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RESEARCH PAPER

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IMPACT OF IMAGE RESIZING FACTOR IN FACE RECOGNITION SYSTEM USING PCA

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Abstract: Image recognition is an emerging field ever since it has been invented. In this field, machine recognition of human face is a challenging task. Human face recognition system has been grabbing high attention from commercial market point of view, as well as research community. Human recognition system is a biometric identification system that authenticates an individual uniquely. Among the existing biometric systems , face recognition system is user friendly, which does not interrupt the user activities. The present paper focuses on Principal Component Analysis (PCA), which is well known for its dimensionality reduction approach. It uses resizing factor as a preprocessing step for training the system, while keeping the aspect ratio the same. The effect of resizing an image using vary resizing factor has been carried out experimentally and obtained challenging results.

Index Terms: Face Recognition, PCA, Eigen Vector, Eigen Value, Resize Factor

INTRODUCTION

Image processing is a technique in which the data from an image are digitized and various mathematical operations are applied to the data, generally with a digital computer, in order to create an enhanced image that is more useful or pleasing to a human observer, or to perform some of the interpretation and recognition tasks usually performed by humans. Face recognition has received substantial attention from researchers in biometric, pattern recognition field and computer vision communities [4][5]. The face recognition system can extract the features of face from still or video images and compare this with the existing feature extracted database.

Initially, face detection is carried out to detect faces from a still or video image. This procedure considers the positions and sizes of the facial organs, such as eyes, nose, mouth, etc., in the image representation. This method consumes very less computer resources and hence efficient to analyze with face database in varied scales.

The problem of face recognition can be stated as follow: Given still images or video of a scene, identifying one or more persons in the scene and validate by using a stored database of faces[4]. The main problem with human recognition is that it has limited memory to recall a person immediately and also the stored database is limited. This must not be the case with the machine recognition system where the memory is manifold. The main problem with the machine recognition system is the complexity involved in identifying some of the factors in a face such as facial expressions, illumination changes, aging, gender classification, size of the image and rotation.

The present paper uses resizing factor as a preprocessing technique on the stored database. Face recognition is the next step of detection. The detected faces are preprocessed so as to increase the efficiency of the face recognition system. A person can be identified from the comparison of a face with an only face (one-to-one) or with a database of faces (one-to-many). The faces presented for recognition are compared with the well-known faces stored in a database, to be classified as a well-known individual's face or as an unknown face.

FACE RECOGNITION SYSTEM

Face recognition system is an automatic biometric identification system. This system recognizes an individual based on facial features extracted. The system is divided into three phases: detecting, preprocessing and recognition.

Recognition can further be categorized into verification and validation. In the real world scenario, there is no exact system, which can depict a human brain.

Face recognition system can use one of the following approaches: knowledge-based method, feature-based method, template-based matching method and appearance-based method [5].

a) Knowledge-based method: In this method a huge knowledge base is required inorder to recognize an image. In takes more time for computation and verification.
b) Feature-based method: In this method the positions and sizes of the facial organs such as, eyes, nose, mouth, etc., in the face are extracted. This method consumes very less computer resources than the template-based method, having a larger processing speed, even though with a face database in varied scales.
c) Template-based method: This method represents the faces by means of a main 2-dimensional template with values representing the facial ellipse borders and of all face organs. The other way is to have multiple templates for representation of the face, under several angles and points of view. The advantage of this model is its simplicity. Its disadvantage is ,great amount of memory is needed and, to apply inefficient comparison method.
d) Appearance-based method: This method projects the face images in a subspace of low dimensionality, to obtain the face representation. The eigenfaces space is an application of this method. It is built on Principal Component Analysis, from the projection of the images of the training set into the face space of low dimensionality.

PRINCIPAL COMPONENT ANALYSIS

Principal Component Analysis (PCA) is one of the appearance-based method. PCA is a technique that can be used to simplify a dataset and it is a transformation that chooses a new coordinate system for the data set such that the greatest variance by any projection of the data set lies on the first axis (1^{st} principal component) , the second greatest variance lies on the second axis (2^{nd} principal component), and so on.

