

# An Approach to Face Detection and Recognition

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**Abstract**—Face detection has attracted immense attention because it has many applications in computer vision communication and automatic control system. Face detection is a method to detect a face from an image which have several attributes in that image. Research into face detection, expression recognition, face tracking, pose estimation is required. By giving a single image, challenge is to detect the face from that image. Face detection is a challenging task because faces are not rigid and it changes in size, shape, color etc. Face detection become more challenging task when given image is not clear and occluded by any other thing and not proper lightning, not facing camera etc. In this paper, viola Jones algorithm is used to detect face and principal component analysis for face recognition.

**Keywords**— *face detection, view based recognition, Viola-Jones algorithm, integral image, Adaboost classifier.*

## I. INTRODUCTION

Image processing is tool or an algorithm to process an image in order to compress image, enhance image or to extract some useful information from the image. There are two methods for image processing, digital and analog. Digital image processing use mathematical model and computer algorithms to process a digital image and a digital image is processed by a digital computer. Analog image processing is used for hard copies like photographs and printouts. Face detection is the area of image processing.

In recent years face detection has been studied due to wide use of computer and human interaction. Video surveillance is used for security purpose. Video surveillance has some phases:

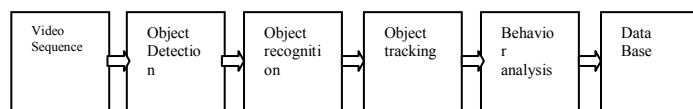


Fig. 1. Phase In Video Surveillance

A machine learning approach for visual object detection used to achieve high detection rate. This paper demonstrates a face detection technique, in which human face is detected from a single image and multiple human faces can also be detected from a single image. A face detector has to tell whether there is any face in that image or not. There are so many technique have been developed to detect a face from image then one of method is viola Jones method to detect a

face, system should fully analyze complete image and have to remove the background image from that image. Method to detect a face should minimize the false positive and false negative rate. To detect a face characteristics can be extracted by a adaboost learning algorithm to make strong classifier using weak classifier. In viola Jones algorithm face detector uses Adaboost to train a cascade technique which makes the Viola-Jones algorithm highly efficient. Viola Jones cascade classifier is used to split features, it have some stages, at first stage a linear SVM (Support Vector Machine) classifier is used to reject as many background and all remaining keeping into next stage. The second stage is one class type classifier which will use hyper plane to approximate the positive data. It is also efficient classifier which removes the background samples which is passed through the first stage. The third stage is a linear SVDD (Support Vector Data Description) classifier which will reject most of the false positive which is passed by above two stages. Last stage makes a final decision and it uses a nonlinear hypersphere model for approximate the object class and it operates the small positive and difficult negatives passed by previous stages.

In face detection two type of error can be considered one is false negative and second is false positive. In false positive region of image is considered that it does not have face but there is face and in false negative, faces are missed because of low detection rate. In an algorithm some measure are used like detection rate, learning time, execution time and ratio between the detection rate and false values. Detection rate is the ratio between the number of faces detected by human and number of faces is correctly detected by system.

In this research field some terms regarding face is “facial feature detection” means to locate the human face features such as eye, nose, lips, chin, eyebrows, mouth, ears etc. “Face authentication” is to verify the identity of a person. “Face tracking” is to track a face location in real time. “Expression recognition” is to recognize the facial expression of a face it happy, sad, surprising etc. “face localization” is to identify the location of a face.

In face detection process first integral image is introduced called as integral image which allows detector to be compute very fast. Second is learning algorithm which is based on Adaboost algorithm which quickly selects some mostly visible features from a large set of features and make an extremely efficient classifier. Last third method is for combining more complex classifier in a cascade to discard the background of

image very quickly. Face detection can't be possible if integral image is not clear means resolution of the input image should be more than  $6 \times 6$  resolutions.

