

## Facial Expression Detection Techniques: Based on Viola and Jones Algorithm and Principal Component Analysis

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### Abstract

Facial expression is a prominent posture beneath the skin of the face. They are the way of communication in humans which convey many things non-verbally. During the past years face recognition has received significant attention as one of the most important applications of image understanding and analysis. Many algorithms have been implemented on different static and non-static conditions. Static conditions include static and uniform background, identical poses, similar illumination, neutral frontal face. Non-static conditions include position, partial occlusion orientation; varying lightening conditions and facial hair which make recognition process a complex problem. All these factors influence face recognition process. The main stages for face recognition include face detection, feature representation and classifications. Researchers have described distinct approaches for face recognition. In this work we present a glimpse of face detection techniques, methods used their performance & their limitations and proposed a new technique for Face Detection based on Viola and Jones algorithm and principal component analysis. At the end we have shown simulation results for the proposed technique and established that proposed technique is performing better than the existing one. The proposed system is implemented in MATLAB version 7.1.4.0.739 (R2012a).

### INTRODUCTION

In recent decade, facial expression recognition has become a progressive area of research. There are many applications and algorithms that use facial expressions to evaluate human nature, feelings, judgment, opinion. These expressions are produced as a result of

distortions of facial features due to the contraction of facial muscles. Facial expression recognition is not an easy task because of circumstances like illumination, facial occlusions, face color, face shape etc..

Face detection systems have many problems pertaining to pose, light, facial expression and quality of picture. It can be solved by applying some sort of image preprocessing before they are applied for further analysis purpose.

The facial expression detection system is divided into four major steps:

1. Face detection
2. Normalization
3. Feature extraction
4. Classification

Face detection & normalization phase detects the face and lighting effects are reduced to some extent. The next step is feature extraction which extracts the features & irrelevant features are eliminated in feature selection process. Final step is classification where the facial expressions are classified into four basic emotions shown in Fig. 1. Generally, there are two techniques in the facial expression recognition process the first technique is based on facial feature & the other considers the holistic view of the recognition problem.

### A. Feature based approach:

In this approach the local features (like nose, eyes) of the face are found. Then these features are segmented & then they are used as the input data for structural classifier. The techniques like dynamic link

architecture, pure geometry & hidden Markov model (HMM) are classified under this category.



### Images with different expressions

Fig.1. Examples of four basic emotions (neutral, happiness, sadness and surprise) uses includes tracking facial features, detection of activation of facial muscles (Facial Action Units).

### B. Holistic approach:

In this approach the statistical methods are used to extracts the statistical characterization from the entire training sample images. There are techniques like eigen faces, probabilistic eigen faces, fisher face, support vector machines(SVM), nearest feature lines (NFL) and independent-component analysis which use holistic approach for facial expression detection.

### C. Hybrid approach:

Hybrid approach is a combination of above two mentioned approaches. The idea of this method comes from how human vision system perceives both local features and whole face. The methods like modular eigenface, hybrid local feature, shape normalized, and component based methods are used in hybrid approach.

### PRE-PROCESSING TECHNIQUES:

Image pre-processing techniques takes the form of signal conditioning (such as noise removal, variation of pixel position) together with segmentation, location and is used for detection and tracking of a face or its parts. Steps involved in pre- processing of an image are as briefed in this section.

### VIOLA-JONES ALGORITHM:

#### STEPS:

#### Read Image:

In this phase a method that can extract the shape of the eyes, nose, mouth and chin, is used and it helps to

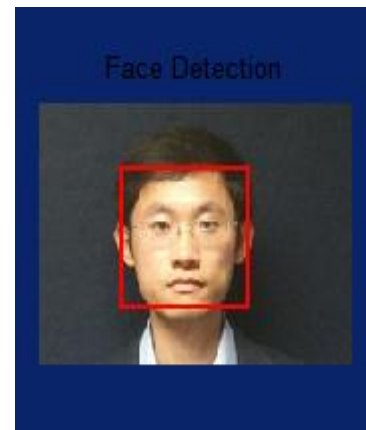
distinguish the face by distance and scale of those organs.



**Fig.2. Image to be read**

#### Detect Image:

The main concern of face detection is to identify all image regions which contain a face regardless of its direction, background & lighting conditions. Such task is tricky since faces can have a vast assortment in terms of shape, color, size or texture. Image detection phase does this.



**Fig.3. Detected Image**

#### Identify Facial Feature Points:

Feature points of an image like eyes, chin, eyebrows, lips, nose, etc. are identified and marked during this phase.

#### Color Space Transformation and Lighting Compensation:

In this phase skin-color detection is used as an intermediate step of face detection.

