

# Facial Authentication System Using Viola Jones

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**Abstract:** This paper presents a facial authentication system for automatically recognizing or verifying a human face from a digital image source. Face detection is performed using some most widely used methods including Knowledge-based method, Feature -based method, Template matching. Feature extraction techniques including Principal Component Analysis and Fisher Linear Discriminant Analysis (FLDA) has been used as pre-processing step for dimensionality reduction. Viola Jones presented in this work is a quick and robust method for face detection which is much faster than any other method and statistically significantly improves the accuracy.

**Keywords:** Principal Component Analysis(PCA), Fisher Linear Discriminant Analysis (FLDA, Viola-Jones, Feature Extraction, Pattern Matching, Face Detection System.

## I. INTRODUCTION

A facial Authentication system is a computer application for automatically recognizing or verifying a human face from a digital image from a source. Face recognition is an extremely active field of research and there is a wide range of real-world applications. To track criminals and monitor for dangerous persons Facial recognition systems are plays an important role and it also uses in other applications. Human face has so many features and face recognition system extract those features of face from the image source or digital image. The person recognised based on these extracted features and then the system generate result in terms of non-identified and identified.

Face detection, Feature extraction and Facial recognition are the steps of face Recognition process. In digital image to find out whether the image exist human faces or not face detection methods are used. Face detection, as a significant feature of automatic face recognition system. With advancement of technologies there are various hardware and software are available that leads to high image qualities in almost every mobile devices. People do a lot of photography or snap and then upload them to social networks to share with their dear ones, friends and family members. Hence face detection plays an important role to examine or arrest the criminals and suspects. Regardless of color, size, position, and features face detection is based on locating and identifying a human face in a digital images. For Face detection there are so many Approaches. Viola and Jones proposed face detection which is most popular technique which is based on statistical methods.

To test the performance of our Face Recognition system on colour image, we have used database containing 20 still images. GUI detects the face and features in face. Here we use feature like left eye, right eye, nose, mouth. After feature detection these entire feature window extract individually and calculate their histogram. The histogram consists of the gray levels of images, that is, a graph indicating the number of times each gray level occurs in

the image. Here we detect the face and extract them in a separated window. A user will be able to judge the whole tonal arrangement at a glance by looking at the histogram for a definite picture. Now days in many digital cameras are coming with picture histogram. We can recognise the face from database with the help of histogram of these entire features. For face detection in images there are so many approaches have been proposed, we discuss here some of them.

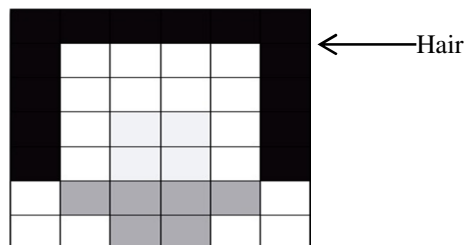
In this paper, the problem of face recognition has been attempted using different techniques. This algorithm and its comparison with the state-of-the-art Viola & Jones face detector are discussed in the paper. Section II emphasizes on face detection method and their approaches. Section III includes proposed method and Section IV concludes the work.

## II. FACE DETECTION SYSTEM

Face detection is a very hot topic in research application of pattern recognition and computer vision. It is generally applied in video surveillance, artificial intelligence, human-machine interaction, identity authentication, and so on [5]. If experienced with enough light and an uncomplicated background the accurateness of the single-face detection is higher than 92 percent with the frame-rate of 10 fps [6]. The computers, with an almost unlimited memory and computational speed and power, should conquer human's limitations [7]. Face recognition is a appropriate subject in neural networks, pattern recognition, image processing, computer graphics and psychology [8]. Engineering started to show attention in face recognition in the 1960's. In 1960's Woodrow W. Bledsoe was the one of the first researcher on this subject, Bledsoe, along other researches, started Panoramic Research, Inc., in Palo Alto, California. Bledsoe, along with Helen Chan and Charles Bisson, worked on using computers to recognize human faces during 1964 and 1965, [9][10]. Kenade is the first one that developed a fully automated face recognition system in 1973.

**A. Knowledge-based method**

Knowledge-based methods extrapolate the human sympathetic of the structural characteristics of a face. From morphological facts knowledge-based rules are formalized.