## II. RELATED WORK

Face recognition is easy for the human but it is more difficult for the computer because human body is not rigid that means, it will not remain same for very long time change takes place in human body time to time. For face recognition first and most important problem is face detection. For automatic face recognition face detection is prerequisite. In face detection there may be some problems like different position for observation make different face, to solve this problem we can make a group of different face image position for a person, face image may be different because of different facial expression and with same expression and same position face image may be different because of lighting. In this paper we have discussed about frontal face detection system which has detect face and has some false positive rate.

As shown in [1] a survey conducted by M. Yang, D. Kriegman, and N. Ahuja face detection can be grouped in four categories: knowledge-based methods, template-based methods, feature invariant methods, and appearance-based methods.

- *Knowledge based Method:* This is a rule based method which tries to find the relationship between features of human face based on some previous knowledge. It works on encoded knowledge of human what a human face is consist of and are used for human face localization.
- *Feature Invariant Approach:* Also used for face localization these methods are used to detect a face in various condition such as low or high light density, face pose from different sides and different viewpoints and combine all these condition to detect the face. This method is used for the solution of different pose of a face.
- *Template based Method:* Template matching method can be used for both face localization as well as face detection. This method store several standard pattern of human face and pattern can be used to describe the whole face or any specific facial feature. We need to find out a correlation between the stored pattern and the input image for detection.
- *Appearance based method:* In this method, instead of templates, a set of training images are given which are used to learn the model of the image. And these models are then used for face detection.

In [2][3], Sung and Poggio, developed a face detection technique as distribution based system and in this technique an object class learned using positive and negative examples. Distribution based system have two components, multilayer perceptron classifier and distribution-based models for face nonface pattern. After normalizing and processing of each face example in a  $19 \times 19$ -pixel image, each image is vectored in 361-dimensional vector. Now using a modified K-means algorithm images are clustered into six faces and six non-face

cluster. Each cluster is then represented as a multidimensional Gaussian Function with a mean image and covariance matrix. In between an input image and cluster, two distances are calculated, normalized Mahalanobis distance and Euclidian distance. At last, multilayer perceptron network is used to classify face and non-face window pattern using a twelve pair of distance for each face and non-face cluster.

In [3], Yang and Huang used a face detection method, in this method set of rules are defined as a knowledge based method and it has rules on an input images first scanning is applied on face and all possible face can be found by scanning. Different rules are defined for face detection from image and at different level of rules are applied like at highest level set of rules are defined to define a human face and at lower level rules for facial feature are described. By averaging and sub sampling multilevel of hierarchy of images is created.

In [4], Ekman and Friesen in 1977, proposed a robust facial action coding system. The Facial Action Coding System works on the changing behavior of facial muscles and try to analyses facial expression. This algorithm gives 7.8% more average detection rate. The algorithm works with 46 Action Points (AP) comprising of the facial behavior of human.

In [5], Lajevardi and Wu suggested a technique to represent the static color images in tensor based representation. It is used to recognize facial expression into color image. It has achieved 68.8% accuracy with different resolution of color image.

In [6], Principal Component Analysis was invented in 1901 by Karl Pearson for recognition of face. It is used to recognize face by reducing the dimensionality of the image by which database size reduces and computation speed reduces. When high dimensional data is used problem arises. It calculates an Eigen picture on training set of face images. PCA is applied on Eigen face approach to reduce dimensionality of big dataset. Due to its easy implementation and low number of steps this method is efficient. It is appearance based approach to recognize face and use information to encode and compare image individual faces in a holistic manner and it reduces space complexity and computation. Encoded image is compared with the encoded dataset. This approach is very useful to capture the information the important information in an image of face which are useful for recognition of face. The number of the Eigen face is equal to the number of face image in training set. By using fewer Eigen face computation performs efficient. Two methods are used in PCA to recognition procedure:

1) *Learning Phase:* By defining Eigen vector for each data a coordinate system is defined by applying PCA on training data. Coordinate system is weight of Eigen vectors.

2) *Testing Phase:* For testing phase test set is used and same PCA coordinate system is used in testing phase and new data is recognized as closest training data.

