Detection of Terrorism Activities Using Face Recognition Technique

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Abstract

With the rapid development in the field of pattern recognition and its uses in different areas (e.g. signature recognition, facial recognition), arises the importance of the utilization of this technology in different areas in large organizations. Biometric recognition has the potential to become an irreplaceable part of many identification systems used for evaluating the performance of those people working within the organization. This research attempts to provide a system that recognizes terrorist using face recognition technology to record their presence in over populated areas by matching their faces already stored in a database according to previous criminal records. For face recognition we will be using technique known as PCA.

Keywords: Face recognition system, authentication, bio-metric, PCA.

Introduction

Face recognition is an important branch of biometric and has been widely used in many applications, such as human-computer interaction, video monitor system and door control system and network security [4].

For detection, color based technique was implemented, which depends on the detection of the human skin color with all its different variations in the image.

For recognition, PCA technique has been implemented which a statistical approach that deals with pure mathematical matrixes not image processing like the color based technique used for detection. PCA can also be used for detection.

In general Face recognition system can help in many ways:

Checking for criminal records. Enhancement of security by using surveillance cameras.

Searching lost children's by using the images received from the cameras fitted at some public places.

Knowing in advance if some VIP or someone known is entering the hotel. Detection of a criminal at public place. Pattern recognition [18].

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Biometric Recognition:

There are three different types of authentication: something you know, such as passwords, something you have, such as badges or cards, and finally something you are, which mainly depends on biometrics and physical traits. Each of these three authentication methods has its advantages and disadvantages, and each is considered appropriate for certain types of application [8].

Among there three types, scientists and researchers consider biometric recognition systems as high-level security systems. Biometrics is used in computer science as a form of access control and identification. It is also used to identify individuals in groups that are under surveillance.

Eye: Analyzing the eye is generally thought to present the highest levels of accuracy and uniqueness .They can be divided into two different technologies: iris biometrics and retina biometrics [8].

Iris:

It is the colored tissue representing the ring surrounding the eye pupil. Each person's iris has a unique structure and a complex pattern. In addition, it is believed that artificially duplicating an iris is virtually impossible. It is also known that the iris is from the first body parts decaying after death, therefore

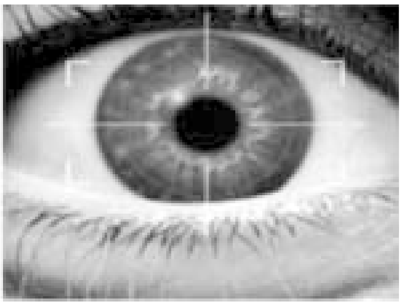

Figure: 1 [18]

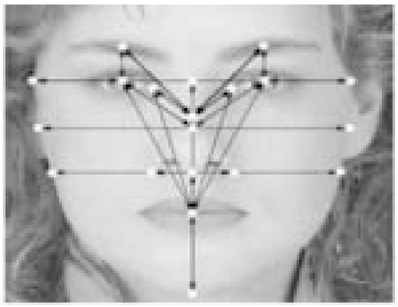

Figure: 2 [18]

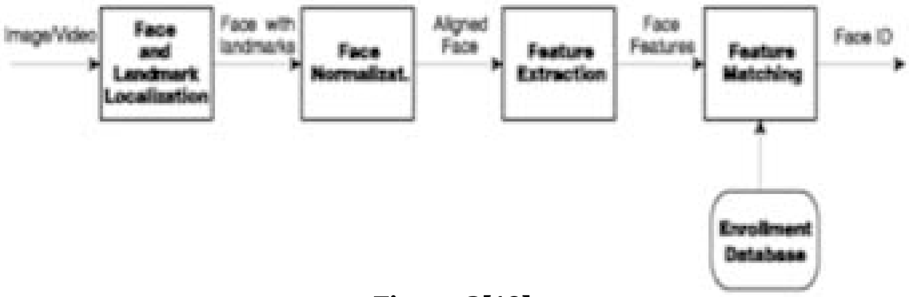

Figure: 3[18]

it is unlikely that a dead iris could be used to by-pass a biometric system.

Retina:

Retina is the layer of blood vessels which is situated at the back of eye. Retina used to form a non-identical pattern and decays quickly after death. Retina recognition systems are complex but at the same time regarded as the most secure biometric system.

Face: For a computerized system to mimic the human ability in recognizing faces, sophisticated and complex artificial intelligence and machine learning is needed to be able to compare and match human faces with different poses, facial hair, glasses, etc. That is why these systems depend greatly on the extraction and comparison engines. Different tools maybe used in these systems such as standard video, or still imaging.

