RESEARCH ARTICLE

Real-Time Secure System for Detection and Recognition the Face of Criminals

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Abstract— in this paper We present a system for real-time, saved images And Video Recorded in this three Method We Can detecting and recognizing faces of a criminal at public place Or Checkpoint such that the system easy to learn And to implementation ,the three method that used in the system make recognition very accuracy , where if we running it will appear Login window in this screen should insert (username And Password) to enter in the main window, in the main window we must firstly insert images to Database and Then choose the way that want to recognition, if the system recognition the Face, the system will show the name of the criminal and in the same time the system will appear Danger Sound Refer that the Criminals Recognition and Matched in the Database , Besides that we can make Easy update(Rename ,Delete) to the Database without complexed.

Keywords— Principle Component Analysis, Eigenfaces, Haar Features, Cascade Classifier

1. Introduction

Face recognition is one of the most active and widely used technique [1][2] because of its reliability and accuracy in the process of recognizing and verifying a person's identity. The need is becoming important since people are getting aware of security and privacy. For the Researchers Face Recognition is among the tedious work. It is all because the human face is very robust in nature; in fact, a person's face can change very much during short periods of time (from one day to another) and because of long periods of time (a difference of months or years). One problem of face recognition is the fact that different faces could seem very similar; therefore, a discrimination task is needed. On the other hand, when we analyze the same face, many characteristics may have changed. These changes might be because of changes in the different parameters. The parameters are: illumination, variability in facial expressions, the presence of accessories (glasses, beards, etc.); poses, age, finally background. We can divide face recognition [3][4] techniques into two big groups, the applications that required face identification and the ones that need face verification. The difference is that the first one uses a face to match with other one on a database; on the other hand, the verification technique tries to verify a human face from a given sample of that face. Face recognition has been an active research area over the last 30 years. It has been studied by scientists from different areas of psychophysical sciences and those from different areas of computer sciences. Psychologists and neuroscientists mainly deal with the human perception part of the topic, whereas engineers studying on machine recognition of human faces deal with the

computational aspects of face recognition. Face recognition has applications mainly in the fields of biometrics, access control, law enforcement, and security and surveillance systems.

2. Biometric Measures

Biometric systems are automated methods for identifying people through physiological or behavioral characteristics. Face recognition As compared with other biometrics systems using fingerprint/palm-print and iris, face recognition has distinct advantages because of its noncontact process. Face images can be(system would allow a person to be identified by walking in front of a camera and captured from a distance without touching the person being identified, and the identification does not require interacting with the person. In addition, face recognition serves the crime deterrent purpose because face images that have been recorded and archived can later help identify a person.

3. Real-time image processing

The term real-time imaging refers to real-time image processing and image analysis. Simply put, the camera gets images which are digitized into computer graphics. Picture processing is any form of signal processing for which the input is an image, such as a photograph or a video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal processing techniques to it . For this process the OpenCV library is used, which is able to query and manipulate images straight from a camera connected to the computer[5] .

4. Face Detection

Face detection is a computer vision technology that determines the locations and sizes of human faces in arbitrary (digital) images. It detects facial features and ignores anything else, such as buildings, trees and bodies. Face detection can be regarded as a specific case of object-class detection. In object-class detection, the task is to find the locations and sizes of all objects in a digital image that belong to a given class. Examples include upper torsos, pedestrians, and cars. human face localization and detection is often the first step in applications such as video surveillance , human computer interface, face recognition and image database management. Locating and tracking human faces is a prerequisite for face recognition and/or facial expressions analysis, although it is often assumed that a normalized face image is available[6] .

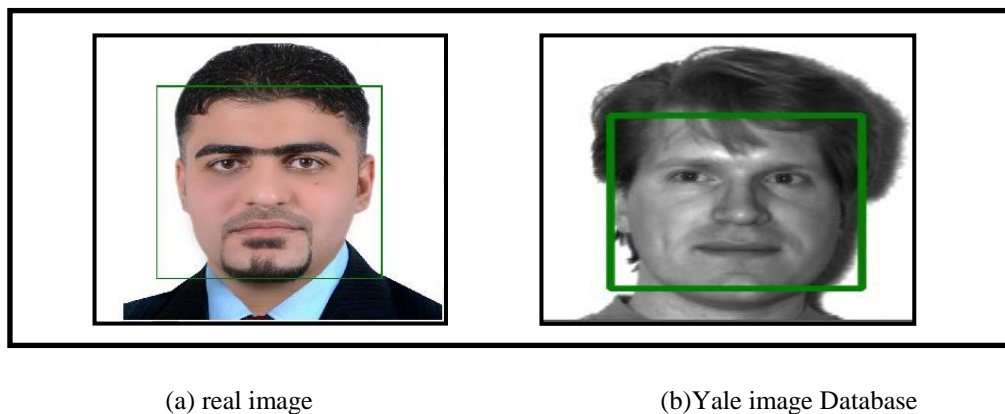(a) real image   (b)Yale image Database

Figure 1: Face Detection

5. Face Detection Techniques

It's always good to know that the method you're applying is in fact the better one among all the rest. For that you should know what methods have been developed, their pros and cons and why you're not using those

instead, who knows you might find some other method more useful for your project? This way you can create your work with maximum efficiency. knowing the current work done allows us to explore future possibilities as well. here are many ways to detect a face in a scene - easier and harder ones [7].

5.1 Finding Faces in images with controlled background

The method that can be used when you simply have a frontal face image against a plain background. In this case the software can easily remove the background, leaving face boundaries. If software uses this approach it tends to have a number of different classifiers for detecting different types of front-on faces, along with some for profile faces. It will attempt to detect eyes, a nose, a mouth, and in some cases even a whole body for pictures that show more than just a face [7] [8].

5.2 Finding faces by color

The method that can use to look for faces. It obviously requires that the photos or video images used be color. The software scans the picture looking for areas that are of a typical skin color, then looking for face segments. A problem with this technique is that skin color varies from race to race, and this method does not work as well for all skin colors. Varying lighting conditions changes the exact hue of a person's skin in the picture, and that can have a major effect on facial detection The advantage: If you have access to color images, you might use the typical skin color to find face segments And the disadvantage: It doesn't work with all kind of skin colors, and is not very robust under varying lighting conditions [9].

5.3 Finding faces by motion

The face in the image is usually in motion So When you are using video images you can use movement as a guide. Faces are usually moving in real-time videos, so one option is for the software to capture the moving area. Of course, other parts of videos also move, so the software needs to look for particular reference points to indicate that it is actually a face that is moving. One specific face movement is blinking. If the software can determine a regular blinking pattern (two eyes blinking together, symmetrically positioned) then this is a good indication that there is a face. From this regular blinking pattern the computer can determine the area of the video image that is actually the face, using one of a number of face models. There will be a number of face models in the software, containing the appearance, shape and motion of faces. There are actually a variety of different face shapes, roughly categorized as oval, rectangle, round, square, heart and triangle. As well as blinking, there are various other motions that signpost to the computer that the image may contain a face. These include raised eyebrows, flared nostrils, wrinkled foreheads and opened mouths. Once one of these actions is detected, the computer will pass their face models over the video image and try and determine a facial match. Once a face is detected, and a particular face model matched with a particular movement, the model is laid over the face, enabling face tracking to pick up further face movements [10].

5.4 Model-based Face Tracking

A Face model can contain the appearance, shape, and motion of faces. This technique uses the face model to find the face in the image. Some of the models can be rectangle, round, square, heart, and triangle. It gives high level of accuracy if used with some other techniques[11].

6. Facial Feature Extraction

In many problem domains combining more than one technique with any other technique(s) often results in improvement of the performance. Boosting is one of such technique used to increase the performance result. Facial features are very important in face recognition. Facial features can be of different types: region, key point (landmark), and contour. In this Method, AdaBoost: Boosting algorithm with Haar Cascade Classifier for face detection and fast PCA and PCA with LDA for the purpose of face recognition. All these algorithms are explained one by one [10] .

7. The Viola-Jones Face Detector

If one were asked to name a single face detection algorithm that has the most impact in the 2000's, it will most likely be the seminal work by Viola and Jones (2001). The Viola-Jones face detector contains three main ideas that make it possible to build a successful face detector that can run in real time: the integral image, classifier learning with AdaBoost, and the attentional cascade structure [12] .

7.1 Weak classifier cascades

The face detection algorithm That used In my Thesis proposed by Viola and Jones is used as the basis of our design. The face detection algorithm looks for specific Haar features of a human face. When one of these features is found, the algorithm allows the face candidate to pass to the next stage of detection. A face candidate is a rectangular section of the original image called a sub-window. Generally this sub-window has a fixed size (typically 24×24 pixels). This sub-window is often scaled in order to obtain a variety of different size faces. The algorithm scans the entire image with this window and denotes each respective section a face candidate. The algorithm uses an integral image in order to process Haar features of a face candidate in constant time. It uses a cascade of stages which is used to eliminate non-face candidates quickly. Each stage consists of many different Haar features. Each feature is classified by a Haar feature classifier. The Haar feature classifiers generate an output which can then be provided to the stage comparator. The stage comparator sums the outputs of the Haar feature classifiers and compares this value with a stage threshold to determine if the stage should be passed. If all stages are passed the face candidate is concluded to be a face. So This Method is distinguished by three key contributions. The first is the introduction of a new image representation called the "Integral Image" which allows the features used by our detector to be computed very quickly. The second is a learning algorithm, based on AdaBoost, which selects a small number of critical visual features from a larger set and yields extremely efficient classifiers. The third contribution is a method for combining increasingly more complex classifiers in a "cascade" which allows background regions of the image to be quickly discarded while spending more computation on promising object-like regions. The cascade can be viewed as an object specific focus-of-attention mechanism which unlike previous approaches provides statistical guarantees that discarded regions are unlikely to contain the object of interest. In the domain of face detection the system yields detection rates comparable to the best previous systems. Used in real-time applications, the detector runs at 15 frames per second without resorting to image differencing or skin color detection [10][12].
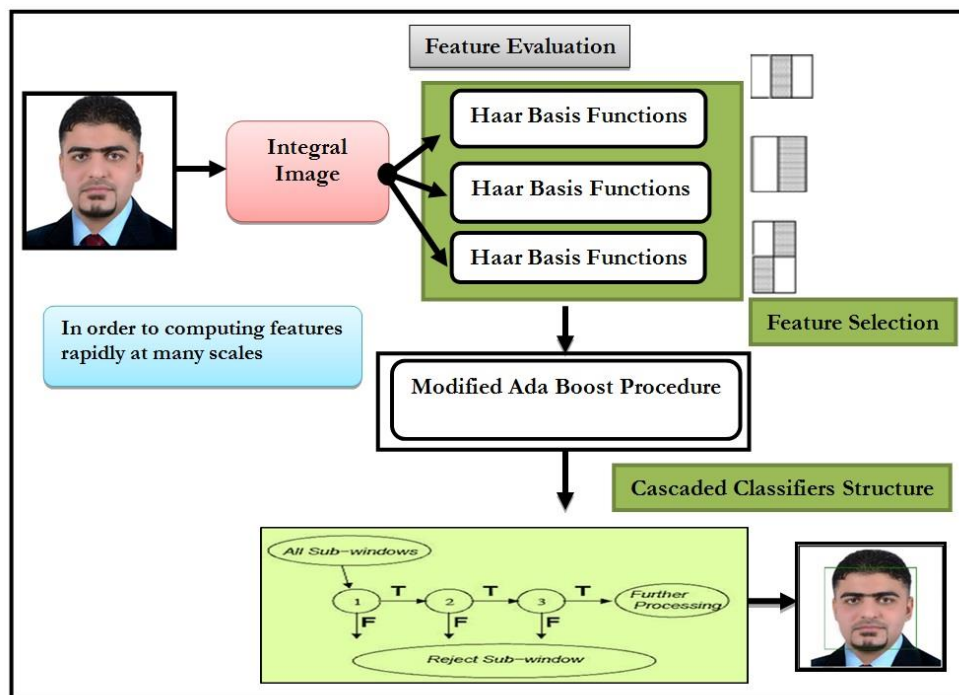