PCA aims for
- Reducing the dimensionality of dataset
- Identifying new meaningful underlying variables

Method:

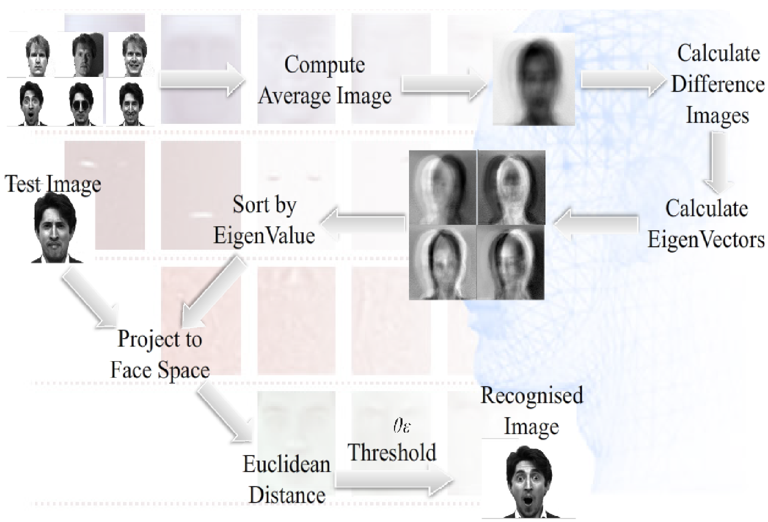

Fig1: Architecture of PCA

a) Training the system:

1) Acquire the set of face images known as the training set. Basically the images in the training set are of size NxN so we have to represent the original images in the form of vectors i.e., of the size N^2x1
2) Let us denote these vectors as $\Gamma_1,\Gamma_2,....,\Gamma_P$, where p=no of images in the training set.
3) Now find the average face of the above set by using the formula
$\mathbf{\Psi=(1/N)\Sigma^{p}_{i=1}\ \Gamma i}$. $\mathbf{\Psi}$ is the mean image with dimensions N^2 x 1.
4) The centered images are found by
$\mathbf{\Phi i= \Gamma i - \Psi}$ where i=1..p.
5) The Covariance matrix is constructed as $\mathbf{C=A.A^T}$ where $\mathbf{A = [\Phi 1 ,\Phi 2 \ldots.\Phi p]}$,the dimensions of C is N^2xN^2 ,here we can observe that the dimensionality is very high so let us take the reverse case as $\mathbf{C = A^T.A}$ so that dimensionality has been reduced to pxp.
6) Now obtain the Eigenvectors and Eigenvalues for the covariance matrix. Let us consider V as Eigenvector and U as Eigenvalue

   CV=* U*V
7) Order the EigenVectors with respective to EigenValues. Keep only the eigenvectors associated with non-zero eigenvalues. This matrix of eigenvectors is the eigenspace *V* **,** where each column of *V* is an Eigenvector

$V = [v_1 \mid v_2 \mid ... \mid v_q]$ where **q<p.**

8) Project the centered training images into the EigenSpace, calculate the dot product of the image with each of ordered Eigenvectors.

$$\Omega_i = V^T . \Phi_i$$

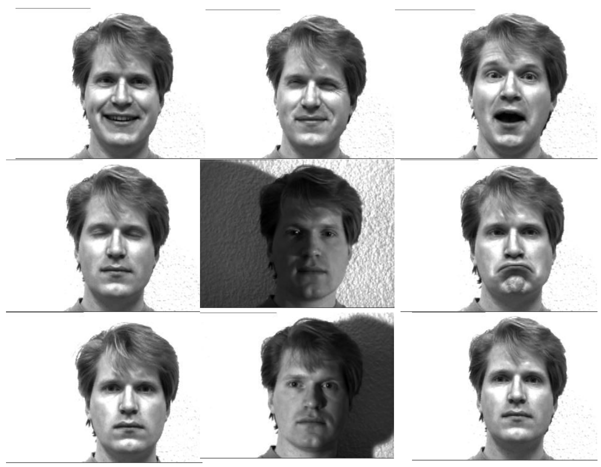

Fig 2:Training Set -- Yale's Database

Therefore, the dot product of the image and the first Eigenvector will be the first value in the new vector. The new vector of the projected image will contain as many values as Eigenvectors.

b) **Testing the system:**

Here the input image is given to the face recognition system for recognition.