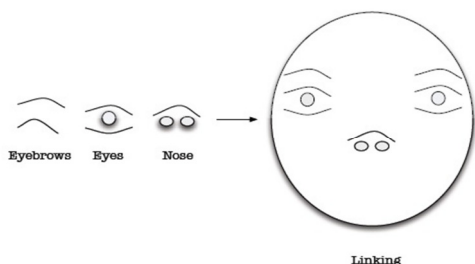


**Figure 1.** Structural characteristics are encoded as rules in different cells. The diagram depicts a Π-shaped hair region, a beard region and central homogenous nose and mouth region [3].

Yang and Huang [11] divide a stereotypical face into a number of units or cells that must conform to specified descriptions as shown in Figure 3.1. In the figure the central region of the face, for instance, occupy 4 × 4 cells. This is referred to as a quartet. The bottom portion of this quartet occupies 4 cells (light gray colour) and typically, this region of a face is homogeneously coloured. Thus, a rule that applies here is “this part of the face has four cells with a basically uniform intensity”.

**B. Feature -based method**

Feature-based methods are those that locating facial features at the start and then collecting their particular enclosing entities such as blobs, graphs, streaks and edges as a detected face in bottom-up manner. To identify particular shapes such as eyes, eyebrows and noses etc. edge detectors are used and between these shapes statistical models estimate distance.

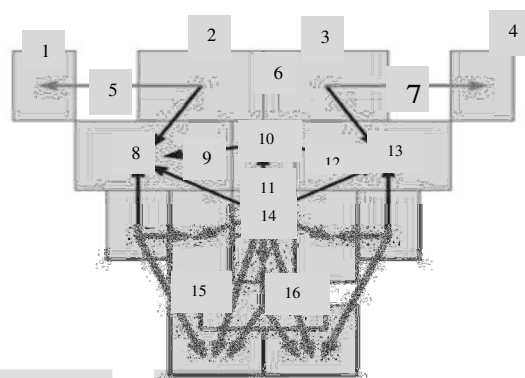


**Figure 2.** Edge detection followed by linking and grouping to detect faces .

Sirohey reasons that since the shape of a face is roughly elliptical, facial features can be combined in an ellipse fitting probe. Essentially, he uses a Canny Edge Detector [10] to identify all the edges. Feature-based approaches, in general, perform poorly with blurred images.

**C. Template matching**

These methods attempt to define a face as a objective. In the given Figure 3. each region is averaged using a gray scale window. As faces in an input image can occur at many scales, the gray scale template is probed for all possible regions of the input image at different scales to detect faces. Some authors propose a generic deformable template based on an energy minimization function. The energy function is defined by peaks, edges and valleys corresponding to a feature.



**Figure 3.** A division of a stereotypical face into 16 regions of interest.

**Feature Extraction**

**A. Principal Component Analysis**

PCA, also known as Karhunen-Lo`eve transformation [13], is a linear transformation which captures the variance of the input data. The coordinate system in which the data resides is rotated by PCA, so that the first-axis is parallel to the highest variance in the data (in a one-dimension projection). The remaining axes can be explained one at the time as being parallel to the highest variance of the data, while all axes are constrained to be orthogonal to all previous found axes. PCA selects eigenvectors which provide best representation of the overall sample distribution. This is used to remove redundancy and compress data.

**B. Fisher Linear Discriminant Analysis**

Fisher Linear Discriminant Analysis (FLDA), also known as Canonical Discriminant Analysis is like PCA, a linear transformation [26]. Unlike PCA, FLDA is a supervised method, which implies that all training-data samples must be associated (manually) with a class. FLDA maximizes the between-class variance as well as minimizes the within-class variance.

**III. PROPOSED METHOD**

In proposed method system consists of various steps: face detection, feature extraction, and face recognition. There is a database of features of face images which is using for recognition.

From the images of the testers database was formed. 200 images are stored in a database, in 20 different subjects each subject contains 10 images. No restrictions were imposed on the expression of the subject and subjects were asked to face the camera. Only limited side movement was tolerated. A number of the subjects had a beard and others were wearing glasses. The images for some subjects were taken at different times, facial expressions (closed or open eyes, smiling or not smiling), varying lighting, facial details and head pose.

For testing the whole database, the faces used in training, testing and recognition are changed and the recognition performance is given for whole database.

#### IV. FACE DETECTION

In digital images Face detection is the procedure that determines the sizes and locations of human faces. It ignores anything else and detects facial features only. A proposed method used here is Viola-jones algorithm.