Figure 2 : The Weak classifier cascades to detecting faces

7.2 Integral Image

Rectangle features can be computed very rapidly using an intermediate representation for the image which we call the integral image. The integral image at location x, y contains the sum of the pixels above and to the left of x, y so The integral image is defined as the summation of the pixel values of the original image. The value at any location (x, y) of the integral image is the sum of the images pixels above and to the left of location (x, y). , inclusive:

$$ii(x,y) = \sum_{x' \leq x, y' \leq y} i(x',y')$$

where ii(x, y) is the integral image and i(x, y) is the original image. Using the following pair of recurrences:

$$s(x, y) = s(x, y - 1) + i(x, y) \qquad \text{…………..……...} \qquad (1)$$
$$ii(x, y) = ii(x - 1, y) + s(x, y) \qquad \text{...………..…….} \qquad (2)$$

where s(x, y) is the cumulative row sum ,s(x , −1) =0, ii (−1, y) = 0

the integral image can be computed in one pass over the original image. Using the integral image any rectangular sum can be computed in four array references Clearly the difference between two rectangular sums can be computed in eight references. Since the two-rectangle features defined above involve adjacent rectangular sums they can be computed in six array references, eight in the case of the three-rectangle features, and nine for four-rectangle features[10][13][14].
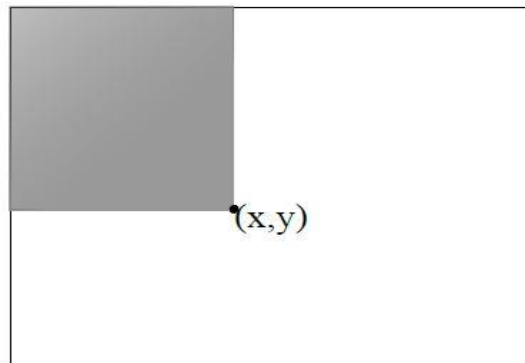

Figure 3 : The value of the integral image at point (x, y) is the sum of all the pixels above and to the left.
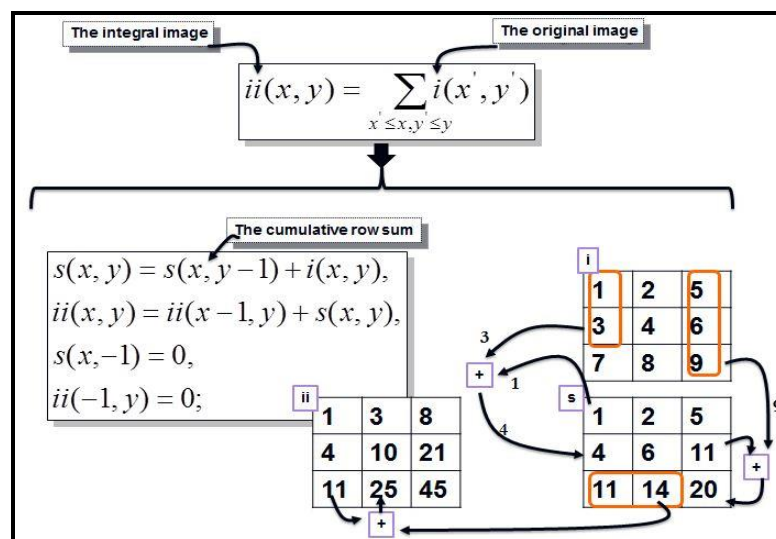

Figure 4 : diagram Represent the Calculate of Integral Image

7.3 Haar Features

The face detection procedure classifies images based on the value of simple features. There are many motivations for using features rather than the pixels directly. The most common reason is that features can act to encode ad-hoc domain knowledge that is difficult to learn using a finite quantity of training data. For this system there is also a second critical motivation for features: the feature-based system operates much faster than a pixel-based system. The simple features used are reminiscent of Haar basis functions. More specifically, we use three kinds of features. The value of a two-rectangle feature is the difference between the sum of the pixels within two rectangular regions. The regions have the same size and shape and are horizontally or vertically adjacent A three-rectangle feature computes the sum within two outside rectangles subtracted from the sum in a center rectangle. Finally a four-rectangle feature computes the difference between diagonal pairs of rectangles. Given that the base resolution of the detector is 24×24, the exhaustive set of rectangle features is quite large, 160,000. Note that unlike the Haar basis, the set of rectangle features is over complete. The value of a Haar-like feature is the difference between the sum of the pixel gray level values within the black and white rectangular regions[14].
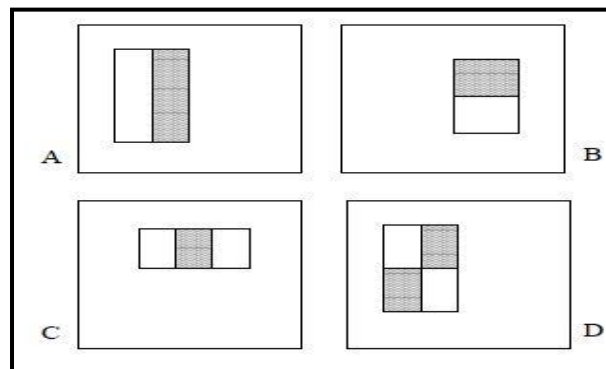
Figure 5: Example rectangle features shown relative to the enclosing detection window. The sum of the pixels which lie within the white rectangles are subtracted from the sum of pixels in the grey rectangles. Two- rectangle features are shown in (A) and (B). Figure (C) shows a three-rectangle feature, and (D) a four-rectangle feature.

7.4 Cascade

The Viola and Jones face detection algorithm eliminates face candidates quickly using a cascade of stages. The cascade eliminates candidates by making stricter requirements in each stage with later stages being much more difficult for a candidate to pass. Candidates exit the cascade if they pass all stages or fail any stage. A face is detected if a candidate passes all stages [15] .
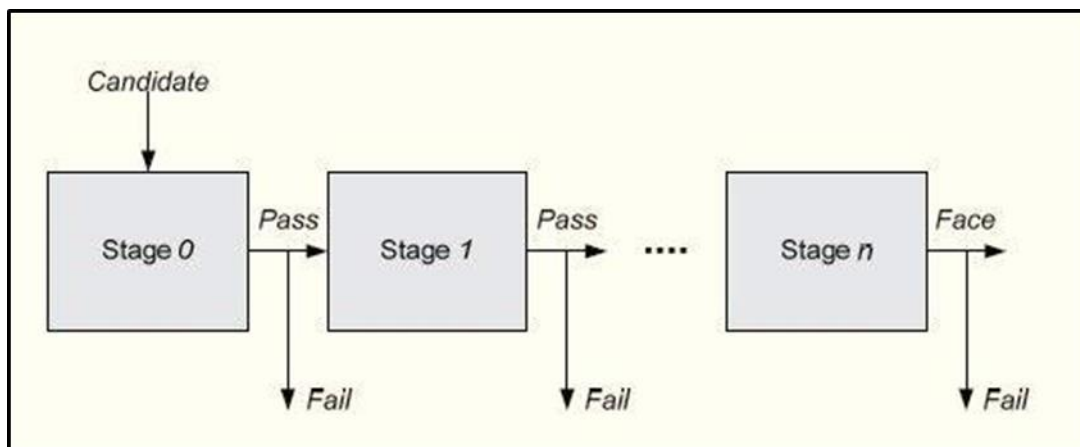
Figure 6 : Cascade of stages. Candidate must pass all stages in the cascade to be concluded as a face.
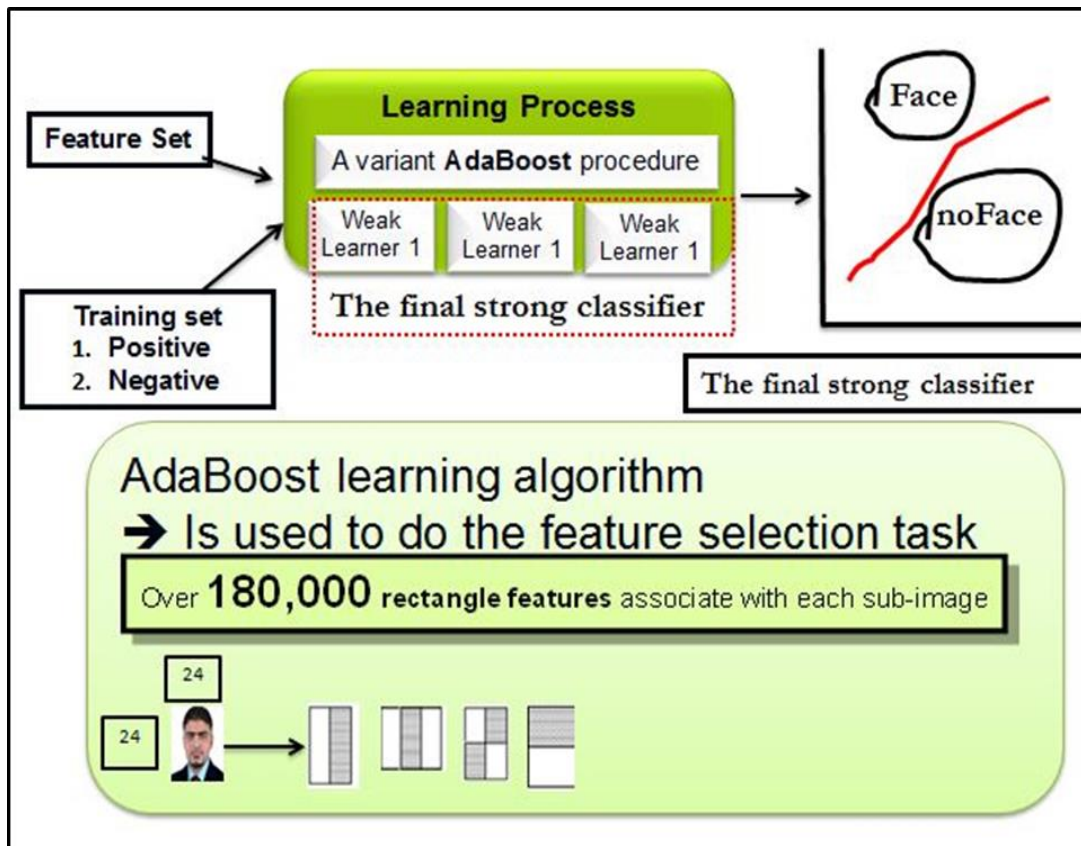
Figure 7 : Explain Detail Of Cascaded Stages

7.5 Learning Results

For the task of face detection, the initial rectangle features selected by AdaBoost are meaningful and easily interpreted. The first feature selected seems to focus on the property that the region of the eyes is often darker than the region [16] .
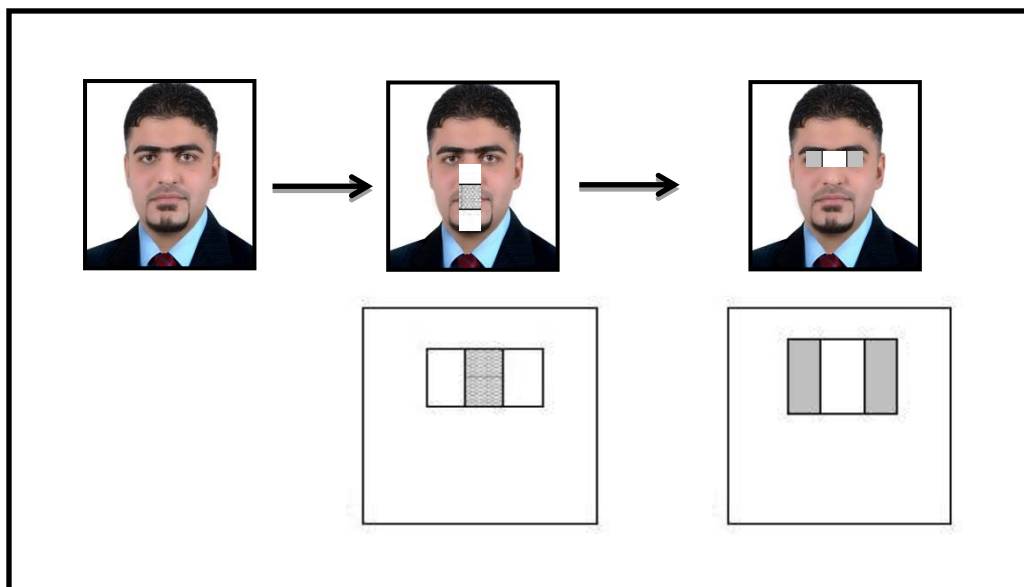

Figure 8 : The first and second features selected by AdaBoost. The two features are shown in the top row and then overlayed on a typical training face in the bottom row. The first feature compares the intensities in the mouth regions to the intensity in the nose and the lower of the mouth bridge of the nose.