1) The input image is converted to a vector of size N^2x1. This vector is considered as Γ.
2) Project the input vector into the EigenSpace $\Omega_{input} = V^T . \Phi_{input}$
3) Calculate the Euclidean distance by using formula $\epsilon^2_i = \| \Omega_{input} - \Omega_i \|^2$
4) The image with the least euclidean distance is considered as the closest image.

VARIATIONS IN IMAGE RECOGNITION BASED ON IMAGE RESIZING FACTOR

Size of an image plays a vital role in the recognition process. The experimental results have be obtained on Yale's database and self database. Initially, the Yale's database is taken for training the system, consists of 10 objects with each having 15 poses(includes lightening conditions also).15 images are taken for testing the system. The primitive size in the database is 320x243. This can be scaled with different scaling factors. The factors which has been considered are Resize_Factor=[5,10,20,30,40,50,60,70,80,90,100] . The rejection rate for the above scaling factors have been evaluated as follows Rejection_Rate=[5,1,3,2,2,2,2,2,2,2,2]

S. No	Resize_Factor	Rejection_Rate	Rejection %
1	100	2	13.33
2	90	2	13.33
3	80	2	13.33
4	70	2	13.33
5	60	2	13.33
6	50	2	13.33
7	40	2	13.33
8	30	2	13.33
9	20	3	20
10	**10**	**1**	**6.66**
11	5	5	33.33

Table 1:Image size vs Rejection Rate on Yale's Database

From the above table it can be observed that as the Resize_Factor is decreasing the Rejection_Rate gradually increases,except in the case of Resize_Factor=10. By the above observations it can be analyzed that Resize_Factor plays a role in face recognition system.

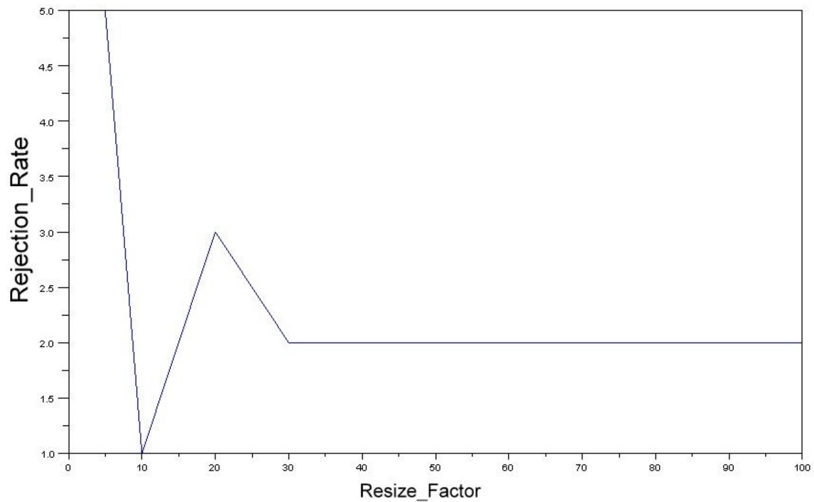

Fig 2: Experimental Results showing relation between Resize_Factor and Rejection_Rate

SELF DATABASE

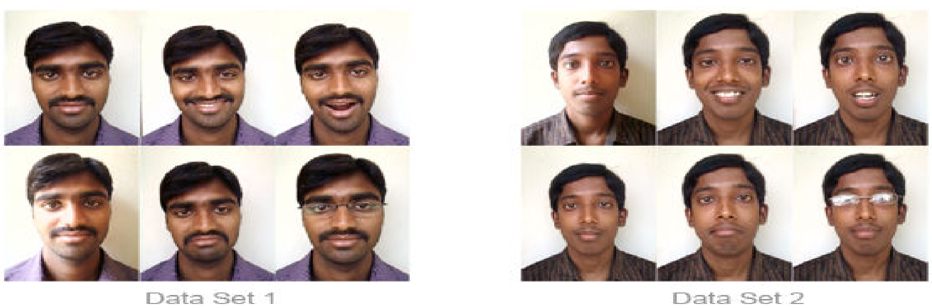

Fig 3:Training Set --Self Database

S. No	**Resize_Factor**	**Rejection_Rate**	**Rejection %**
1	100	3	20
2	90	3	20
3	80	3	20
4	70	3	20
5	60	3	20
6	50	2	13.33
7	40	2	13.33
8	**30**	**1**	**6.66**
9	**20**	**1**	**6.66**
10	10	6	40