##### Viola-Jones

Paul Viola and Michael Jones presented a quick and robust method for face detection which is 15 times faster than any method at the time of release with 97% accuracy. The method relies on the use of simple Haar-like features that are evaluated quickly through the use of a new image representation. On the bases of "Integral Image" it generates a huge set of features and to decrease the over-complete set the boosting algorithm AdaBoost is used and to provides for strong and quick interferences the introduction of a degenerative tree of the boosted classifiers is used. The detector is applied in a scanning manner and used on gray-scale images, the scanned window that is applied can also be scaled, as well as the features evaluated. Paul Viola and Michael Jones in 2001 proposed a first object detection framework to present real time competitive object detection[14].

Even though it can be skilled to detect a variety of object classes, it was motivated mainly by the difficulty of face detection. The Viola-Jones algorithm is implemented in OpenCV as cvHaarDetectObjects(). On the bases of Haar wavelets Viola and Jones features are used. These classifiers are single square waves (one low interval and one high interval). A square wave is a couple of adjacent rectangles - one dark and one light, In two dimensions.



Figure 4. Different Haar classifiers used in Viola-jones [14].

The diagram represents above are not true Haar wavelets in Figure 4. For visual object detection these feature rectangle combinations are for visual recognition tasks they are much better suited.



Figure 5. Rectangular features over a face[14].

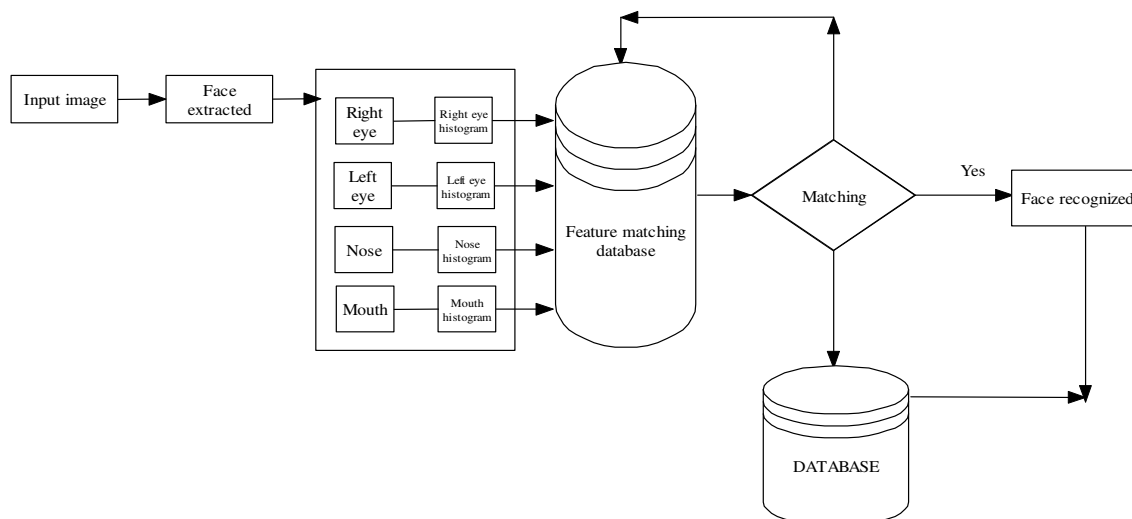


Figure 6. Step in Face recognition using featured histogram

of a Haar feature . The Haar feature is said to be present if the difference is above a threshold (set during learning).

Viola and Jones used a method called an Integral Image to conclude the occurrence or nonexistence of hundreds of Haar features at every image location and at a number of scales efficiently. In this case, the integral value for every pixel is the sum of all the pixels above it and to its left. With a few integer operations per pixel, starting from the top left and traversing to the right and down the entire image can be integrated through this process.

A machine-learning method used by Viola and Jones called AdaBoost was used to set threshold levels and select the specific Haar features. To create one "strong" classifier AdaBoost combines many "weak" classifiers.

For classifying image regions, a filter chain is a combined series of classifiers which is efficient. With a quite small number of weak classifiers, each filter is a separate AdaBoost classifier.

### V. Implementation and Result Analysis

The main functions of the program are shown by the initial state of the program. The menu contains but tons for the loading of database from the file, the training of database images, the Face detection, the Face Recognition and the button for Exit the application. This GUI is shown in figure 6. Load database button load all the images and show the image in list box.

