STUDY & ANALYSIS OF FACE DETECTION & RECOGNITION; MATLAB APPROACH

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Abstract

Face recognition from image or video is a popular topic in biometrics research. Many public places usually have surveillance cameras for video capture and these cameras have their significant value for security purpose. It is widely acknowledged that the face recognition have played an important role in surveillance system as it doesn't need the object's cooperation. The actual advantages of face based identification over other biometrics are uniqueness and acceptance. As human face is a dynamic object having high degree of variability in its appearance, that makes face detection a difficult problem in computer vision. In this field, accuracy and speed of identification is a main issue. A facial recognition system is a computer application for automatically identifying or verifying a person from a digital image or a video frame from a video source. One of the ways to do this is by comparing selected facial features from the image and a facial database. The goal of this paper is to evaluate Principal Component Analysis (PCA),one of the most successful techniques that have been used in image recognition and compression.

Index Terms: *Face Detection, Face Recognition, MATLAB, Biometrics, Face Identification.*

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1. INTRODUCTION

PCA is a statistical method under the broad title of factor analysis. The purpose of PCA is to reduce the large dimensionality of the data space (observed variables) to the smaller intrinsic dimensionality of feature space (independent variables), which are needed to describe the data economically. The main idea of using PCA for face recognition is to express the large 1-D vector of pixels constructed from 2-D facial image into the compact principal components of the feature space. The way to represent a face determines the successive algorithms of detection and identification. PCA is a classical technique which can do something in the linear domain; applications having linear models are suitable, such as signal processing, image processing, system and control theory, communications, etc.

Face recognition has many applicable areas. Moreover, it can be categorized into face identification, face classification, or sex determination. The most useful applications contain crowd surveillance, video content indexing, personal identification (ex. driver's license), mug shots matching, entrance security, etc. The main idea of using PCA for face recognition is to express the large 1-D vector of pixels constructed from 2-D facial image into the compact principal components of the feature space. This face detection system is most clearly distinguished from previous approaches in its ability to detect faces extremely rapidly.

2. FACE DETECTION

Face detection is to locate a face in a given image and to separate it from the remaining scene. Visual pattern detection is a problem of significant importance and difficulty. Automatic detection of targets is the first step in most automatic vision systems. Most of the research carried out by the computer vision community relies on the robust detection and accurate location of objects within the tested images. In many cases, algorithms for automatic, visual detection of targets are not provided. In other cases, rather useless algorithms are used which are based on assumptions (for example, controlled environment) that are not suitable for real-life applications. Although it seems an easy task for the human vision system, machine detection of visual patterns is difficult due to the wide range of variations present in real-live data. Aside from the intra-class variation proper of any family of objects, this method of detection of patterns has to deal with other sources of image variations such as light conditions, object pose, imaging system, etc. Considering it as a pattern, the face is a challenging object to detect and recognize. The face anatomy is rigid enough so that all faces are similar in structure, yet we are very much different from each other. In addition to individual variations and the racial variations, there are the facial expressions, which allow an individual to change his or her appearance significantly. The main approaches for pattern recognition have been used in face and facial feature detection. However, a complete evaluation and comparison of these techniques is rather difficult since too many aspects are to be considered such as the training set, the testing set, computational requirements, and other testing conditions.

3. FACE RECOGNITION

Face identification is performed at the subordinate-level. At this stage, a new face is compared to face models stored in a database and then classified to a known individual if a correspondence is found. The performance of face identification is affected by several factors: scale, pose, illumination, facial expression, and disguise. The scale of a face can be handled by a rescaling process. In Eigen-face approach, the scaling factor can be determined by multiple trials. The idea is to use multistate Eigen-faces, in which a test face image is compared with Eigen-faces at a number of scales. In this case, the image will appear to be near face space of only the closest scaled Eigen-faces. Equivalently, we can scale the test image to multiple sizes and use the scaling factor that results in the smallest distance to face space.

Varying poses result from the change of viewpoint or head orientation. Different identification algorithms illustrate different sensitivities to pose variation. To identify faces in different luminance conditions is a challenging problem for face recognition. The same person, with the same facial expression, and seen from the same viewpoint, can appear dramatically different as lighting condition changes. In recent years, two approaches, the fisher-face space approach and the illumination subspace approach, have been proposed to handle different lighting conditions. The fisher-face method projects face images onto a three-dimensional linear subspace based on Fisher's Linear Discriminant in an effort to maximize between-class scatter while minimize within-class scatter. The illumination subspace method constructs an illumination cone of a face from a set of images taken under unknown lighting conditions. This latter approach is reported to perform significantly better especially for extreme illumination.
Different from the effect of scale, pose, and illumination, facial expression can greatly change the geometry of a face. Attempts have been made in computer graphics to model the facial expressions from a muscular point of view.

