



## An Efficient Method of PCA Based Face Recognition Using Simulink

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### ABSTRACT

The purpose of research work is to develop a computer system that can recognize a person by comparing the individuals. As such we know reliable automatic face recognition has become a realistic target of biometrics research. In this paper we introduce a method for face recognition that is (PCA) principal component analysis. It is easy and not costly as compare to other, like iris scan or finger print scan. In PCA we only required 2-D frontal image of the person whose face to be recognize.

**Key terms:** Face recognition, Principal Component Analysis, Eigen value, Eigenvector.

### 1. INTRODUCTION

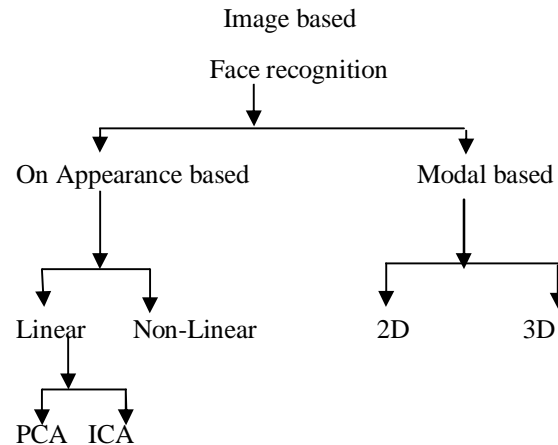
As we know human face is an extremely complex dynamic structure with characteristics that can quickly and significantly change with time. The human ability to recognize face is remarkable. In our lifetime we recognize thousands of faces, but after some time separation we unable to recognize them. It is only due to the face variability [1].

Face recognition is playing very important role in our life and hot research area in the field of computer vision. It is very important research area because of its application. Security point of view face recognition is very better technique [2]. It is very useful in field of entertainment, law enforcement, surveillance, smart cards (national ID, passport) and widely used in many corporate and educational institutions. There are so many techniques for face recognition one of them is Principal Component Analysis. A face recognition system for automatically identifying or verifying a person from a digital still and video image based on computer-driven application [3].

Basically face recognition can be done by the two type of method.

#### 1. Image-based face recognition.

#### 2. Video-based face recognition.



**Figure 1:** Image based face recognition

Fig1: Image based face recognition. As shown in diagram image based face recognition is sub-divided into two parts that is appearance based and model based. Appearance based is also sub-divided into two parts that is linear and non-linear. PCA is sub-type of linear appearance based. Principal Component Analysis is based on mathematical procedure that transforms number possible correlated variables into small number of uncorrelated variable called principal components. First principal component having much variability in the data as possible and next component tries too much of the remaining variability as possible.

### 2. EVOLUTION OF FACE RECOGNITION

Face recognition is very interesting and popular from 50-60 years. In 1960s first semi-automated system for face recognition is generated. In it some feature of face is extracted (like ears, nose, eyes and mouth etc.). Then comparison is done between the reference data and calculated distance and ratio to a common reference point. In 1970s specific marker based technique was developed by Lesk, Goldstein and Harmon [4]. They used 21 specific subjective markers for automate the recognition. These specifications were like hair color, lip thickness, skin color, face shape and nose shape etc. But the problem with both the techniques was that the measurement and locations were manually computed. Kirby and Sirovich generate a technique called Principal

Component Analysis in 1988. It is a standard linear algebra technique for the problem of face recognition [5]. Another the Eigen face techniques were discovered by Turk and Pentland in 1991. There no further improvement was done on it because it was environmental effect. In 2001 new technology came out and it captured very good public's attention. That approach captured surveillance image and compared them to the database of digital photos. That was very better for security point of view. Face recognition technique is increasing day by day and play major role in our life. Now it is being used to identify missing children's, passport fraud, identity fraud etc [6].

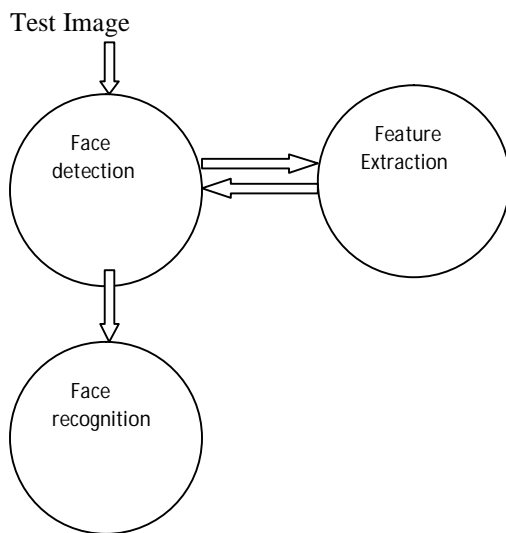
### 3. METHODOLOGY

Generally face recognition works in two steps:

#### 1. Face Detection    2. Face Recognition

Face detection- In it we detect face from image. After detect many face from image we make database of it. And it is used for comparison with test image.