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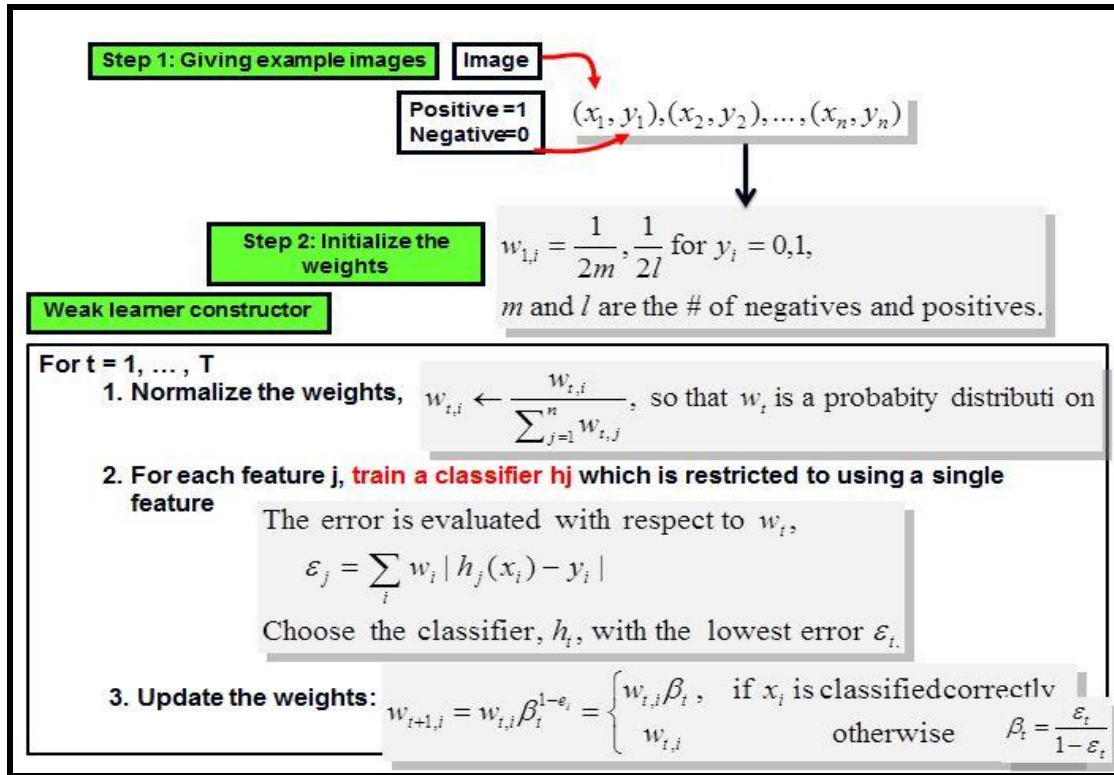
Figure 9: The Steps Of The AdaBoost algorithm for classifier learning
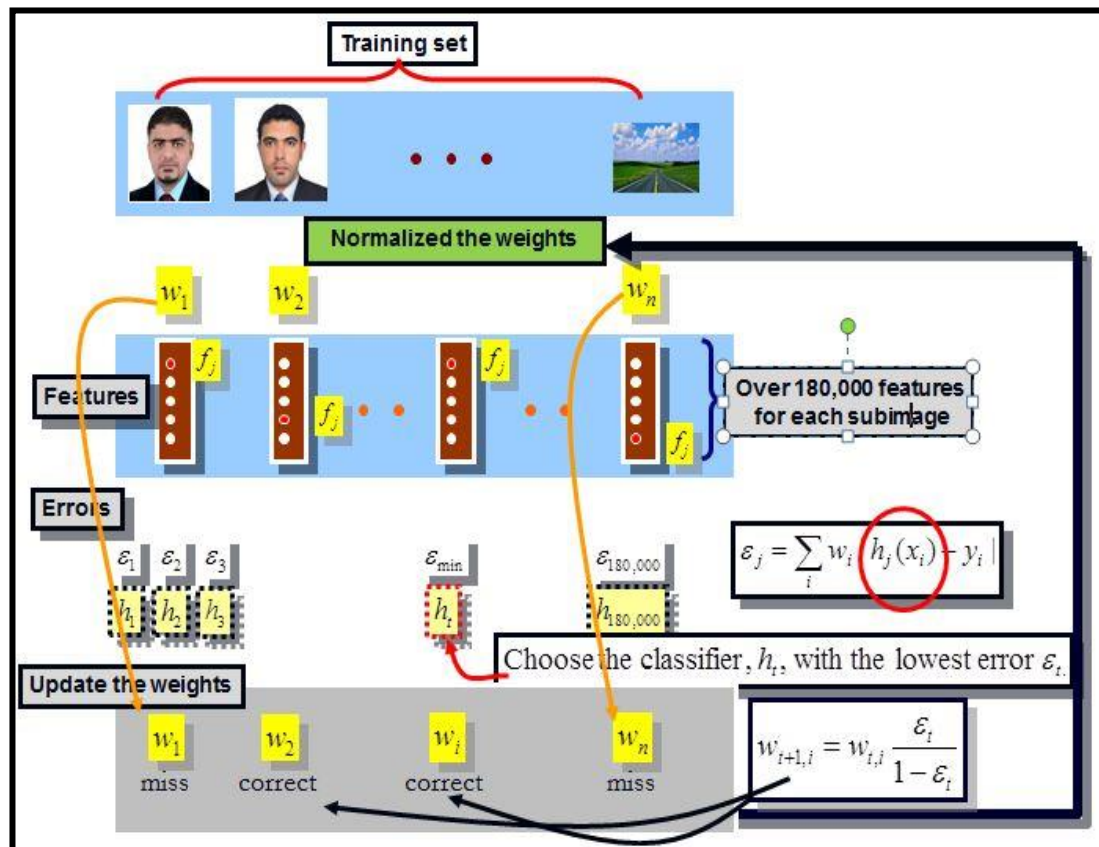
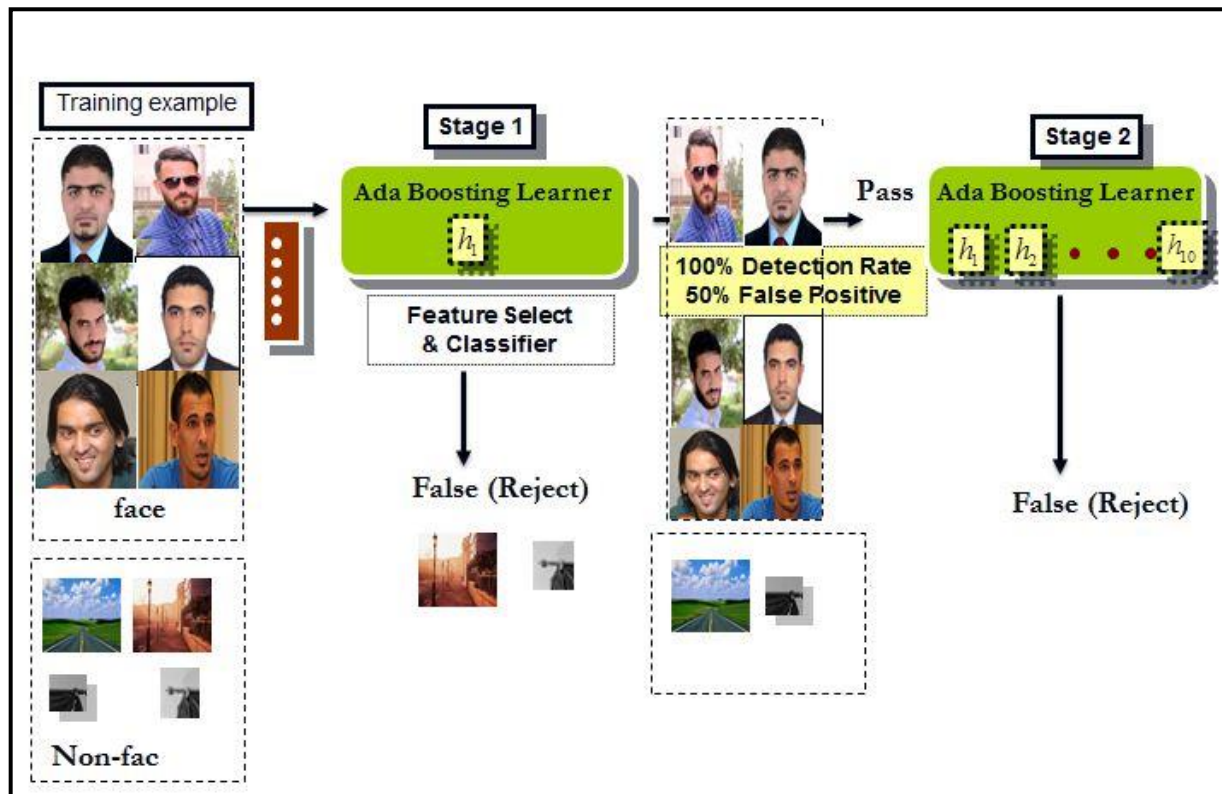

Figure 10 : Weak learner constructor

Figure 11: The Final Result Of Haar Cascade Classifier For Face Detection

8. Face Recognition Techniques

Face recognition is a technique to identify a person face from a still image or moving pictures with a given image database of face images. Face recognition is biometric information of a person. However, face is subject to lots of changes and is more sensitive to environmental changes. Thus, the recognition rate of the face is low than the other biometric information of a person such as fingerprint, voice, iris, ear, palm geometry, retina, etc. There are many methods for face recognition and to increase the recognition rate [10] .

Stages of Facial recognition systems in general:
1) Stage of the get the image (taken) Acquire.
2) Detect stage that Extracting the facial image from the all image .
3) Alignment and Standardization's stage (adjust the face angle with the camera) Align angle.
4) Extract stage that will extract the important feature from face.
5) The Matching stage with the images that stored in DB.
6) Report stage that tell us if the face recognition or Not.
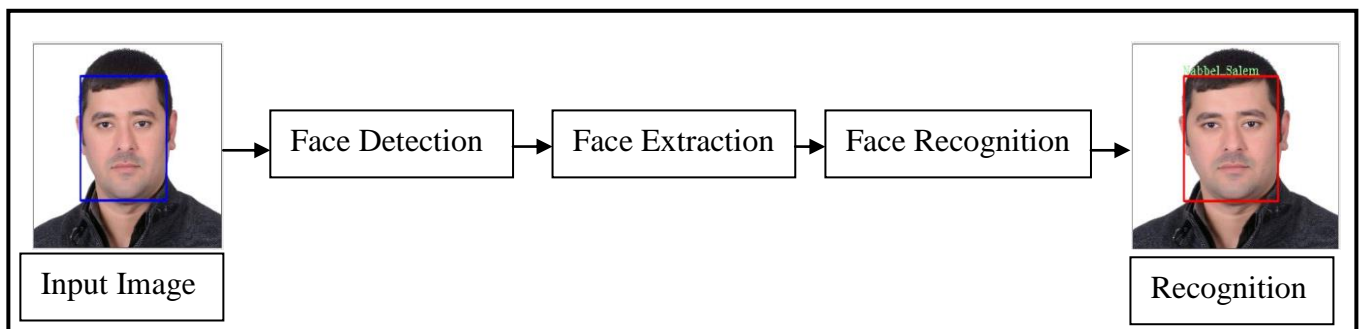

Figure 12. Basic Block Flow Diagram of Face Recognition.