Block diagram of face recognition technique is explained here:

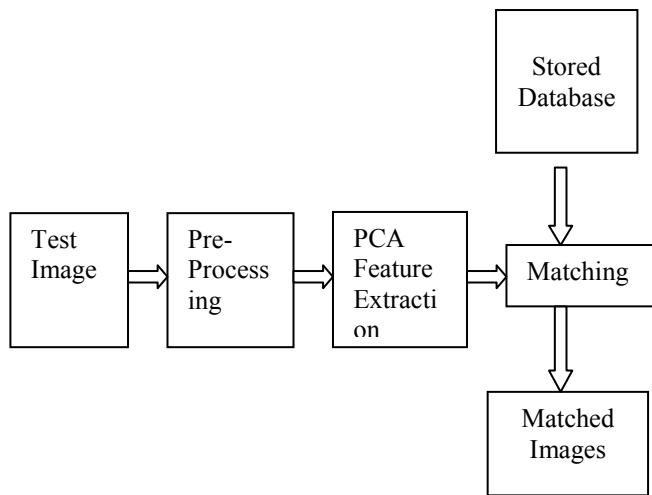


Fig. 2. Block Diagram of Face Recognition with PCA

## II. PROCESS OF FACE DETECTION

Fig.3. shows the procedure of capturing image and detect face in that image and store that image.

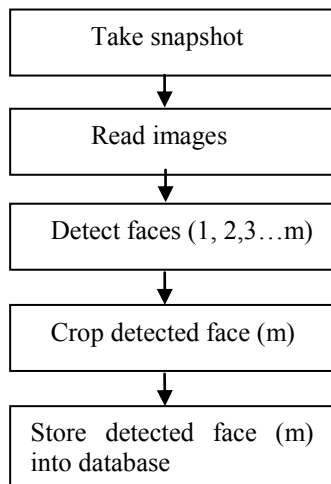


Fig. 3. Process Of Face Detection

### A. Face detection

In this paper viola jones algorithm is used for face detection and the process of face detection for a single image different steps are used, these are as follows:

1) *Capture image*: To give input image to be read first Image is captured and stored into a database. Other images can be used which is stored already into dataset.

2) *Read image*: first image has to be read using imread function. This method extracts the features shape for eye, nose, chin, mouth.

3) *Detect Face*: The main objective of this step is to identify the face where it is into image and detect it. Also make a boundary around the face by identifying background

image. It works by detecting feature points and edges using following equations.

4) To detect feature points by equation 1

$$I(x) = \sum_{i=0}^{i \leq} \sum_{j=0}^{j \leq y} I(x, y) \quad (1)$$

5) To find edges of image by equation 2

$$V+F-E = 2 \quad (2)$$

Where

V= vertices,

F= no. of faces, and

E= no. of edges

6) *Crop Image*: Images are cropped after detection of face, only face value will be used at matching time. Computation time and complexity will be reduced because most of image part will be cropped applying crop operation. Then again store into database by using a string name.

7) This algorithm constructs a “strong” classifier as a linear combination of weighted simple “weak” classifiers.

$$h(x) = \text{sign} \left( \sum_{j=1}^M A_j h_j(x) \right)$$

8) weak classifier is a threshold function based on the features.

$$h_j(x) = \begin{cases} -s_j, & \text{if } f_j < \theta_j \\ s_j, & \text{Otherwise} \end{cases}$$

The threshold value  $\Theta_i$  and the polarity  $s_i$ ,  $\epsilon \pm 1$  are determined in the training, as well as the coefficients.

### B. Face Recognition

We will use the image database created with sample images to recognize the face in new image. The process of face recognition explanation is here and process of face recognition involves following steps:

1) Read a new image which we want to identify.  
 2) Detect face from new image.  
 3) Remove all background data of new image.  
 4) Using principal component analysis method match with the stored database of images.

5) Matching will be performed with each image one by one and matching percentage with each image in database is calculated.

6) Whose matching percentage of two image is highest that image will be as resulted as recognized face.