Disguise is another problem encountered by face recognition in practice. Glasses, hairstyle, and makeup all change the appearance of a face. Most research work so far has only addressed the problem of glasses.

4. PCA ALGORITHM

- The first step is to obtain a set S with M face images. In our example M = 25 as shown at the beginning of the tutorial. Each image is transformed into a vector of size N and placed into the set.

$$S = \{\Gamma_1, \Gamma_2, \Gamma_3, \ \ldots\ldots\ldots \ ,\Gamma_M\}$$

2. After you have obtained your set, you will obtain the mean image **Ψ**

$$\Psi = \frac{1}{M}\sum_{n=1}^{M}\Gamma_n$$

Fig-1: Mean Image

3. Then you will find the difference **Φ** between the input image and the mean image

$$\Phi_i = \Gamma_i - \Psi$$

4. Next we seek a set of M orthonormal vectors, $\mathbf{u_n}$, which best describes the distribution of the data. The k^{th} vector, $\mathbf{u_k}$, is chosen such that

$$\lambda_k = \frac{1}{M}\sum_{n=1}^{M}\left(u_k^T\Phi_n\right)^2$$

is a maximum, subject to

$$u_l^T u_k = \delta_{lk} = \begin{cases} 1 & \textbf{if } l = k \\ 0 & \textbf{otherwise} \end{cases}$$

Note: $\mathbf{u_k}$ and λ_k are the eigenvectors and eigenvalues of the covariance matrix **C**

5. We obtain the covariance matrix **C** in the following manner

$$C = \frac{1}{M}\sum_{n=1}^{M}\Phi_n\Phi_n^T$$
$$= AA^T$$

$$A = \{ \Phi_1, \Phi_2, \Phi_3, \ldots\ldots, \Phi_n \}$$

6. A^T

$$L_{mn} = \Phi_m^T \Phi_n$$

7. Once we have found the eigenvectors, $\mathbf{v}_l$, $\mathbf{u}_l$

$$u_l = \sum_{k=1}^{M} v_{lk} \Phi_k \qquad l = 1, \ldots\ldots, M$$

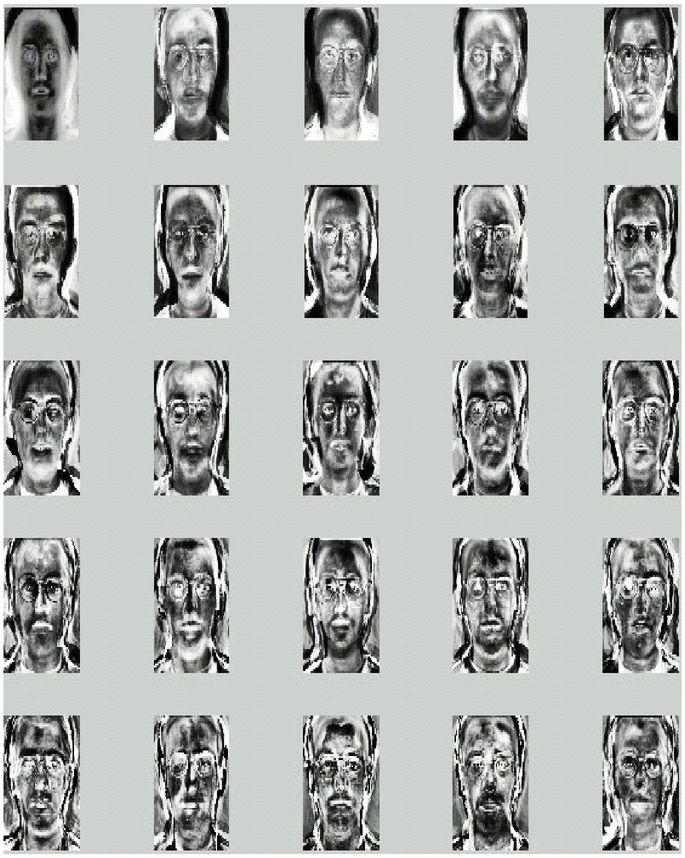


Fig-2: Eigen-faces of our set of original imag

4. RECOGNITION PROCEDURE

1. A new face is transformed into its Eigen-face components. First we compare our input image with our mean image and multiply their difference with each eigenvector of the L matrix. Each value would represent a weight and would be saved on a vector Ω.

