authentification de visage, JIG'2007 – 3èmes Journées Internationales sur l'Informatique Graphique, Constantine, Algérie, 29-30 octobre2007.pages120-126.
[12] D. Saigaa, S. Lelandais, K. Bemahammed and N. Benoudjit "Color Space for Face Authentication using Enhanced Fisher linear discriminant Model (EFM)", WSEAS International Conference on Applications of

Electrical Engineering (AEE'06), Prague, Czech Republic, March 12-14, 2006, pp. 196-201.
[13] D. Saigaa, S. Lelandais, K. Bemahammed and N. Benoudjit " Improvements for face authentication using color information", WSEAS Transactions on Signal Processing, ISSN 1790-5022, Vol. 2, March 2006, pp. 343-350.
[14] M. Fedias, D. Saigaa ,Fusion de la couleur à l'authentification de visage, STA'2007 – The Eighth international conference on Sciences and techniques of Automatic control ,November 05-07, 2007, Sousse, Tunisia.