Table 2:Image size vs Rejection Rate on Self Database

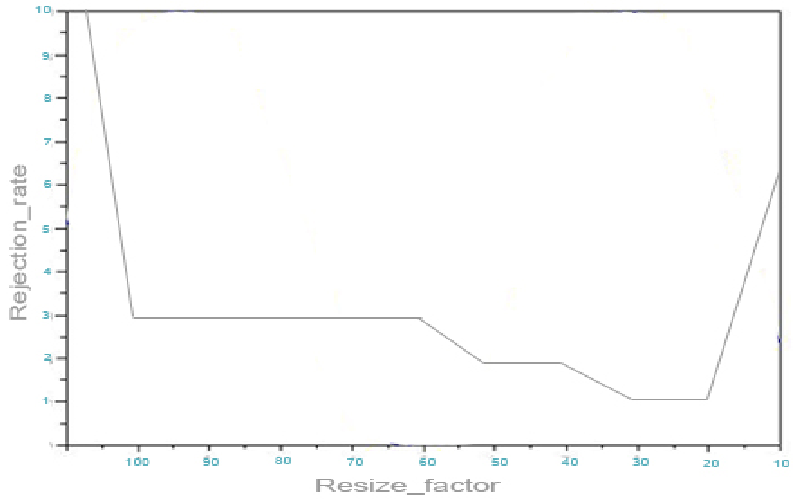

Fig 4: Experimental Results showing relation between Resize_Factor and Rejection_Rate

VARIATIONS IN TIME COMPLEXITY BASED ON IMAGE SIZE

Image size has its effect on the time complexity i.e., time for training and testing the system. In this observation also the same Resize_Factor is considered ie., Resize_Factor=[5,10,20,30,40,50,60,70,80,90,100].
Time complexity with respective to Resize_Factor is tabulated in Table 3 on Yale's database.

S. No	Resize_Factor	Time Taken(sec)
1	100	17.57
2	90	15.35
3	80	13.29
4	70	11.4
5	60	9.94
6	50	8.6
7	40	7.3
8	30	6.44
9	20	5.94
10	**10**	**5.67**
11	5	5.79

Table 3:Image size vs Time Taken

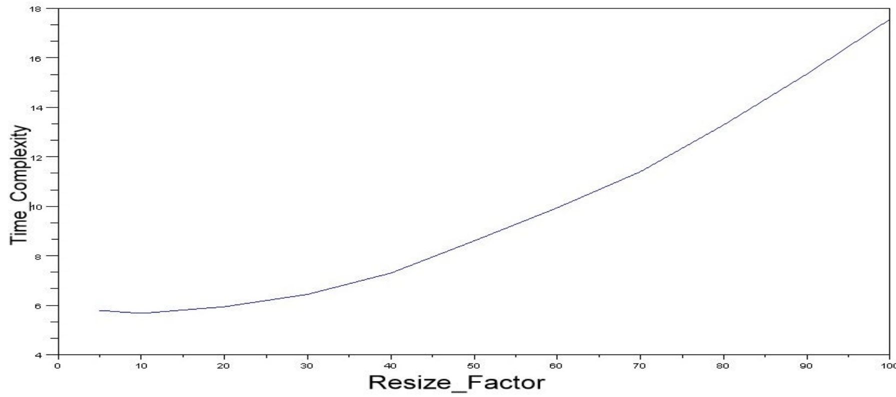

Fig 5: Experimental Results showing relation between Resize_Factor and Time_Complexity

In the above Table 3 we can observe that as the Resize_Factor increases the time taken by the system is also increasing, except in the case of the Resize_Factor=10.

CONCLUSION

PCA for face recognition is fast and simple. It works very well in a constrained ambiance. The size of an image plays a critical role in the procedure. So , the reduction in size of image and corresponding rejection rate and time complexity is calculated. It can be observed that as the image size is decreasing the results go worse. So a constant size should be maintained to decrease the time complexity and to keep the recognition rate high.

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