*Recognition And Matching Technique:*

1) To recognize face the following equations have been used

$$[C, S, L] = \text{princomp}(I)$$

Where

$C = A$  p-by-p matrix

$S$  = Principle component representation of  $X$

$L$  = Eigen values of the covariance matrix of  $I$

2) To calculate Eigen values and Eigen vectors of image the following equation has been used

$$(A - \lambda I)Kv = 0$$

3) Mean value of the image used for training is calculated.

4) Euclidian Distance is calculated by:  
Euclidian Distance  $(x, y) =$

$$\sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2 + \dots + (x_n - y_n)^2}$$

5) Calculation of accuracy rate is calculated by:

$$acc = \left( \left( Dist_{frm_{Neutral}} - error \right) * Dist_{frm_{Neutral}} \right) * 100$$

### III. EXPERIMENTAL SETUP AND RESULT

#### Experimental Setup:

TABLE I. EXPERIMENTAL SETUP

1	Software used	Matlab 2014a
2	Operting System	Window operating system
3	Processor	Intel® Core™ i3-2500 CPU@ 2.53GHz
4	Installed Memory	3 GB
5	System Type	32-bit Operating Sysytem

#### Face detection:

1) *Capture image*: Fig 4 shows the images captured by camera which are not stored in the database.



Fig. 4. Images captured by camera

Fig 5 shows the image which is already stored in the database



Fig. 5. Image which is already stored into database

2) *Read image*:



Fig. 6. Read images direct from capture



Fig. 7. Read image form database

3) *Detect Image*: Fig.8 and Fig.9 shows the detection performed by the algorithm for single face and for multiple face and false value is also detected in the Fig.9.



Fig. 8. Face detection



Fig. 9. Multiple faces detection

4) *Crop Image and save into database:* Fig.10. shows the cropped face which is detected in the above figure and stored in the database. Instead of storing complete image only store the face image by which storage will be minimum space.

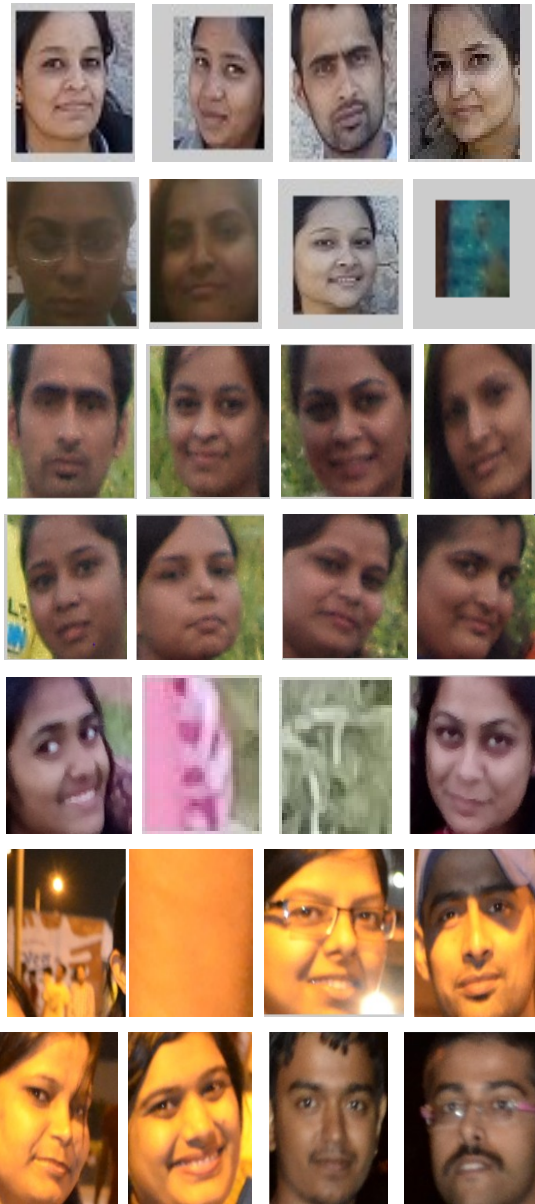


Fig. 10. Detected face is cropped from image and all extra pixel value which is not useful for future is removed