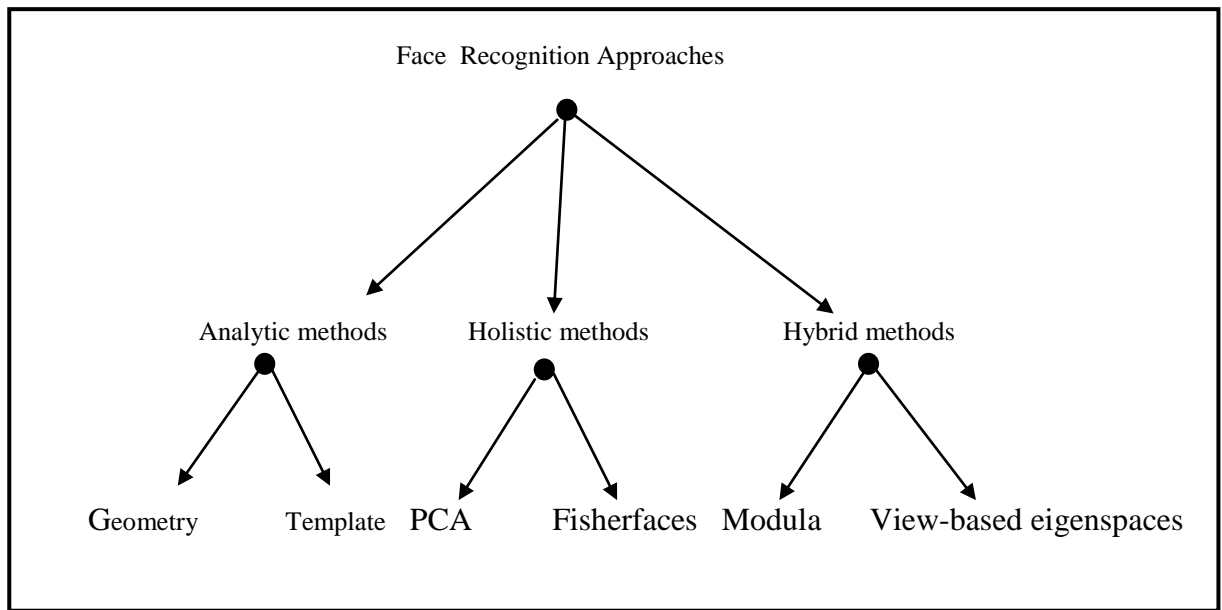Some of the basic commonly used face recognition techniques are as below:

Figure 13: Classification of face recognition methods.

8.1 Geometry and Templates(Analytic)

face recognition were focused on detecting individual features such as eyes, ears, head outline and mouth, and measuring different properties such as size, distance and angles between features. This data was used to build models of faces and made it possible to distinguish between different identities [16][17].

Advantages	Drawbacks
➢ Robust against scaling, orientation and translation when face is correctly normalized ➢ Can handle high resolution images efficiently ➢ Saves neighbourhood relationships between pixels ➢ Can handle very low resolution images ➢ Geometric relations are stable under varying illumination conditions ➢ Good recognition performance	➢ Sensitive to faulty normalization ➢ Sensitive to noise and occlusion ➢ Templates are sensitive to illumination ➢ Sensitive to perspective, viewing angle and head rotation (can be improved using more templates) ➢ Sensitive to facial expressions, glasses, facial hair. etc. ➢ Slow training and recognition/High computational complexity

8.2 Hybrid methods

Hybrid face recognition systems use a combination of both holistic and feature extraction methods. [18][20] So In the field of pattern recognition, computer vision has emerged as an independent field of research activities. Within this field face recognition systems have especially turned out to be the focus of interest for a wide field of demanding applications in areas such as security systems or indexing of large multimedia databases .Holistic matching and Feature-based matching approaches are the two major classes of face recognition methods. Holistic matching is based on information theory concepts; seeks a computational model that best describes a face, by extracting the most relevant information contained in that face. Feature-based matching is based on the extraction of the properties of individual organs located on a face such as eyes, nose and mouth, as well as their relationships with each other. Current Face Recognition methods, which are based on two-dimension view of face images, can obtain a good performance under constraint environment. However, in the real application face appearance varies due to different illumination, pose, and expression. Each individual classifier based on

different appearance of face image has different sensitivity to these variations, which motivate to move towards hybrid approach [21][16][17].

8.3 Holistic Methods (PCA & Fisherface)

Holistic methods that do not depend on detailed geometry of the faces. The main difficulty in recognizing faces by feature-based approach is that it is not easy to design proper face models due to large variability of face appearance, e.g. pose and light variance. Rather than constructing face models based on geometry, a face recognition system should learn the models automatically from a collection of training images, that is to learn what attributes of appearance will be the most effective in recognition. Of course, enough training data should be available in order the system to account for variations in images. These methods use global representation of faces by treating images as a vector of gray level intensities. Hence, this approach can be referred as image or appearance-based [19][17].

Advantages	Drawbacks
➤ Robust against noise and occlusion ➤ Robust against illumination, scaling, orientation and translation when face is correctly normalized ➤ Robust against facial expressions, glasses, facial hair, etc. ➤ Can handle high resolution images efficiently ➤ Can handle very low resolution images ➤ Can handle small training sets ➤ Fast recognition/Low computational cost	➤ Removes neighborhood relationships between pixels ➤ Sensitive to faulty normalization ➤ Sensitive to perspective, viewing angle and head rotation (can be improved using eigen light-fields or other view-based methods) ➤ Sensitive to large variation in illumination and strong facial expressions ➤ Slow training/High computational cost (with large databases)

Principle Component Analysis (PCA) common method based on holistic approach for face recognition and it is a dimensionality reduction technique that is used for image recognition and compression. It is also known as Karhunen-Loeve transformation (KLT) or eigenspace projection. The main goal of PCA is dimensionality reduction. Therefore, the eigenvectors of the covariance should be found in order to reach the solution. The eigenvectors correspond to the directions of the principle components of the original data, and their statistical significance is given by their corresponding eigenvalues .The first introduction of a low-dimensional characterization of faces was developed at Brown University. This was later extended to eigenspace projection for face recognition. recently used eigenspace projection to identify objects using a lookup table to view objects at different angles. The Method extended grayscale eigenfaces to color images. So PCA allows us to compute a linear transformation that maps data from a high dimensional space to a lower dimensional sub-space [22][23] .
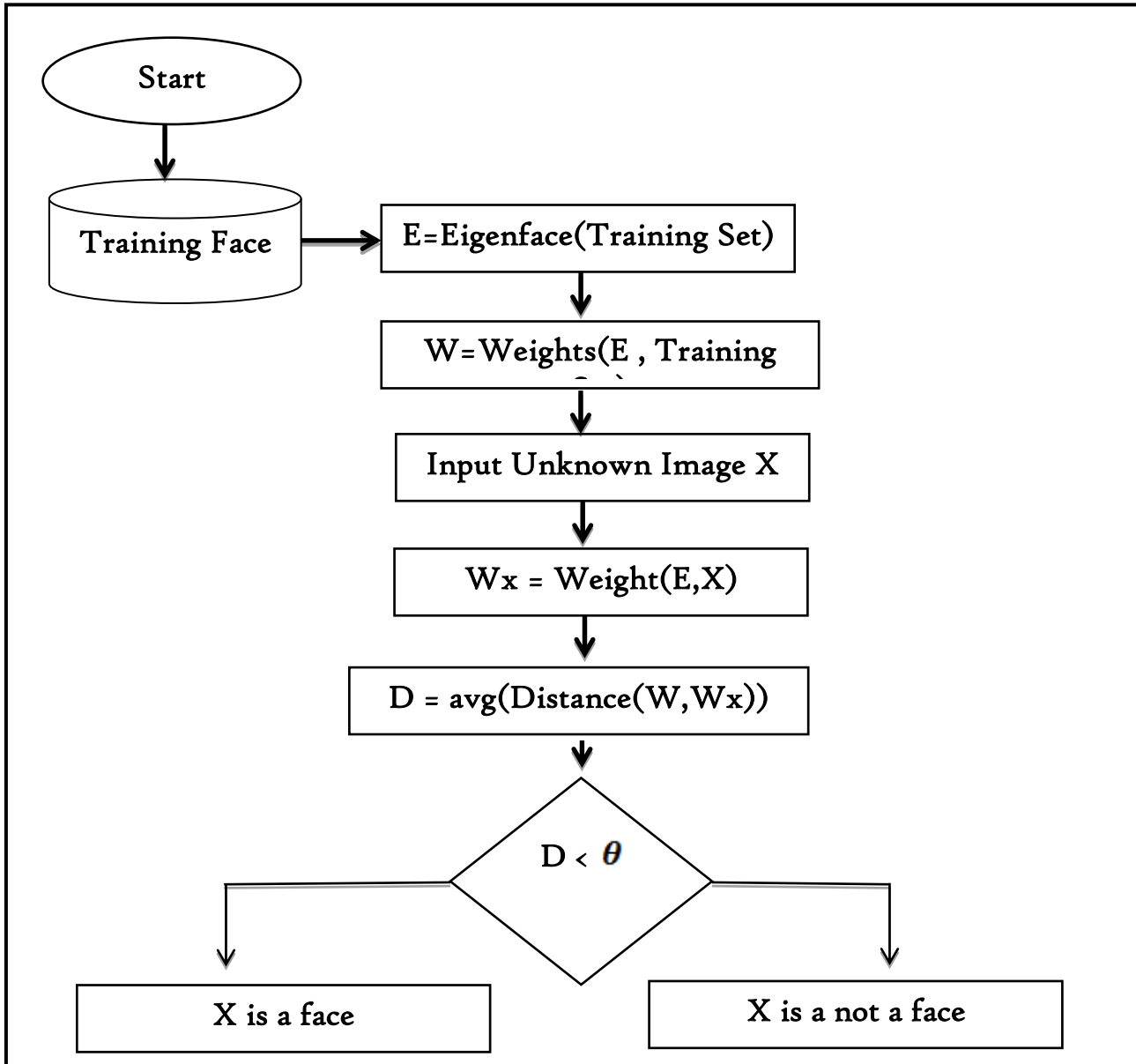
Figure 14: Architecture of PCA algorithm

8.3.2 The PCA approach for face recognition involves the following initialization operations:

1. Acquire a set of training images.
2. Calculate the eigenfaces from the training set, keeping only the best M images with the highest eigenvalues. These M images define the "face space". As new faces are experienced, the eigenfaces can be updated.
3. Calculate the corresponding distribution in M-dimensional weight space for each known individual (training image), by projecting their face images onto the face space.
    Having initialized the system, the following steps are used to recognize new face images:
1. Given an image to be recognized, calculate a set of weights of the M eigenfaces by projecting the it onto each of the eigenfaces.
2. Determine if the image is a face at all by checking to see if the image is sufficiently close to the face space.
3. If it is a face, classify the weight pattern as eigher a known person or as unknown.

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4. (Optional) Update the eigenfaces and/or weight patterns.
5. (Optional) Calculate the characteristic weight pattern of the new face image, and incorporate into the known faces.

8.3.3 The Statistical steps for algorithm PCA

8.3.3.1: Calculating Eigenfaces

Step 1: Training Set

Let a face image $\Gamma(x,y)$ be a two-dimensional N by N array of intensity values. An image may also be considered as a vector of dimension N^2, so that a typical image of size 256 by 256 becomes a vector of dimension 65,536, or equivalently, a point in 65,536-dimensional space. An ensemble of images, then, maps to a collection of points in this huge space. Images of faces, being similar in overall configuration, will not be randomly distributed in this huge image space and thus can be described by a relatively low dimensional subspace. The main idea of the principal component analysis is to find the vector that best account for the distribution of face images within the entire image space. These vectors define the subspace of face images, which we call "face space". Each vector is of length N^2, describes an N by N image, and is a linear combination of the original face images. Because these vectors are the eigenvectors of the covariance matrix corresponding to the original face images, and because they are face-like in appearance, they are referred to as "eigenfaces".

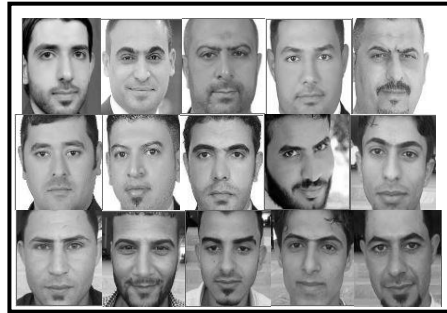Let the training set of face images be $\Gamma_1, \Gamma_2, \Gamma_3, \ldots, \Gamma_M$.

Figure 15: A set of training images from Digital Camera .