Facial Recognition

Face recognition is considered to be one of the most successful applications of image analysis and processing; that is the main reason behind the great attention it has been given in the past several years [4].

The facial recognition process can be divided into two main stages: processing before detection where face detection and alignment take place (localization and normalization), and afterwards recognition occur through feature extraction and matching steps as shown in figure above [9].

a. Face Detection:

This process separates the facial area from the rest of the background image. In the case of video streams, faces can be tracked using a face tracking component.

b. Face Alignment:

This process focus on finding the best localization and normalization of the face; where the detection step roughly estimates the position of the face, this step outlines the facial components, such as face outline, eyes, nose, ears and mouth. Afterwards normalization with respect to geometrical transforms such as size and pose, in addition to photometrical properties such as illumination and grey scale take place.

c. Feature Extraction:

After the previous two steps, feature extraction is performed resulting extracting the in effective information and essential information that is useful for distinguishing between faces of different persons.

d. Face Matching:

The extracted features are compared to those stored in the database, and decisions are made according to the sufficient confidence in the match score.

Facial Recognition Techniques: That is applied to frontal face:

A. Eigen faces:

Eigenfaces is the name given to a set of eigenvectors which are used in the computer problem for vision of human face recognition.

B. Geometrical Feature Matching:

Geometrical feature matching techniques are based on set of geometrical features from the picture of a face. Current automated face feature location algorithms do not provide a high degree of accuracy and require considerable computational time.

C. Template Matching:

A simple version of template matching is that a test image represented as a two-dimensional array of intensity values is compared using a suitable metric, such as the Euclidean distance, with a single template representing the whole face. In general, template-based approaches compared to feature matching are a more logical approach.

Limitations and Challenges of Face Recognition Technologies: As mentioned earlier, face recognition technology, just as any other biometric technology, has not yet delivered it promise. In spite of all its potentials, it is still quite limited in its applied scope. Many researchers have identified different problems for the biometric system; they can be categorized as follows: [8]

1. Accuracy: Two biometric samples collected from the same person are not exactly the same due to the imperfect imaging conditions. In addition, the face recognition technology is not robust enough to handle uncontrolled and unconstrained environments. In consequence, the results accuracy is not acceptable.

Errors in Accuracy

Errors are mainly caused by the complexity and difficulties of the recognition process because of the uncontrollable variables such as lighting, pose, expression, aging, weight gain or loss, hairstyle and accessories [1]. Figures shown below (4,5,6) depicts the errors caused by either pose variation or ageing as a factor or hiding of images [18].

2. Security: Facial recognition and other biometric systems are used for many security applications, claiming that biometrics is a secure way of authenticating access. But in fact, security of biometrics (especially face), is very questionable. This is caused by two main reasons:

a. Biometrics is not a secret: This means that anyone including the attacker knows exactly the biometric features of the targeted user.

b. Biometrics is not recoverable: This means that one cannot change his face in case it became compromised [18].

Implementation

For detection, Color based technique was implemented, which depends on the detection of the human skin color with all its different variations in the image. The skin area of the image is then segmented and passed to the recognition process.

Figure:4[8]

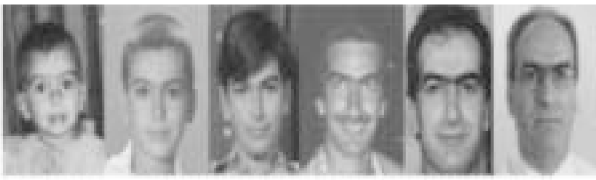

Figure:5[18]

Figure: 6[18]

For recognition, PCA technique has been implemented which a statistical approach that deals with pure mathematical matrixes not image processing like the color based technique used for detection. PCA can also be used for detection [9].

PCA (Principal Component Analysis)

Description: Based on an information theory approach, PCA used to breakdown face images into a small set of characteristic features images or modules called "Eigenfaces" that can be described as the principal components of the initial training set of images.

In PCA, one can change each original image of the training set into a corresponding eigenface. Therefore, one important feature of PCA is that the reformation of any original image from the training set by combining the eigenfaces is possible. Eigenfaces are the unique features of the faces. Therefore one could say that the original face image can be reconstruct form eigenfaces if one adds up all the features in the right proportion. Each eigenface represents only certain features if the face, which may or may not be present in the original image. If the feature is present in the original image to a higher degree, the share of the corresponding eigenface in the sum of the eigenfaces should be greater. On the other hand if the particular feature is not present in the original image, the corresponding eigenface should contribute a smaller part to the sum of eigenfaces. Indeed, in order to reconstruct the original image form the eigenfaces, one has to build a kind of weighted sum of all the eigenfaces. That is, the reconstructed original image is equal to a sum of all eigenfaces, with each eigenface having a certain weight. This weight specifies, to what degree the specific features (eigenface) is present in the original image. If all the eigenfaces extracted from the original images are used, one can reconstruct the original images from the eigenfaces exactly. But using only a part of the eigenfaces is applicable. Hence, the reconstructed image is an approximation of the original image [7].