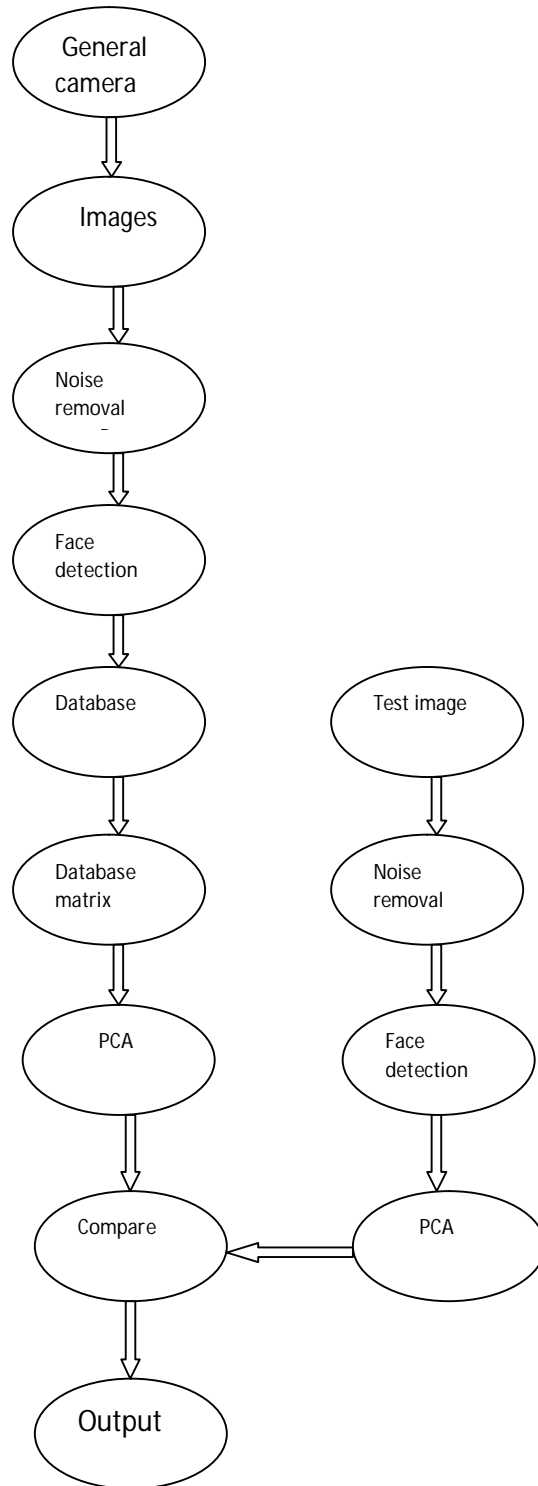
Face recognition- Test image face is also detect by using face detection technique. Then that face is compared with the constricted database. On basis of that comparison we can say face is known or not [2].



**Figure 2 : Face Recognition**

### 4. SYSTEM ARCHITECTURE

Generally face recognition steps are shown in above diagram. Now I am going to introduce the system architecture for face recognition [7].



**Figure 3: System architecture**

That is system architecture of PCA technique for face recognition. In it one column is of database and another one is of test image, then compare for output. Simple 2-D image captures from different angle of same object by using general camera. Now in the preprocessing stage, noise removal, alignment and cropping is done. On next stage face is detected and creates a data base of detected face. Then arrange database in matrix pattern. PCA algorithm is applied on the created matrix. On other hand same procedure is applied on test image and compares them for output [8].

Face detection can be regarded as a specific case of object-class detection. The locations and sizes of all object in an image are search in object-class detection. The locations and sizes of a known number of faces are searched in face localization. The proposed system implements the face –detection task related to binary pattern-classification task. Feature is extracted from the capture image. Then trained classifier decides about face is real or not. PCA employs a window-sliding technique. PCA is orthogonal linear transformation system. PCA transforms the data to a new coordinating system such that the greatest variance by any projection of the data comes to lie on the first coordinate. This is known as 1st principal component. The second greatest variance will on the second coordinate and similarly next.