Step 2: Mean Face

The average face of the set if defined by [25].
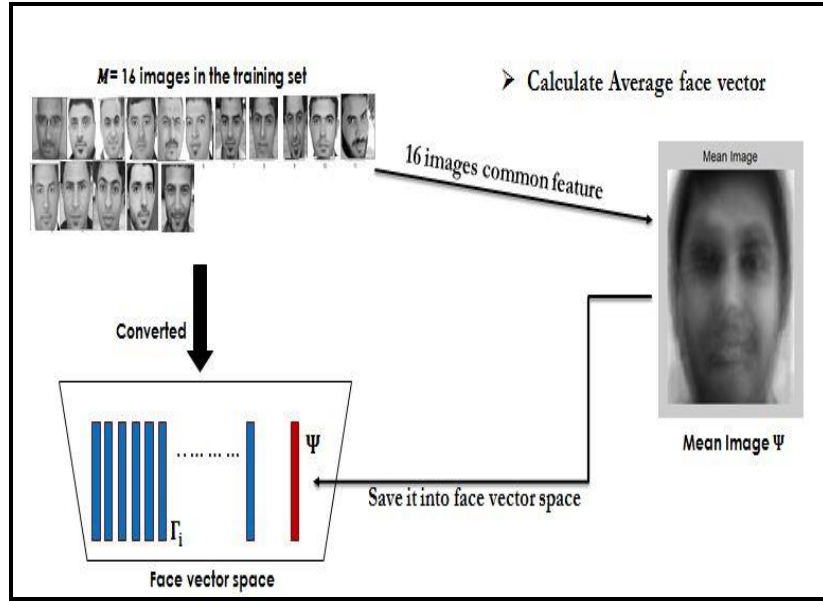
$$\Psi = \frac{1}{M} \sum_{n=1}^{M} \Gamma_n \ .$$

Figure 16 :Mean Image

Step 3: Mean Subtracted Image

Then you will find the difference Φ between the input image Γi and the mean image Ψ [26] .
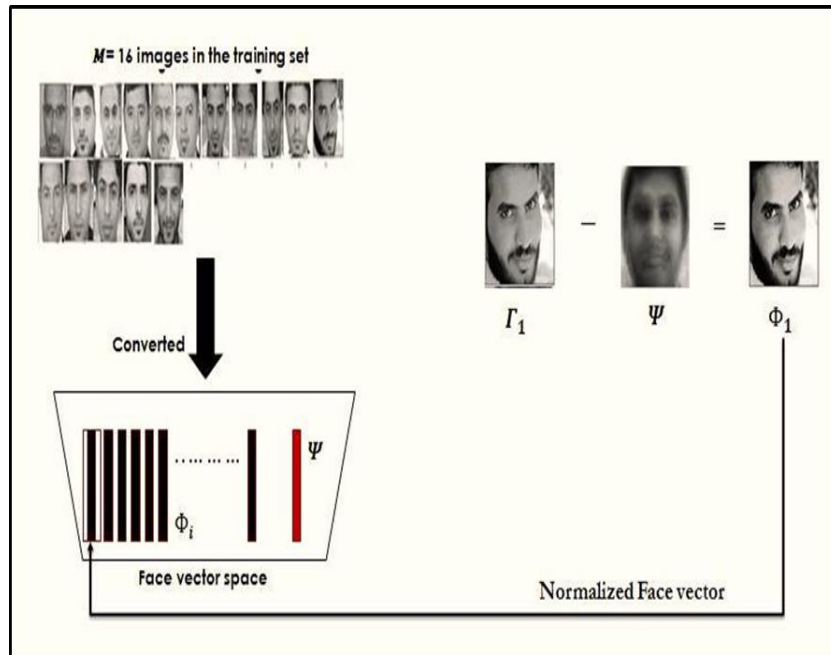
$$\Phi_n = \Gamma_n - \Psi .$$

Figure 17: Mean Subtracted Image

Step 4 : Difference Matrix

A is N x M , A^T is M x N. Thus C will be an N x N matrix Each of mean subtracted training image vectors are then appended column wise to form difference matrix [27] .

$$A = [\Phi_1 \Phi_2 ... \Phi_M]$$

Step 5: Create the covariance matrix

The covariance matrix C Create by multiplying the mean subtracted matrix by its transpose
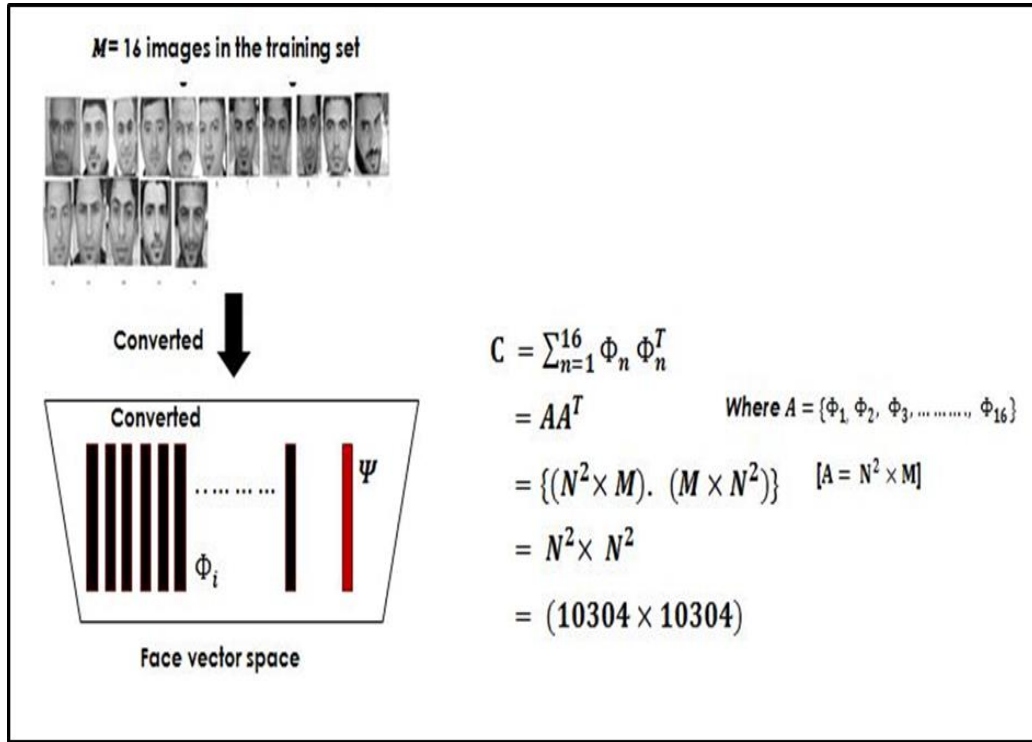
$$C = \frac{1}{M} \sum_{n=1}^{M} \Phi_n \Phi_n^T = AA^T$$

Figure 18. Calculate the Covariance Matrix (C)

Step 6 : Eigen Vectors & Eigen Values :

Training set with the average face Ψ . This set of very large vectors is then subject to principal component analysis, which seeks a set of *M* orthonormal vectors, μ_n , which best describes the distribution of the data. The *k*th vector, μ_k is chosen such that

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

is a maximum, subject to

$$\mu_l^T \mu_k = \begin{cases} 1, l = k \\ 0, otherwise \end{cases}$$

The vectors μ_k and scalars λ_k are the eigenvectors and eigenvalues, respectively, of the covariance matrix

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

where the matrix $A = [\Phi_1\Phi_2...\Phi_M]$. The matrix *C*, however, is N^2 by N^2, and determining the N^2 eigenvectors and eigenvalues is an intractable task for typical image sizes. A computationally feasible method is needed to find these eigenvectors. If the number of data points in the image space is less than the dimension of the space (M< N^2), there will be only M-1, rather than N^2, meaningful eigenvectors (the remaining eigenvectors will have associated eigenvalues of zero). Fortunately, we can solve for the N^2-dimensional eigenvectors in this case by first solving for the eigenvectors of and *M* by *M* matrix—e.g., solving a 16 x 16 matrix rather than a 16,384 x 16,384 matrix—and then taking appropriate linear combinations of the face images Φ_n. Consider the eigenvectors v_n of $A^T A$ such that

$$A^T A v_n = \lambda_n v_n$$

Premultiplying both sides by *A*, we have

$$AA^T A v_n = \lambda_n A v_n$$

from which we see that $A v_n$ are the eigenvectors of $C = AA^T$. Following this analysis, we construct the *M* by *M* matrix $L = A^T A$, where $L_{mn} = \Phi_m^T \Phi_n$, and find the *M* eigenvectors v_n of L. These vectors determine linear combinations of the *M* training set face images to form the eigenfaces μ_n:

$$\mu_n = \sum_{k=1}^{M} v_{nk}\Phi_k = A v_n, n = 1,......,M$$

With this analysis the calculations are greatly reduced, from the order of the number of pixels in the images (N^2) to the order of the number of images in the training set (*M*). In practice, the training set of face images will be relatively small (M< N^2), and the calculations become quite manageable. The associated eigenvalues allow us to rank the eigenvectors according to their usefulness in characterizeing the variation among the images.
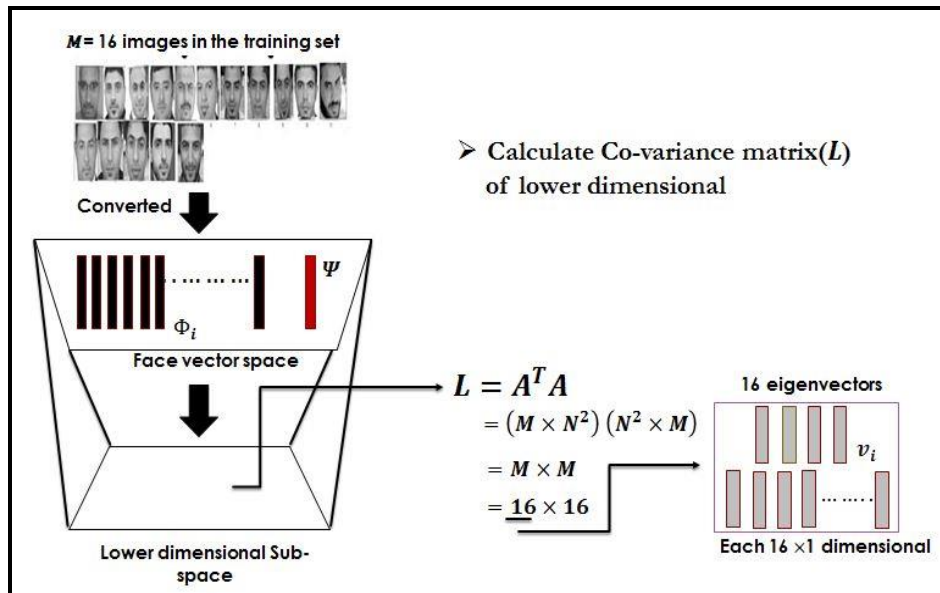

