

# Face Recognition System Using PCA

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**Abstract:** Security and identification of a person plays vital role in any industry. There are several ways for utilizing this purpose. One is face recognition. Face recognition is an essential means of confirming a person. The benefit of face recognition is that, it allows us to know the transformations in the face pattern of a person to considerable limit. This system for recognizing face can tolerate local variants in the face appearance. Hence face recognition system can be used as a key aspect in identifying criminals in crime patrolling. There are numerous techniques to face recognition of which Principal Component Analysis (PCA) is assimilated in our project. For each person, the system contains a database of a set of facial patterns. The distinctive features called 'eigenfaces' are obtained from the stored images using which the system is trained for consequent recognition of new images of an individual.

**Keywords:** Face recognition, Principal Component Analysis, Eigen faces.

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## 1. INTRODUCTION

Face recognition has been an active research area over last 40 years. The face recognition research has several disciplines such as image processing, machine learning approach, pattern recognition, computer vision, and neural networks. Face recognition has various applications in the fields of artificial intelligence, security observation, surveillance conduction, and user access control and law enforcement in criminal cases. The drawback of face recognition system can be stated as given static face images or video of a particular event, categorizing or pinpointing one or more persons in the given video by using a stored database of face images [R. Chellappa et. al. 1995][2]. Classification is the main demerit. In the process of face recognition it includes, to train the images of person at a particular spot and then to ascertain the test images into a set of facial patterns for each individual.

## 2. LITERATURE SURVEY

There are chiefly two types of face recognition system algorithms image template based and geometry feature-based namely. In template based method it (Robert J. 1981) calculates the correlation between a face image and one or more aspects of face image patterns to evaluate the face image identity from the database of set of images. Brunelli and Poggio (R. Brunelli, 1993) advised optimum method for recognition system which is all inclusive and resembles to pattern matching. The arithmetical means such as Support Vector Machines (SVM) (E. Osuna, 1997), (Vladimir N, 1995) Independent component Analysis, Principal Component Analysis (PCA) (L. Sirovich, 1987), (Matthew Turk, 1991), Linear Discriminant Analysis (LDA) (Peter N. Belhumeur et.al, 1997), kernel methods (Bernhard Scholkopf et.al, 1998), (M. H. Yang, 2002), and neural networks (A. Jonathan, 1995), (Steve Lawrence, 1998), (T. Poggio, 1994) used to prepare a relevant dataset of face image patterns.

Apart from these two methods there is other approach known as hybrid approach which combines both statistical pattern based approaches and neural networks. Examples for hybrid approaches embrace the merging of PCA and Radial Basis Function (RBF) neural network (M. J. Er, 1999), (C. E. Thomaz et. al, 1998). Among other procedures, people have used range (R. Chellappa, 1995), infra-red scanner (Y. Yoshitomi et. al, 1997) and profile (Z. Liposcak, 1999) images for recognition. Templates can be provisionally used as features, but essentially they depict comprehensive features of the face image of an individual. Facial constriction (Face images with goggles, specs, scarf etc) and low resolution is often difficult to manage in these given methodologies. In the geometry feature based methods the explicit local facial features are found, and their geometric relationships [5]. Cootes et al. (Andreas Lanitis et.al, 1997) have displayed a model which was an extending method by Yuille (Alan L, 1991). Wiskott et al. (Laurenz Wiskott, 1997) developed a variable bunch

graph matching algorithm for identification of face. Penev et al. (P. Penev, 1996) developed PCA into Local Feature Analysis (LFA). This technique is one of the most successful and useful commercial face recognition systems, FaceIt.

#### Template based Approach:

Template matching is abstractly related to universal approach which endeavors to classify faces using global representations (J. Huang, 1998)[2]. Such approaches the face image as a whole and try to excerpt features from the whole face region and then classify the image by relating a pattern classifier. One of the methods used to extract features in an all-inclusive system, is based on statistical methodology.

#### Statistical methodology:

There are certain methods that categorize structure and examine linear subspaces. Apart from these subspaces some statistical face recognition approaches which are based on some linearity based values (like merging of kernel with PCA & LDA), transformation (like HMM, DCT transform and Fourier (sin and cosine)) and Support Vector Machine (SVM). Appearance-based techniques for face recognition system like PCA, LDA, and mathematical subspace view a 2D face image as a vector representation in image space.

#### Neural Network based methods:

Artificial Neural Network (ANN) (B. Yegnanarayana, 1999) is apparently valuable aspect for pattern recognition difficulties. In Kohonen's associative map (T. Kohonen, 1998), one of the earliest descriptions of neural network for face image recall applications is reported in a significant manner. Using a small set of face images, recollection of pattern was reported even when input image is very blaring, low resolution and dimensionality was not optimum or when portions of the images were misplaced.

**Multilayer Perceptron (MLP):** As per the present works on face recognition system with neural networks there are results with a small number of curriculum (often below 25). In (D. Demers, 1993) the existing 50 principal components which were taken in beginning, the face images were extracted and reduced to five dimensions using auto subordinate neural network. The resulting representation was categorized using standard catalogued methodology named multilayer perceptron (MLP).

**Hop-field memory model:** (Y. Dai, 1998), a Hop-field memory model is a constructive model and is organized in an optimal way for learning and demonstrating facial images. The manner in which recognition of face is done using Hop-field memory model basically uses combination of Hop-field memory model along with the pattern matching. It replicates better working of database enduring 20 faces of more or about 40 subjects.