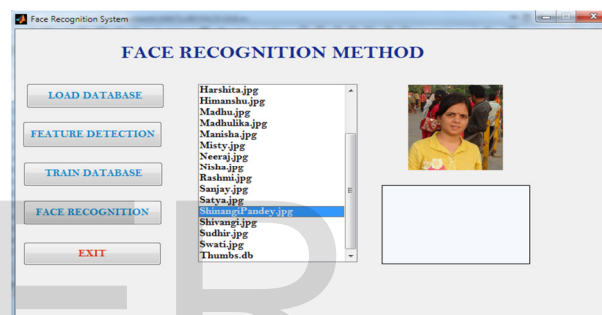


Figure 7. Main Menu GUI

Face detection button detect the face part and extracted the entire feature with their histogram. Train button is use for training of data and save all the features in a feature database. Face recognition button match the feature with the database and recognise the person.

#### A. FACE DETECTION

Face Detection is the first option on the main menu. In real time images this part of application is able to find the faces from a camera. It's done automatically. A rectangle of red colour appears on the windows which is surrounding the face when the face detection is done. As such, they bear some resemblance to Haar basis functions, which have been used previously in the realm of image-based object detection.

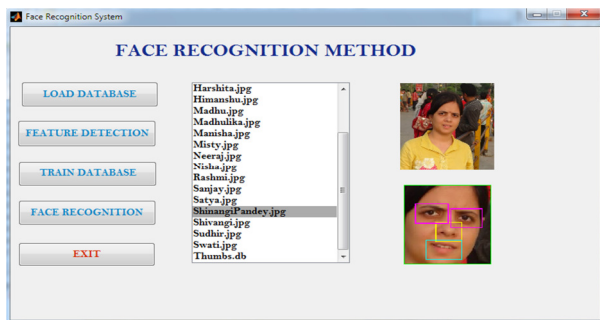


Figure 10. GUI with face detection (Female)

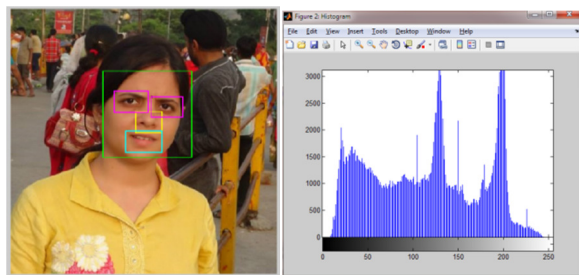


Figure 8. Detected face and their histogram

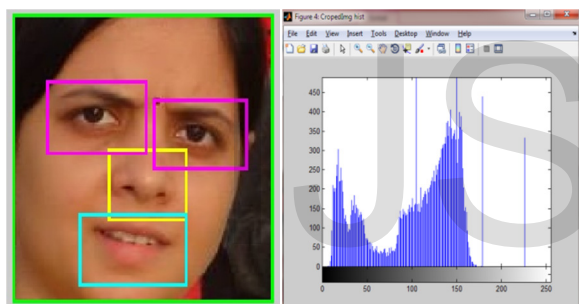


Figure 9. Extract detect face in separated figure and histogram

**B. FEATURE EXTRACTION**

Feature extraction is the task of reducing the high dimensional training data to a set of features to investigate characteristics of the data.

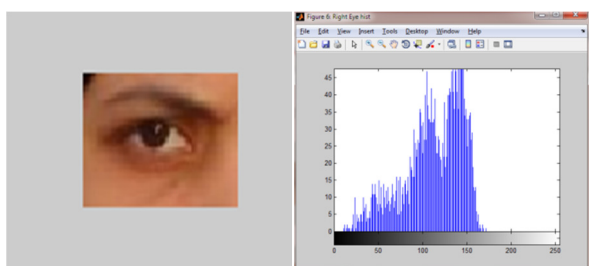


Figure 11. Extract right eye from image and histogram (Female)

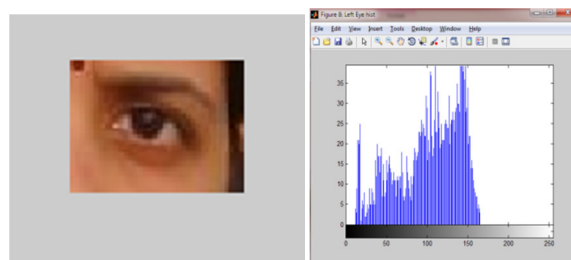


Figure 12. Extract left eye from image and histogram (Female)