However, losses due to omitting some of the eigenfaces can be minimized, which is achieved by selecting only the most important features (eigenfaces).

Moreover, it is possible not only to extract the f ace from eigenfaces given a set of weights, but to the extract the weights from eigenfaces and the face to be recognized. These weights act as the amount by which the face differs from the "typical" face represented by the eigenfaces.

Therefore, using these weights one can determine two important things:

1. Check whether the image is a face. In the case the weights of the image differ too much from the weights of face images, the image probably not a face.
2. Similar faces (images) possess similar features (eigenfaces) to similar degrees (weights). If weights form all images available is extracted, the images could be grouped to clusters. Thus, all images having similar weights are likely to be similar face.

PCA-based face recognition algorithm: The approach to PCA-based face recognition involved the following initialization operations: [7]

Initialization: Acquire an initial set of face images (the training set). Calculate the eigenfaces from the training set, keeping only the M images that correspond to the highest eigenvalues. These M images define the face space. As new faces are experienced, the eigenvalues can be updated or recalculated. Calculate the corresponding distribution in M-dimensional weight space for each known individual, by projecting their face images onto the face space. Having initialized the system, the following steps are used to recognize new faces: Calculate a set of weights based on the input image and the M eigenfaces by projecting the input image onto each of the eigenfaces. Determine if the image is a face at all (whether known or unknown) by checking to see if the image is sufficiently close to the face space. If it is a face, classify the weight pattern as either a known person or as unknown. The coming sections will elaborate the steps needed to perform the PCA using eigenfaces on a set of images in detail [6, 7].

Main Algorithm phases: The previous initialization processes can be summed up into three main phases [6, 7].

Three main functional units are involved in these phases .The characteristics of these phases are described below:

Face database formation phase: During this phase, the gathering and the preprocessing of the face images that are going to be added to the face database are performed. Face images are stored in a face library (file system) in the system. Every action such as training set or eigenface formation is performed on this face library. In order to start the face recognition process, the face library has to be filled with face images. Weight vectors of the face library members are empty until a training set is chosen and eigenvectors are formed.

Training phase: Images that are going to be in the training set are chosen from the entire face library. After choosing the training set, eigenfaces are formed and stored for later calculations. Eigenfaces are calculated from the training set, keeping only the M images that correspond to the highest eigenvalues. These M eigenfaces define the M-dimensional face space. When the new faces are acknowledged, the eigenfaces can be updated or recalculated. The corresponding weight vector of each face library member has now been updated. **Note:** Once a training set has been chosen, it is not possible to add need members to the face library with the established method that is presented in the "face database formation phase" because the system does not know whether this item already exists in the face library or not. Therefore, a library search must be performed.

Recognition and learning phase:

After choosing a training set and constructing the weight vectors of face library members, now the system is ready to perform the recognition process. The recognition process in initialized by choosing the input image (the image, one seeks to recognize). The weight vector is constructed with the aid of the eigenfaces that were already stored during the training phase. After obtaining the weight

Vector, it is compared with the weight vector of every face library member with a user defined "threshold". If there exists at least one face library member that is similar to the acquired image within that threshold then, the face image is classified as known". Otherwise, a miss has occurred and the face image with its corresponding weight vector for later use. This process is called learning to recognize.

Eigenvectors and eigenvalues definitions

An eigenvector of a matrix is a vector such that, if multiplied with the matrix, the result is always an integer multiple of that vector. Its direction is not changed by that transformation. This integer value is the corresponding eigenvalue of the eigenvector. The corresponding eigenvalue is the proportion by which an eigenvector's magnitude is changed. This relationship can be described by the equation $M * u = * u$, where u is an eigenvector of the matrix M and is the corresponding eigenvalues. This means, an eigenvalue of 2 means that the length of the eigenvector has been doubled. An eigenvalue of 1 means that the length of the eigenvector stays the same. Eigenvectors posses following properties:

- They can be determined only for square matrices.
- There are n eigenvectors (and corresponding eigenvalues) in an n * n matrix.

All the eigenvectors are perpendicular, i.e. at right angle with each other [7].