### 3. PRINCIPAL COMPONENT ANALYSIS (PCA)

Karl Pearson invented PCA in 1901. PCA is variable reduction procedure and useful when obtained data have some redundancy. This will result into reduction of variable into smaller no. of variables which are called Principal Component. The major advantage of PCA is using it in Eigen faces approach which helps in reducing the size of the database for recognition of a test image. The images are stored as their feature vectors in the database which are found out projecting each and every trained image to the set of Eigen faces obtained. PCA is applied on Eigen faces approach to reduce the dimensionality of a large data set.

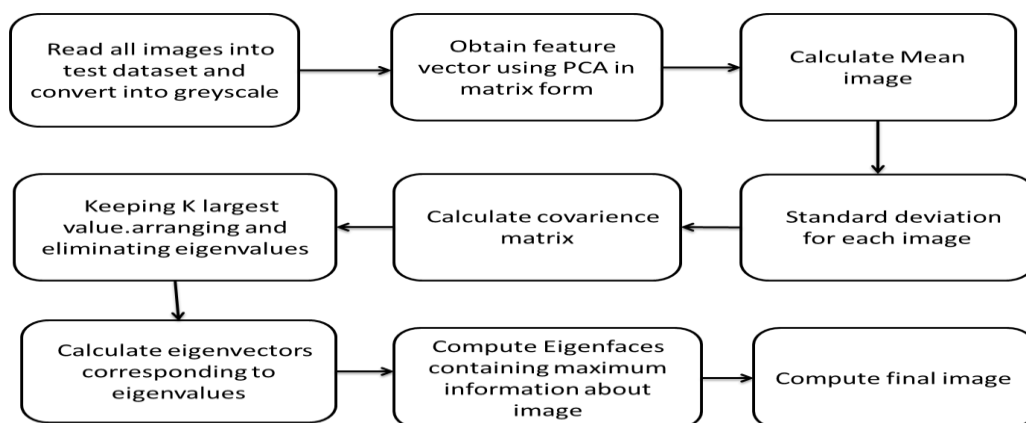


Fig 1: Computing Eigen faces using PCA

PCA projects the data along the directions where variations in the data are maximizes. The algorithm is follows as:

- Assume the m face images contained in the database as P1, P2, P3.....Pm
- Calculate the average image,  $\bar{P}$ , as:  $\bar{P} = \sum P_i / M$ , where  $1 < i < M$ , each image will be a column vector the same size.
- The covariance matrix is computed as by  $C = PTP$  where  $P = [O_1 O_2 O_3 \dots O_m]$ .
- Calculate the eigenvalues of the covariance matrix C and carry on only k largest eigenvalues for dimensionality reduction as  $\lambda_k = \sum_{n=1}^m (U_k T O_{nn})$ .
- Eigenfaces are the eigenvectors UK of the covariance matrix C corresponding to the largest eigenvalues.
- All the centered images are projected into face space on Eigenfaces basis to compute the projections of the face images as feature vectors as:

$$w = U^T O = U^T (P_i - \bar{P}), \text{ where } 1 < i < m.$$

#### 4. LIMITATIONS OF EXISTING SYSTEM

The existing face recognition system is occupied with certain limitations which can be overwhelmed by accepting new methods of face recognition:

- If there are variations in existing system then this cannot be tolerated .Conditions and requirement is that we need to find exactly matching image with 1 image that is contained in dataset of several images else there will be denial to the access of user.
- The functioning level and optimal efficiency of the existing system is not significant and substantial

#### 5. ADVANTAGES

The proposed face recognition system overpowers certain drawbacks and inadequacies of already present system. It particularly extricates the essential features human faces. Hence when a new image of a particular person is provided to the system for recognition the essential characteristics are imported and evaluated to find the dissociated between the provided images and already present images. Thus, certain **variants** can be highlighted in the new face image, which can be tolerated. When there is difference between the images of the person, image provided to system is different from the images already present, then the system will clearly recognize the new face and give identification of person. The proposed system is enhanced and improved mainly due to the use of limited and essential facial features only rather than the entire full face. It is advantageous in following manner:

- accurateness and better mathematical assumption
- Low Computational makes less processing.
- use of less essential features and used as an important aspect in authentication

#### 6. SCOPE AND IMPROVEMENT

This project uses eigenface technique that gives optimal accuracy .Using Neural Network technique, we can improve the results for future scope. And hence accuracy can be significantly enhanced .The recognition system rely on database of facial images and resolution of camera. Better resolution digital or analog camera shows better results .So good future scope is there with enclosure of good resolution camera and neural network technique .Structuring efficient documentation has saved large amount of work load for this software and this domain has been unnoticed due to time constraints. The help message services for applicable user authentication can be established in future, as well as software certification.

#### 7. COMMERCIAL USE

1. Daily Care: Confirming persons for picking up the children
2. Resident Secure: Aware homeowners of coming persons.
3. Voter validation: verifying identity to avoid proxy voting

4. ATM Banking: The software is able to quickly verify a customer's face.
5. Physical entry mechanism control of structured areas, constructing fabricants, doors, vehicles or net access.
6. Automated Attendance system for marking attendance.

## 8. CONCLUSION

The objective of research was to explore and instigate face recognition using PCA algorithm with maximum functionality and efficiency. The aim was to develop a system that identifies faces of individuals and can be used for authentication in a real world environment using PCA.

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