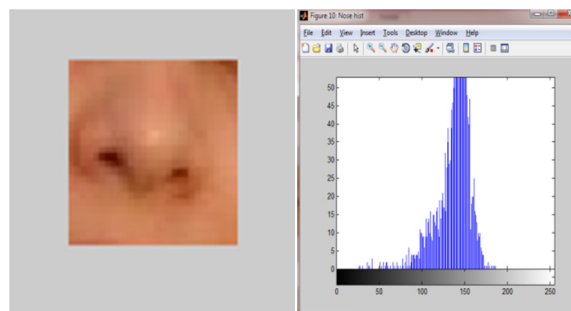


Figure 13. Extract nose from image and histogram (Female)

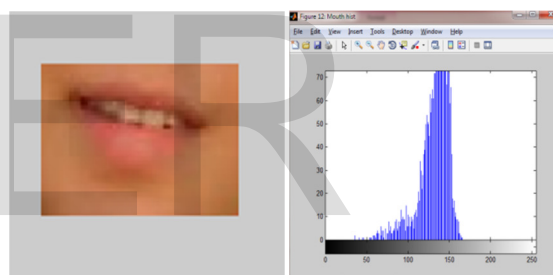


Figure 14. Extract mouth from image and histogram (Female)

Here features of input image are extracted such as eye, nose and mouth and calculate their histogram for recognition phase.

These all extracted features of input image are matched with the feature database one by one, in a nested loop and have to decide if the person is belongs to the database or not. Here a female image is use for detection and her facial feature like eye, nose, mouth are extracted in a new figure window.

**C. FACE RECOGNITION**

The next options of the main menu dedicated to the Face Recognition. This button appears a new GUI to recognize With the database of previously saved images the face recognition works. The database is created and where the faces of different persons were identified and complete name were given in this part of program.

image from a file.

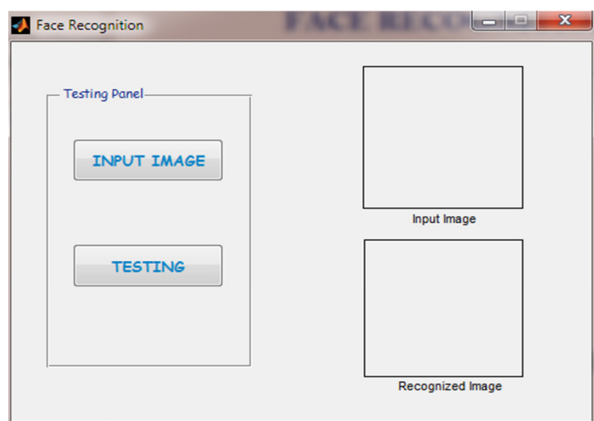


Figure 15. Face recognition GUI

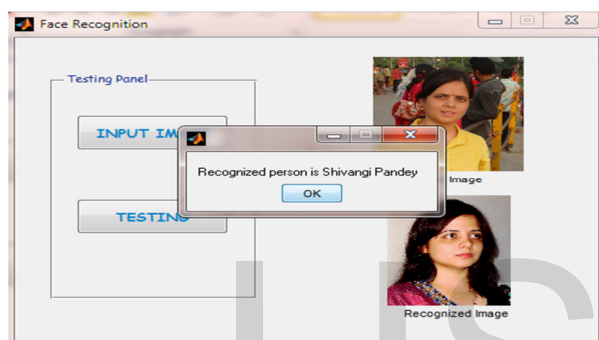


Figure 16. Recognise image from database (Female)

The application took 10 images of the subjects, and for the later use of the recognition process it trained the images. The database was architecture in a very simple and easy way; it is based on processed histogram method.

## VI. CONCLUSION AND FUTURE WORK

In this paper some most widely used face detection techniques has been evaluated over dataset to determine their accuracies in terms of overall accuracies using Viola-jones, and Some feature extraction techniques like Principal Component analysis (PCA) and Fisher Linear Discriminant Analysis (FLDA) are also used for dimensionality reduction.

The Viola-jones and computer vision success rates were given while for face detection, the success rate was different for different images depending on the external factors. The overall success rate was 97%. Even though the aim of the study was completed, there are still a lot of possibilities for future development. Image Processing Toolbox implements many functions that were not used in my application. Among them there is a group of morphological operations such as dilation, erosion, morphological opening and closing, filling certain areas and more. IPT also provides couple of methods of a thresholding.

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