#### Face recognition:

The practical implementation is here with more than 1000 image database and input image is matched with its image which is stored in database. Fig.11. shows the complete procedure of practical. By using following procedure face is matches:

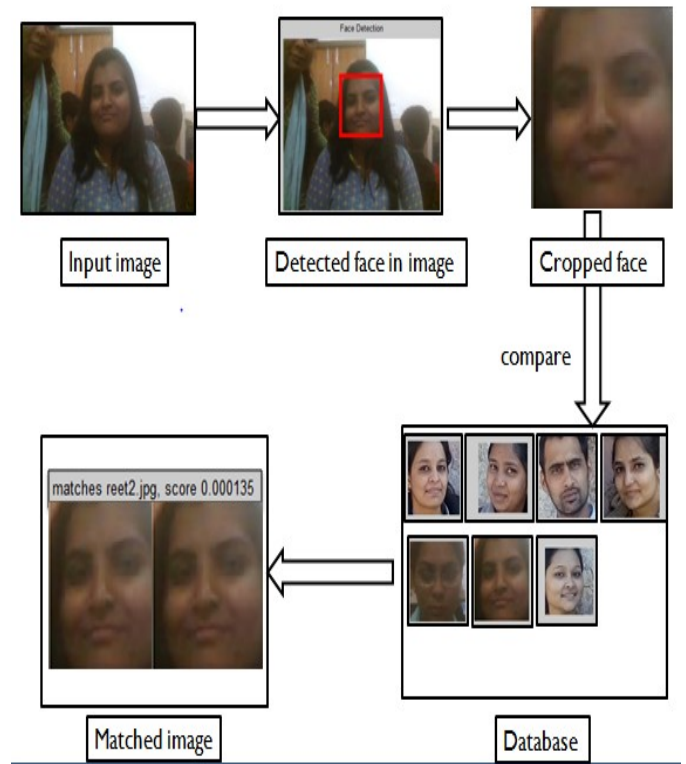


Fig 11. Image Recognition and matching

After performing Viola Jones Algorithm and Principle Component Analysis (PCA) it is concluded that in occluded image face cannot be detected and false positive value is also given. If the image is static then only it detects the face.

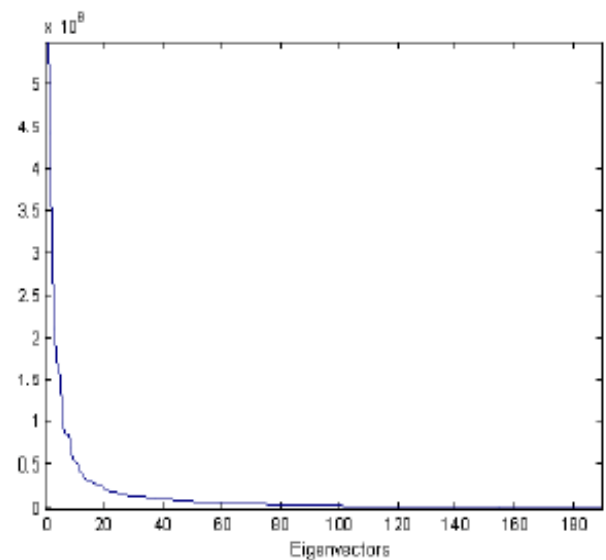


Fig. 12. Eigen value



It is a fast detection technique and fig.12 show the Eigen face value. This algorithm has been tested on database with more than 1000 images and it gives 90% accuracy with some false positive values. Each Eigen value is an Eigen vector and it tell how much images vary from mean image. Eigen vector which correspond to small Eigen value can be ignored because it does not have any important information.

#### IV. CONCLUSION AND FUTURE WORK

In this paper we have concluded that combination of Viola Jones algorithm and Principle component analysis gives result with fast detection and high accuracy. Some drawbacks of these techniques are high computation time when image size is large and resolution is high and if high dimensional data is used problem arises.

Future work is to increase the accuracy of the face detection and recognition. Viola Jones Algorithm is a fast face detection technique but it has some false positive values for images with occluded faces, so future work is to try to reduce the false positive values.

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