$$\omega_k = u_k^T (\Gamma - \Psi) \quad \Omega^T = [\omega_1, \omega_2, \ldots\ldots, \omega_M]$$

2. We now determine which face class provides the best description for the input image. This is done by minimizing the Euclidean distance

$$\varepsilon_k = \left\| \Omega - \Omega_k \right\|^2$$

3. The input face is considered to belong to a class if ε_k is bellowing an established threshold θ_ε. Then the face image is considered to be a known face. If the difference is above the given threshold, but bellow a second threshold, the image can be determined as a unknown face. If the input image is above these two thresholds, the image is determined NOT to be a face.

4. If the image is found to be an unknown face, you could decide whether or not you want to add the image to your training set for future recognitions. You would have to repeat steps 1 trough 7 to incorporate this new face image.

BLOCK DIAGRAM

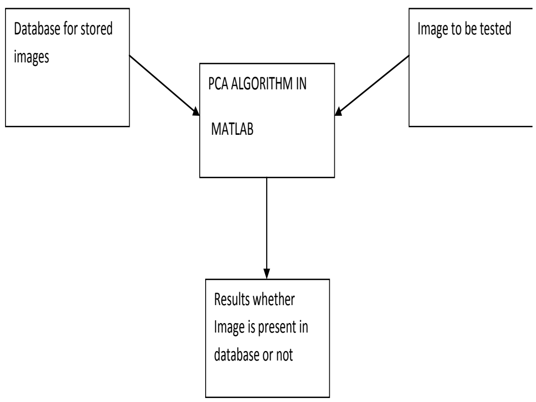


Fig-3: Block Diagram

PCA Based Algorithm

This block is the main building block of our project in this we are having main codes which takes images from database and takes test image if our image is matching from database then it will tell which image is that if it is not then it will display that image is not present in the database.

Database for Stored Image

This database stores all the images which needs to be tested with the test image

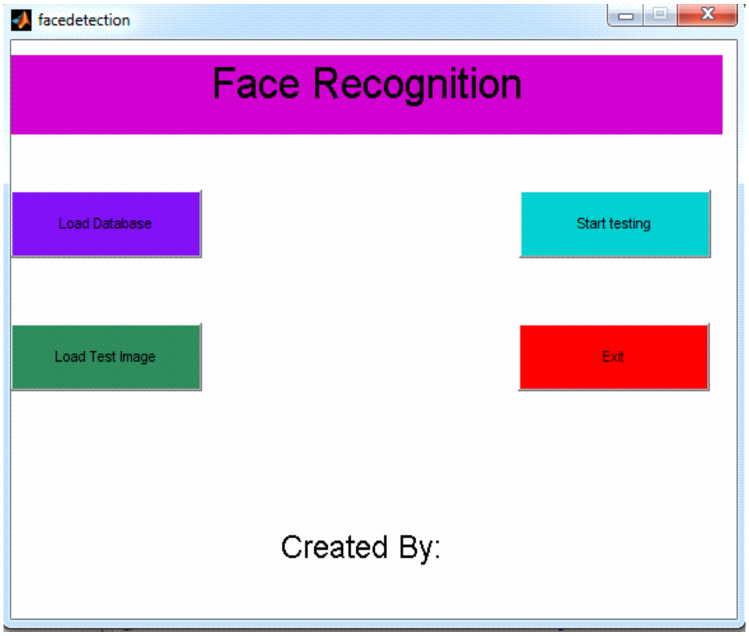
Test Image

This is the image which we match with the database.

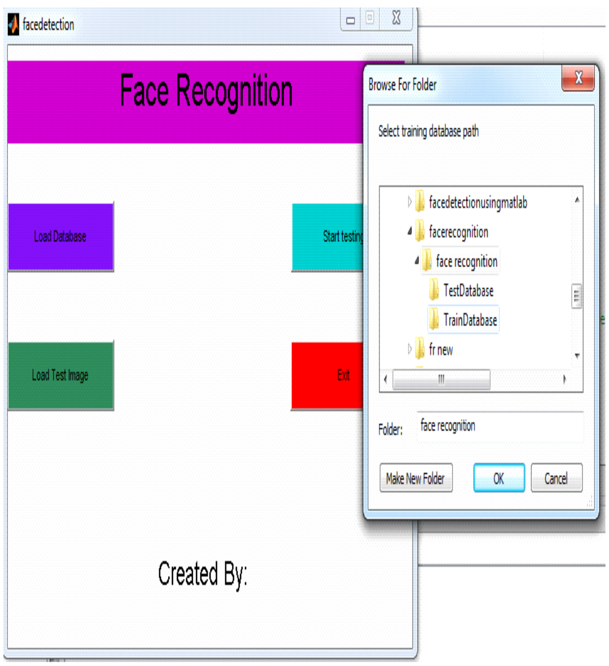
Result

If our PCA code finds that test image is present in database then result shows found if it is not there then it shows not found.