Fig.3 is of system architecture for face recognition using Principal Component Analysis. In diagram flowing stage are present. Now I am going to describe one by one. The first stage of face recognition system architecture is image acquisition.

#### 4.1 Image acquisition

The first stage of system architecture is to capture the simple 2-D image of any person from different angle by any digital system [9].

#### 4.2 Image preprocessing

The next stage of system architecture is image preprocessing. In which noise is removed using filter from the image and cropping & alignment is also done on image [9].

#### 4.3 Face detection

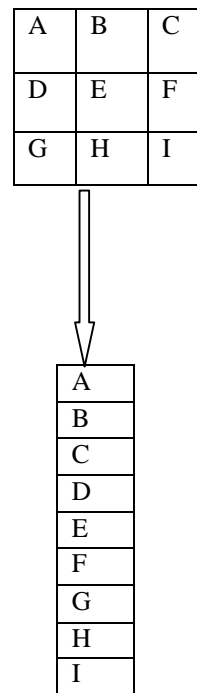
Face detection is 3<sup>rd</sup> and important stage of face recognition. As we know face are of several shapes. These are oval, rectangle, triangle, heart, square and round etc face can be tracked by passing the model over the image and trying to find the face. The movement of the face is also tracked by the model.

#### 4.4 Create a database

Different face is detected of different person from different angle. By using detected face we make database. Database is nothing but is collection of different face. In the database 3 or 4 image of same person with different angle is used for better result. In other techniques frontal face is considered but in that technique we can use frontal and side poses. This technique can handle the illumination problem because environments and lighting problem are well control.

#### 4.5 Concatenation

The database is arranged in the form of matrix of order  $p \times q$ . Now in this step concatenation of the matrix is performed. In concatenation process, the matrix is converted into  $p \times q \times 1$  form. The database matrix is converted into single column and rows are equal to the product of row and column of database matrix. Then that matrix is rearranged images in data matrix.



**Figure 4:** Concatenation of matrix

Then we apply PCA algorithm on that rearranged matrix.

## 5. STEPS OF PCA ALGORITHM

### Steps 1

In this step we take mean of rearranged matrix. Matrix mean is similar to the general mean. In which we add all the columns then sum is divided by number of total number of column [10].

$$\text{Mean} = \frac{1}{q} \sum_{k=1}^q (I_k)$$

### Step 2

In that step mean is subtracted from every value of matrix. We get mean subtracted data matrix as resultant [10].

$$D = [(I_1 - \text{mean}), (I_2 - \text{mean}) \dots (I_k - \text{mean})]$$

### Step 3

When we multiply the mean subtracted by its transpose matrix then covariance matrix is generated.

$$C = DD^T$$

### Step 4

Now in this step system finds Eigen vector and Eigen values. For P dimension vector there will be P Eigen values and Eigen vector.

### Step 5

In this step we try to find out Eigen image and we can find out it by multiplying Eigen vector with the mean subtracted data matrix.

$$\text{Eigen Image} = (D) (\text{Eigen vector})$$

### Step 6

In this step we choose highest Eigen vectors. Maximum information is contained by the highest Eigen value and highest Eigen vector.

### Step 7

In this step we calculate weight matrix. And that matrix can be calculated by multiplying mean subtracted data matrix with the transposed large Eigen image.

$$\text{Weight matrix} = (\text{transpose of L.E.I.}) (D)$$

### Step 8

On other hand test image is taken. And same procedure is applied on it as on the other hand's images.

### Step 9

In this step all PCA steps are applied on it.

### Step 10

The outputs of both hands after applied PCA algorithm are comparing for final output. Final output of face recognition comes out after applying PCA algorithm.

## 6. BENEFICIARY OF FACE RECOGNITION

- Accurate and fast identification
- High security
- Law enforcement agencies use it as CFT
- Needs for identification and the verification of identity claims.
- Face as a Biometric

## 7. APPLICATIONS

- Entertainment: video game, Human robot interaction.
- Smart cards: Drivers Licenses, An National ID, Passports.
- Information security: Personal device logon, for entry gate.
- In law enforcement and surveillance.

## 8. CONCLUSION

In this paper we presented a face recognition system using PCA technique based on Simulink in Matlab. We use a database of images on one side and on other hand we take a test image. Then on basis of PCA algorithm we compare them finds results. Some of the face recognition methods gives consistent results whereas some behaves randomly. In current system many features like eyes, nose, mouth etc. can be obtained by using Most Likely-Landmark Locator and Principle Face Feature. Many verification system are available for physical and electronics security today, but in near future face recognition will be used for customization and surveillance system by different agencies.

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