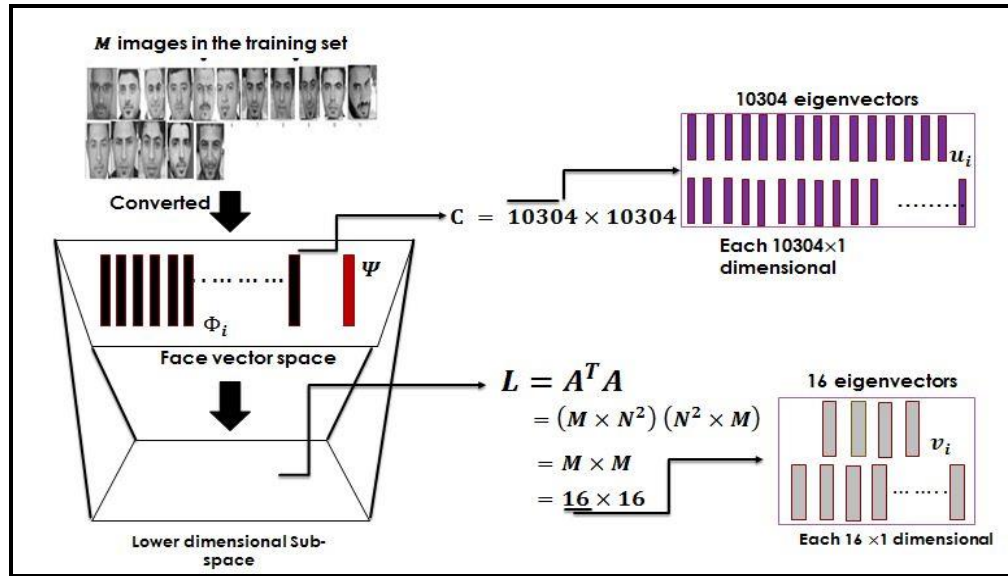Figure 19. Calculate Co-variance matrix(L) of lower dimensional
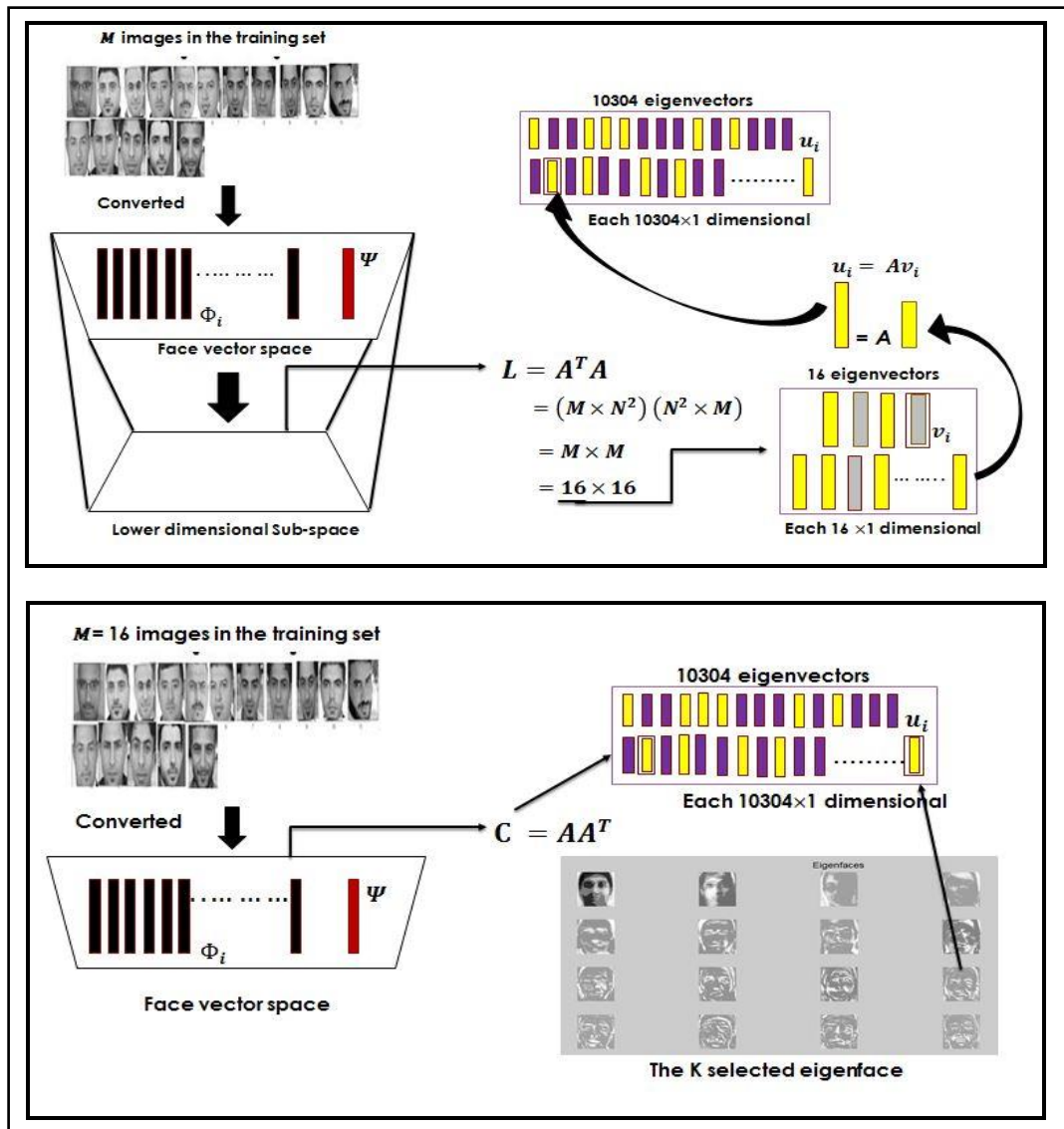
Figure 20. Eigenvalue And Eigenvectors

Figure 20. Select The best K Of eigenvectors

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8.3.3.2: Face Recognition Using Eigenfaces

The eigenface images calculated from the eigenvectors of L span a basis set with which to describe face images. As mentioned before, the usefulness of eigenvectors varies according their associated eigenvalues. This suggests we pick up only the most meaningful eigenvectors and ignore the rest, in other words, the number of basis functions is further reduced from M to M' ($M'<M$) and the computation is reduced as a consequence. Experiments have shown that the RMS pixel-by-pixel errors in representing cropped versions of face images are about 2% with M=115 and M'=40 [11].

In practice, a smaller M' is sufficient for identification, since accurate reconstruction of the image is not a requirement. In this framework, identification becomes a pattern recognition task. The eigenfaces span an M' dimensional subspace of the original N^2 image space. The M' most significant eigenvectors of the L matrix are chosen as those with the largest associated eigenvalues.

A new face image Γ is transformed into its eigenface components (projected onto "face space") by a simple operation

$$\omega_n = \mu_n(\Gamma - \Psi)$$

for n=1,......,M'. This describes a set of point-by-point image multiplications and summations.

The weights form a vector $\Omega^T = [\omega_1, \omega_2, ..., \omega_{M'}]$ that describes the contribution of each eigenface in representing the input face image, treating the eigenfaces as a basis set for face images. The vector may then be used in a standard pattern recognition algorithm to find which of a number of predefined face classes, if any, best describes the face. The simplest method for determining which face class provides the best description of an input face image is to find the face class k that minimizes the Euclidian distance

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

where Ω_k is a vector describing the kth face class. The face classes Ω_k are calculated by averaging the results of the eigenface representation over a small number of face images (as few as one) of each individual. A face is classified as "unknown", and optionally used to created a new face class.

Because creating the vector of weights is equivalent to projecting the original face image onto to low-dimensional face space, many images (most of them looking nothing like a face) will project onto a given pattern vector. This is not a problem for the system, however, since the distance ε between the image and the face space is simply the squared distance between the mean-adjusted input image $\Phi = \Gamma - \Psi$ and $\Phi_f = \sum_{i=1}^{M'} \omega_i \mu_i$, its projection onto face space:

$$\varepsilon^2 = \left\| \Phi - \Phi_f \right\|^2$$

Thus there are four possibilities for an input image and its pattern vector: (1) near face space and near a face class; (2) near face space but not near a known face class; (3) distant from face space and near a face class; (4) distant from face space and not near a known face class. In the first case, an individual is recognized and identified. In the second case, an unknown individual is present. The last two cases indicate that the image is not a face image. Case three typically shows up as a false positive in most recognition systems; in this framework, however, the false recognition may be detected because of the significant distance between the image and the subspace of expected face images.
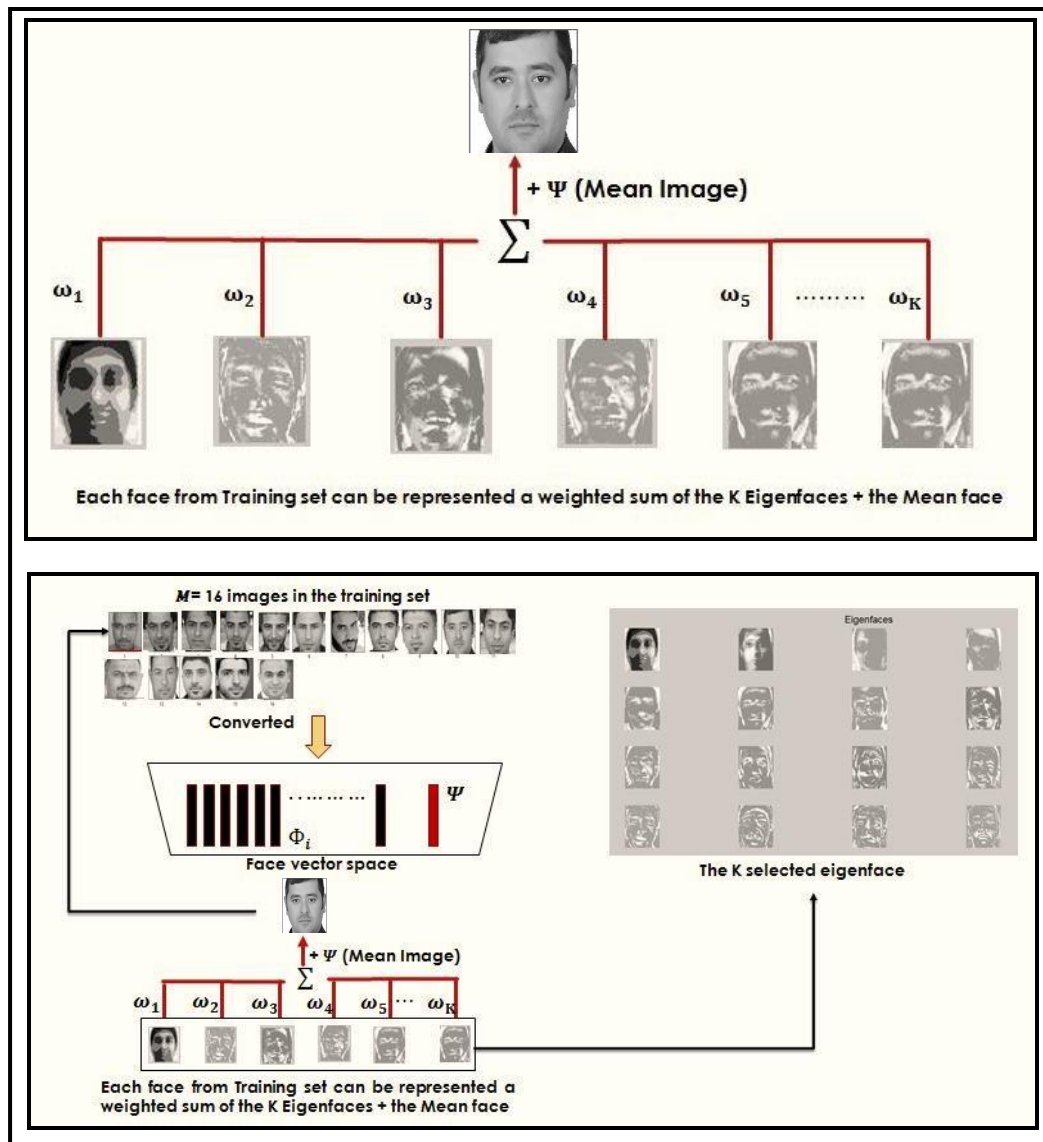
Figure 21 Represent Each Face Image a Linear Combination of all K Eigenvectors
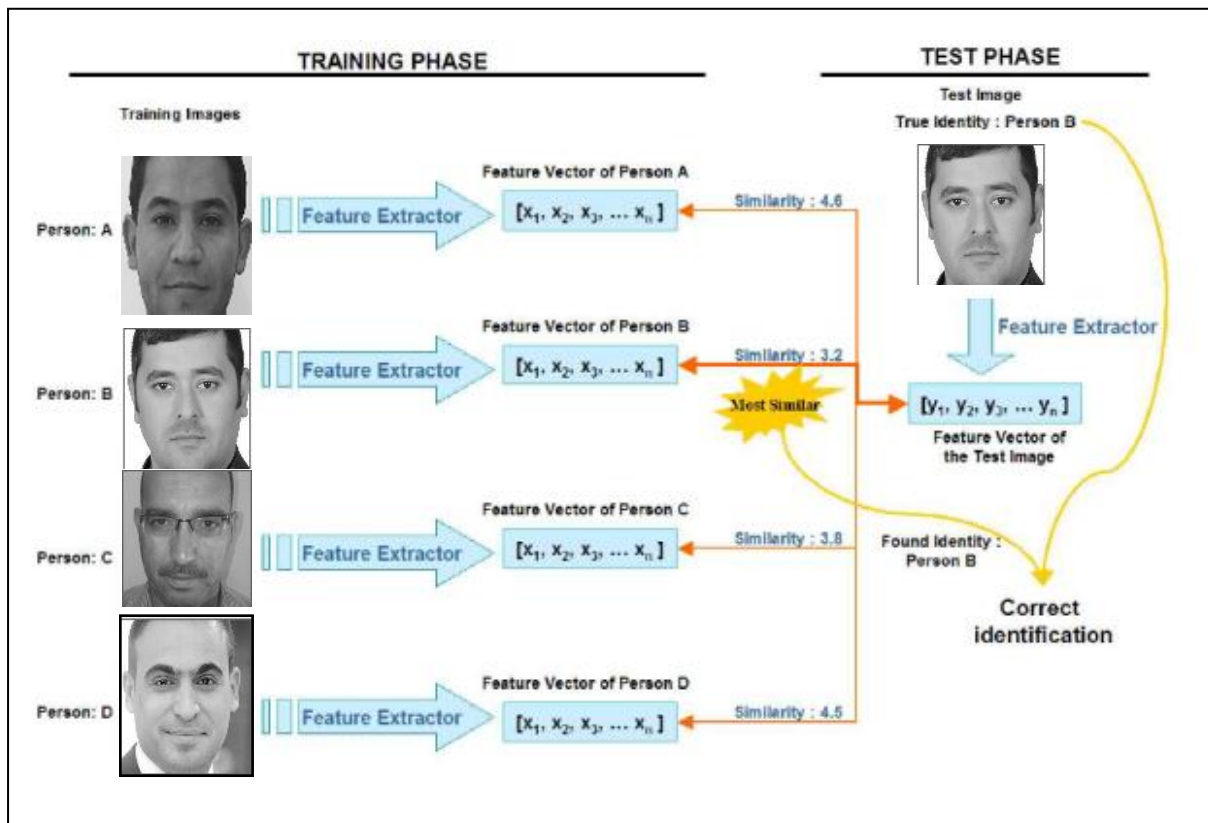
Figure 22: The Final Result Of Face Recognition Using PCA