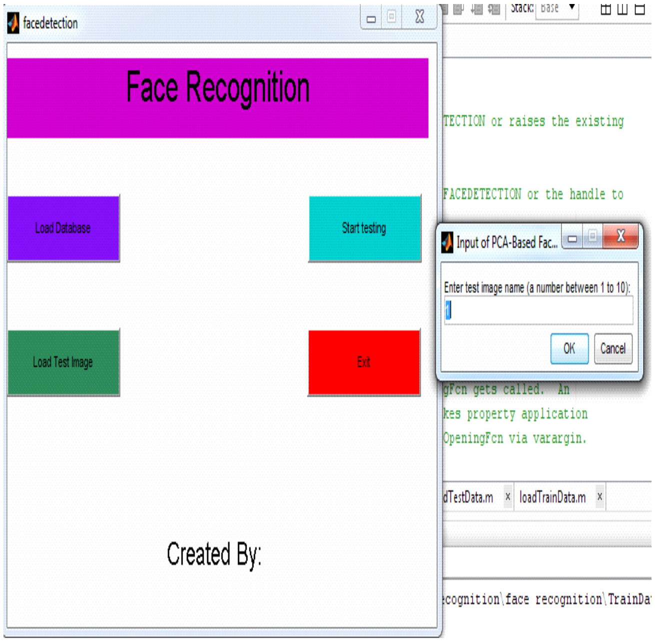
4.1 Startup Screen



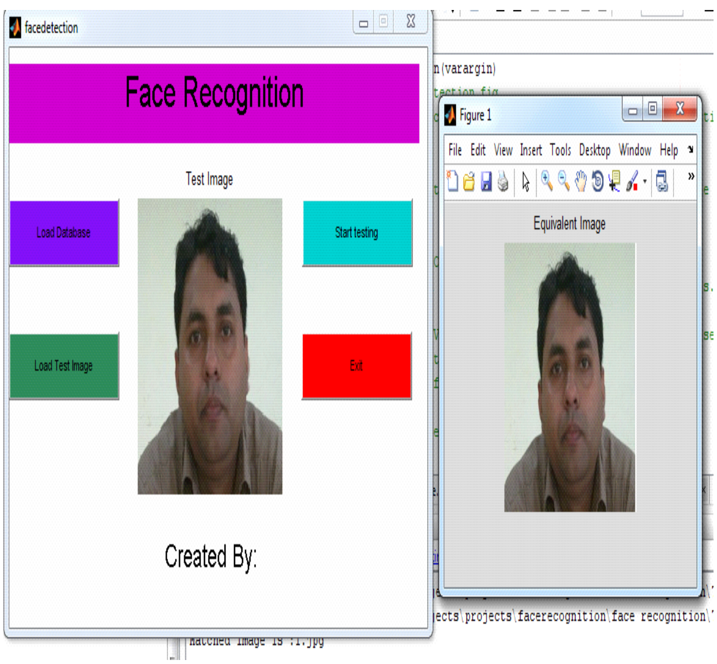
4.2 Selecting Train Database



4.3 Searching For Particular Image



4.4 Final Output



CONCLUSION

With this analysis we can conclude that PCA based face recognition has been successfully achieved using our algorithm. In this we have also seen that different databases are required for both testing and training our algorithm. It is a known fact that the number of images or name of image files in the test and train data base should be continuous otherwise we can test them using loop. One more thing which we have learned is train database should always have greater number of images so that our systems get trained properly.

Face recognition is a technology just reaching sufficient maturity for it to experience a rapid growth in its practical applications. Much research effort around the world is being applied to expanding the accuracy and capabilities of this biometric domain, with a consequent broadening of its application in the near future. Verification systems for physical and electronic access security are available today, but the future holds the promise and the threat of passive customization and automated surveillance systems enabled by face recognition.

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