The Use of Eigenfaces for Recognition:

Overview of the algorithm using eigenfaces: The algorithm for the facial recognition system using eigenfaces is basically described in Fig. First, the original images of the training set are transformed into a set of eigenfaces E. Afterwards; the weights are calculated for each image of the training set and stored in the set W. When observing an unknown image X, the weights are calculated for that particular image and stored in the vector W_X Afterwards, is compared with the weights of images, of which one knows for certain that they are faces (the weights of the training set W). One way to do it would be to regard each weight vector as a point in space and calculate an average distance D between the weight vectors from and the weight vector of the unknown image (the Euclidean distance described in the appendix B would be a measure for that). If this average distance exceeds some threshold value, then the weight vector of the unknown image lies too far apart from the weights of

Figure:7[7]

the faces. In this case, the unknown X is considered not a face. Otherwise (if X is actually a face), its weight vector is stored for later classification [7].

Problems faced: Calculating the average and weights of the faces takes so much processing and time when run for the first time to run the program.

Limitations: Non-uniform backgrounds and lighting conditions affect the recognition process.

Recommendation:

- Using black or uniform background used in the image.
- Use sufficient light to illuminate the scene

Computation step:

We make use of Eigenvectors and Eigenvalues for face recognition with PCA [7].

Step 1: we prepare an initial set of face images [X1, X2, ...,Xn].

Step 2: The average face of the whole face distribution is

X = (X1 + X2 + ... + Xn)/n

Step 3: Then the average face is subtracted from each face,

Xi' = Xi - X, i = 1, 2, ... , n

Step 4: calculation of eigenvectors

[Y1, Y2, ...,Yn] eigenvectors are calculated from the new image set [X1', X2', ... Xn'].

These eigenvectors are orthonormal to each other.

Step 5: Starting with a preprocessed image I(x, y), which is a two dimensional N by N array of intensity values. This may be considered a vector of dimension. A database of M images can therefore map to a collection of points in this high dimensional "face space" as G1, G2, G3…..GM. With the average face of the image set defined as

$$\gamma = \frac{1}{m}\sum_{n=0}^{m} Gn \qquad (1)$$

Each face can be mean normalized and be represented as deviations from the average face by i=Gi-. The covariance matrix, defined as the expected value of can be calculated by the equation

C= 1/m (2)

Set of very large vectors is subject to PCA, which seeks a set of M ortho-normal vectors, , which best describes the distribution of the data.
The kth vector, is chosen such that
=1/m pow 2 (3)

Is a maximum, subject to
={ 1 if i=j , 0 if i ! =j }

Given the covariance matrix C, we can now proceed with determining the eigenvectors and eigenvalues of C in order to obtain the optimal set of principal components, a set of eigenfaces that characterize the variations between face images [7].

C= 1/m = A

Where the matrix A= [Ø1, Ø2, Ø3…ØM]

Following the matrix analysis, the M * M matrix L=A is constructed, where
=, and the M eigenvectors, of L is computed. These vectors

determine linear combinations of the M training set face images to form the
eigenfaces.

= , I =1,…………,m
The success of this algorithm is based on the evaluation of the eigenvalues and the
eigenvectors of the real symmetric matrix L that is composed from the training set of images. After this step, the "training" phase of the algorithm is accomplished.

Classifying Images:

Classifying an image with eigenfaces

A new face image (G) is transformed into its eigenface e components (projected onto "face space")

=(G-)
For k=1,…,

The weights form a feature vector,
=[]

The face classes W_1 can be calculated by taking the average of the results of the eigenface representation over a small number of face images (as few as one) of each individual. Classification is performed by comparing the feature vectors of the face library members with the feature vector of the input face image. This comparison is based on the Euclidean distance between the two members to be smaller than a user defined threshold. If the comparison falls within the user defined threshold, then face image is classified as "known", otherwise it is classified as "unknown" and can be added to face library with its feature vector for later use, thus making the system learning to recognize new face images [7].

Output

The output of our system will consist of the face ID with the closest match, as well as a value representing how close this match is (a distance value).

Conclusions and Future work

In order to obtain the presence of terrorist or any unwanted activity in the over populated areas or the targeted areas, this project is imposed to identify the criminals by matching their face with the faces stored in the database. The database comprise of the criminal images that is the images of those having any back record. The database can be updated to add new faces. It can be done at regular intervals or within particular timestamp.

This research aims at providing the system to automatically detect or match the face with the faces stored in the database. In case a match is found, immediate action can be taken and the unwanted attack can be resolved frequently.

In further work, our system can be used in a completely new dimension of face recognition application, automated attendance system using face recognition technique.

The efficiency and the effectiveness of the project can also be improved by using high quality surveillance cameras to achieve more clear vision or images. So as to make the process of identification could be easier and faster.

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