9. Proposed The System

The aim Of the system proposed is a real-time system and the two other method are to make the system in high accuracy and to make sure that the criminal is the same that in the Database , The recognition in real time I used (Logitech 720p webcam) to Acquire the Face's from the real word , Firstly Stage should be insert Training images to DB in this stage we can insert images to DB in the method (Video Live , Video Recorded , Saved image),Second Stage choose the Way Of the Recognition , here is the heart of the system such that if the system Recognize three Event will appear (The name of the criminal up his face, Danger Sound make attention to the person that used system and the rectangle color of face will convert from green to Red) , Third Stage we can Update the Training images in Database (Delete, Rename).The System Used (Yale Database images , Real world images taken in LG G3 mobile Phone),The deal with the system is very easy because more of the button in the main window not able in same time that make the user know the steps of the system.
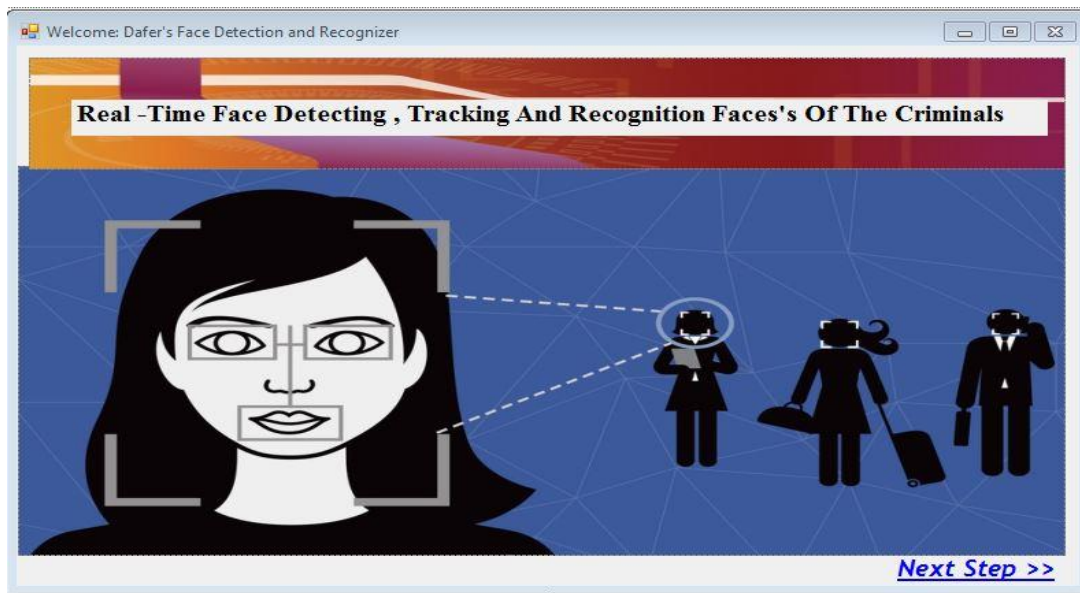
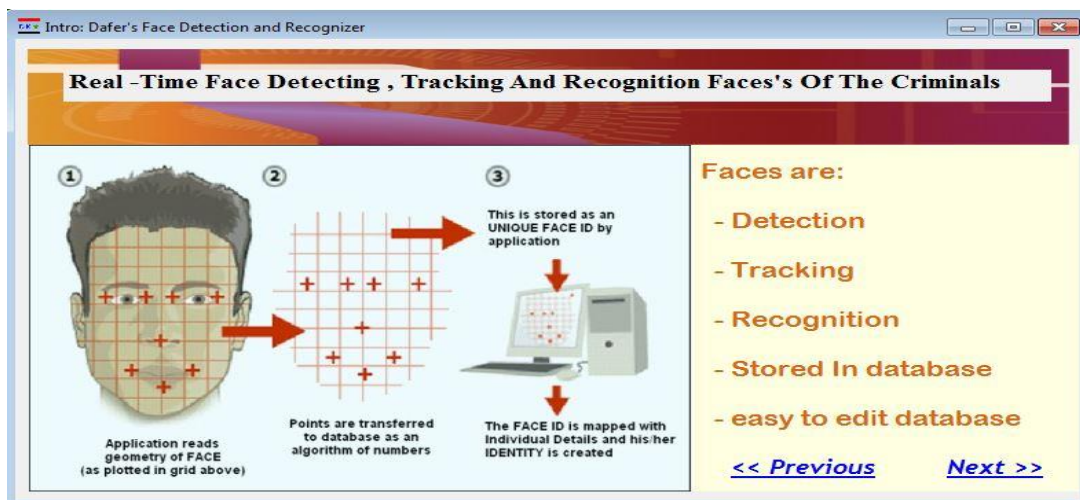Figure 23. Welcome Screen of the system Application GUI.

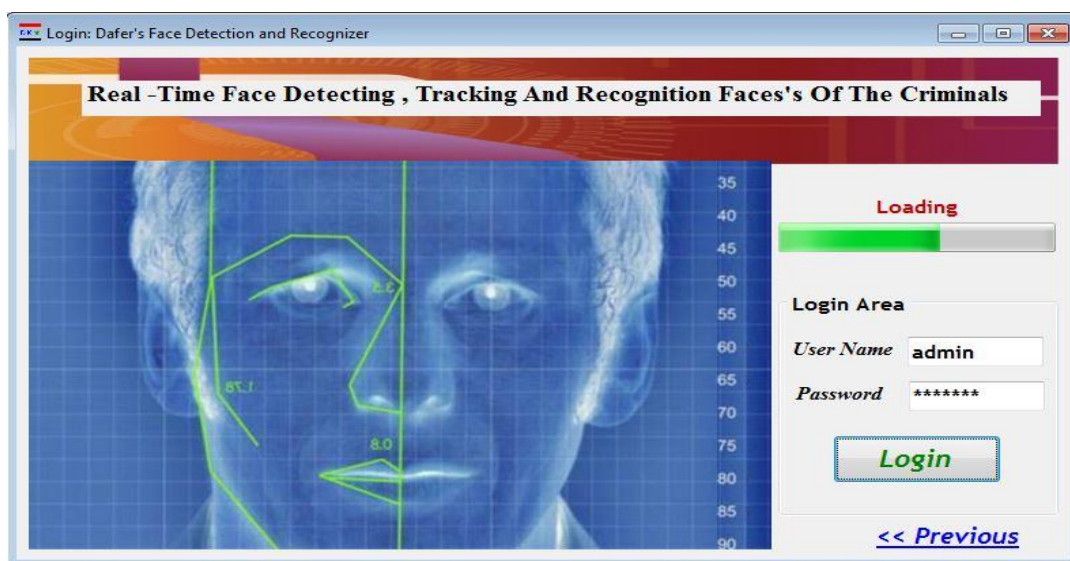Figure 24. The Operation in the Face Recognition System
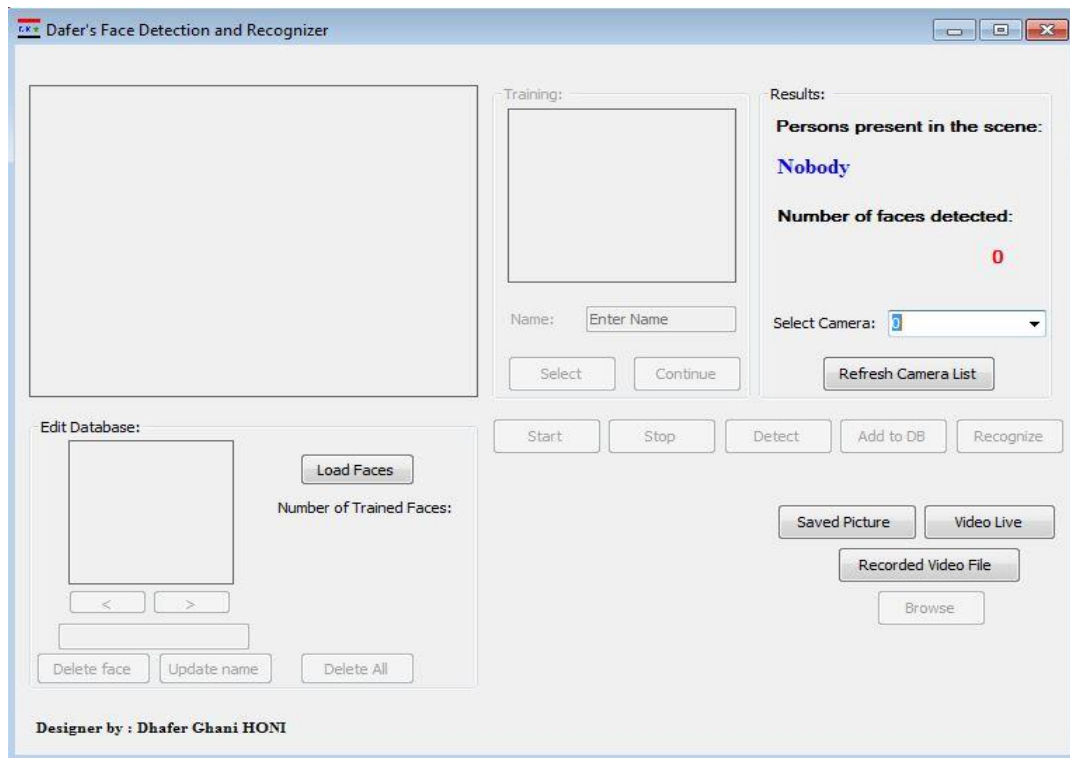

Figure 25. The Login Window

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Figure 26. The Main Window of The System

In the Yale database there are 111 Images For 10 person each person 11 images in different position with different emotions. The recognition rate is very high (99-98%) For Saved images, the figure shown the recognition rate.
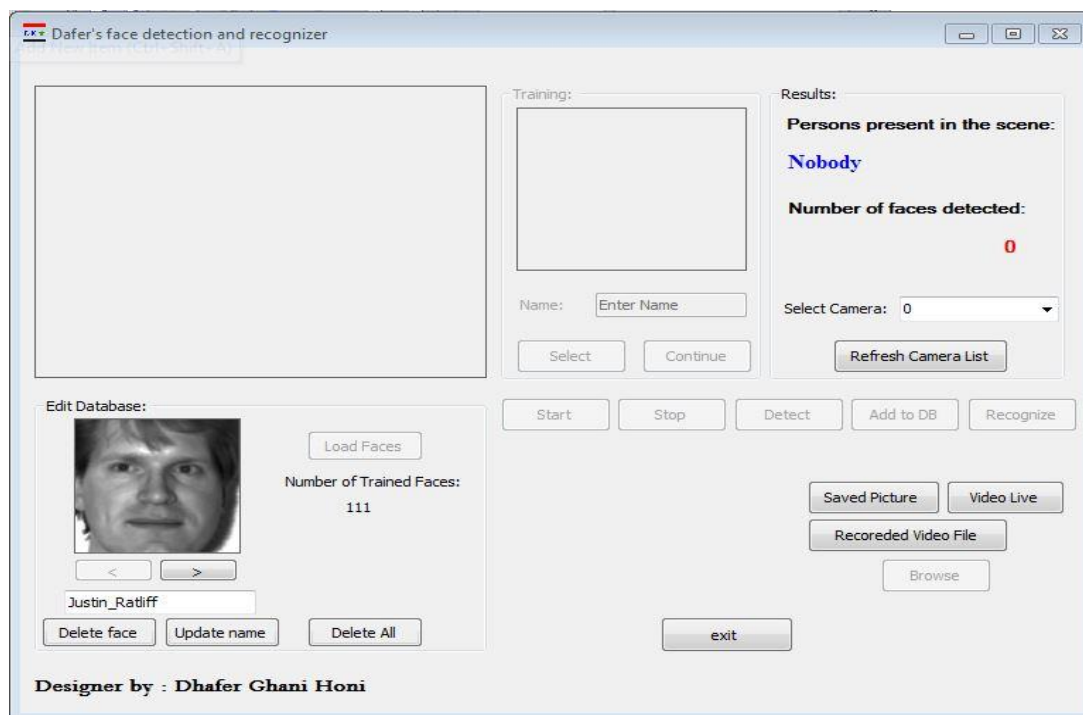

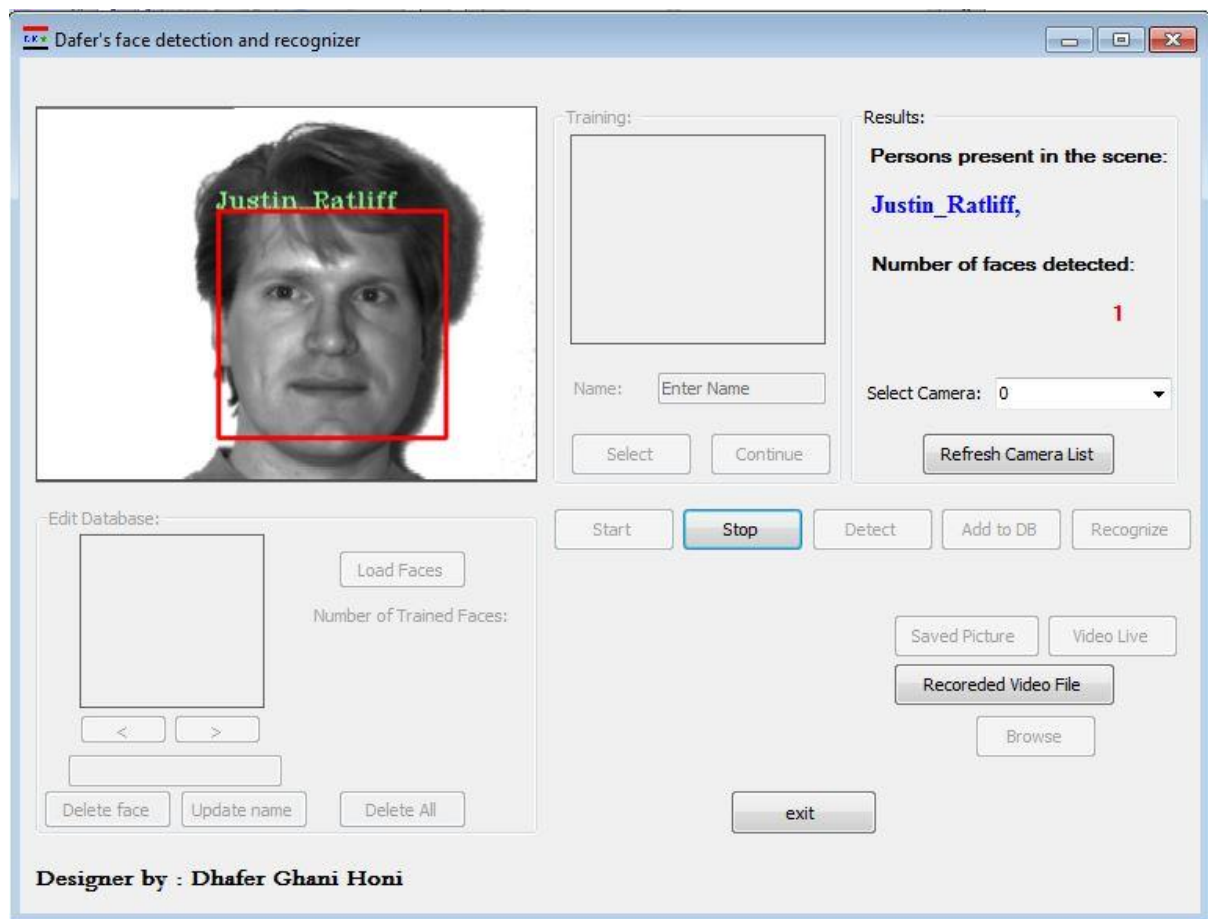Figure 27. Yale Database with 111 gray images
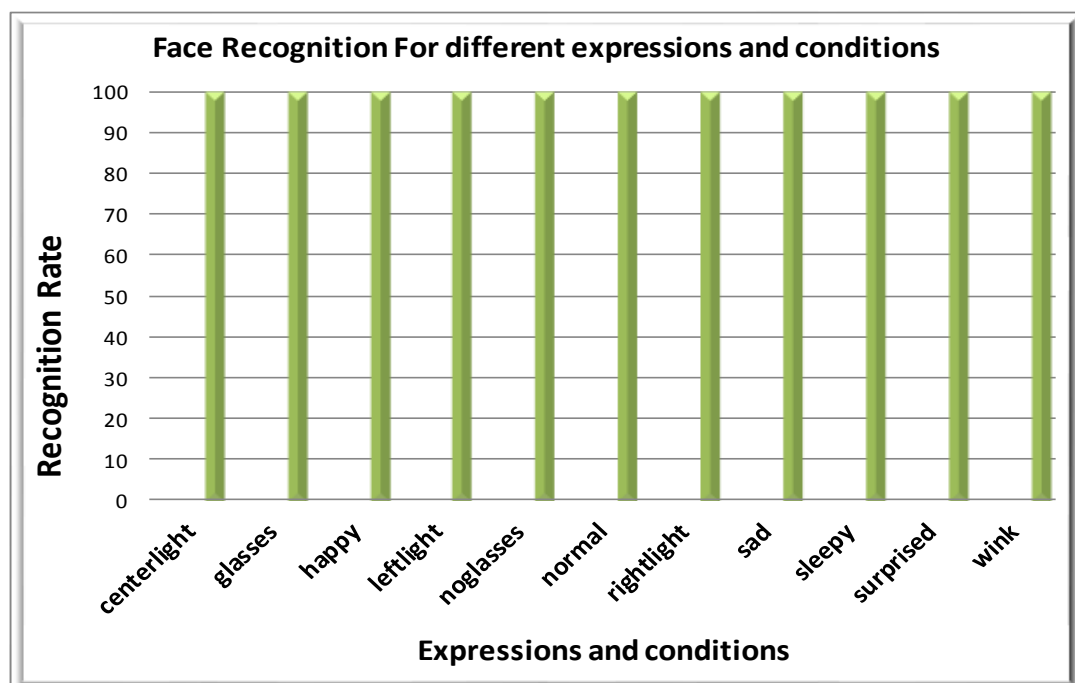
Figure 28. Face Recognition
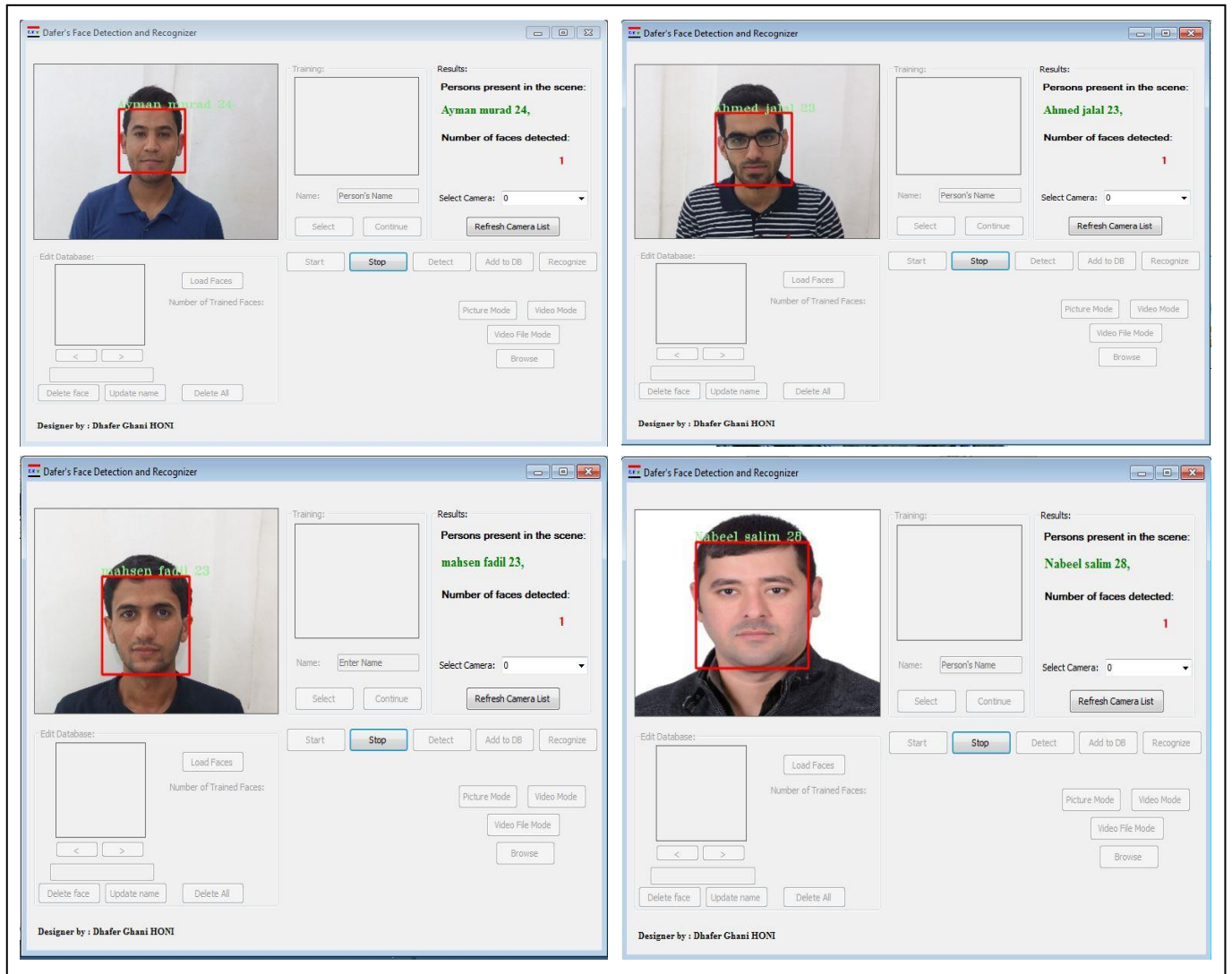

Figure 29. Recognition Rate For Saved Picture

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Figure 30. Recognition For Video live mode And Saved Image mode

10. CONCLUSIONS

The system has been tested on a wide variety of face images(Real images and Yale DataBase images), with many emotions and many different angles other than frontal face image , whether the person is authorized or not. The system is giving very high accuracy. The system is capable of using multi cameras as the capturing device simultaneously. Thus, the system is good and efficient in the field of security the police to match the criminals and also can use for general purpose like online Authentication and also in the organization to determine if the person who entry belong to the organization or not.

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