**High Frequency Noisy Removing:**

Noise from the image is removed in this stage using noise removal algorithms



**Fig.. Noise Removal from the Image**

**Edge Detection and Size Reduction:**

Image edges are detected and marked in this stage. End points of features, chooses the dimensionality reducing linear projection that maximize the scatter of all projected samples.



**Fig.. Edge Detection and Size Reduction**

**PCA (PRINCIPAL COMPONENT ANALYSIS):  
FACE RECOGNITION:**

Principal Components Analysis (PCA) is a way of identifying patterns in data, and expressing the data in such a way as to highlight their similarities and differences. Since patterns in data can be hard to find in data of high dimension, where the luxury of graphical representation is not available, PCA is a powerful tool for analyzing data. If there are a lot of images that are close to each other in the PCA space, it means that the images quite resemble but differ slightly from each other. The directions of these variations is important because it „says“ something about in what the images differ. A „cloud“ of these images could therefore be spanned by the directions of the variations, which are called the Principal Components. To characterize the trends exhibited by this data, PCA extracts directions where the cloud is more extended. For instance, if the cloud is shaped like a football, the main direction of the data would be a midline or axis along the length of the football. This is

called the first component, or the principal component. PCA will then look for the next direction, orthogonal to the first one, reducing the multidimensional cloud into a two-dimensional space. Using PCA we find a subset of principal directions (principal components) in a set of training faces. Then we project faces into this principal components space and get feature vectors. Comparison is performed by calculating the distance between these vectors. Usually comparison of face images is performed by calculating the Euclidean distance between these feature vectors. Sometimes the angle-based distance is used. The steps involved in performing PCA on a set of data are:-

1. Get some data
2. Subtract the mean
3. Calculating the covariance matrix
4. Calculate the eigenvectors and Eigen values of the covariance matrix Choosing components and formatting a feature vector
5. Deriving the new data set
6. Getting the old data back

PCA is a technique based on the concept of Eigen faces and was first introduced by Kirby and Sirivich in 1988. PCA also known as KarhunenLoeve projection). It is one of the more successful techniques of face recognition and easy to understand and describe using mathematics. This method involves using Eigen faces. Eigen faces have been used to track human faces. They use a principal component analysis approach to store a set of known patterns in a compact subspace representation of the image space, where the Eigen vectors of the training image set span the subspace. In this method, the input image and images of the eigen face gallery should be the same size and we have to normalize the input image so that the eyes, nose and mouth are properly lined up i.e. we only consider the face region and that should be a frontal face. In case of a non-frontal face it may result poor performance.

**Eigen faces:**

In information theory concept, if we want to extract some information from a face image, we first encode it and then compare it with some other encoded face

image on a database. A simple way to extract the information from a face image is to capture the variation in a collection of face images and use this information to encode and compare individual face images. Mathematically, we wish to find the principal components of distribution of faces or the eigenvectors of the covariance matrix of a set of face images. These eigenvectors are a set of features, which together characterize the variation between face images. Each image location contributes more or less to each eigenvectors, so that we can display the eigenvectors as a sort of ghostly face, which we call an eigenfaces. In the training set, each face image is represented by a linear combination of the eigenfaces. Hence the number of possible Eigen faces is same as the number of face images.

A facial recognition system is a computer application for automatically identifying or verifying a person from a digital image or a video frame from a video source. One of the ways to do this is by comparing selected facial features from the image and a facial database. It is typically used in security systems and can be compared to other biometrics such as fingerprint or eye iris recognition systems. Among the different biometric techniques, facial recognition may not be the most reliable and efficient. However, one key advantage is that it does not require aid (or consent) from the test subject. Properly designed systems installed in airports, multiplexes, and other public places can identify individuals among the crowd.

### **EXPRESSION ANALYSIS:**

Expression categorization is performed by a classifier, which often consists of models of pattern distribution, coupled to a decision procedure. A wide range of classifiers, covering parametric as well as nonparametric techniques, has been applied to the automatic expression recognition problem. The two main types of classes used in facial expression recognition are action units (AUs), and the prototypic facial expressions defined by Ekman.

### **PREVIOUS METHOD:**

Facial expression is one of the most powerful, natural, and immediate means for human beings to communicate their emotions and intentions. Facial expression carries crucial information about the mental, emotional and even physical states of the conversation. . It is a desirable feature of the next generation human-computer interfaces. Computers that can recognize facial expressions and respond to the emotions of humans accordingly enable better human-machine communication development of information technology Recognition of facial expression in the input image needs two functions: locating a face in the image and recognizing its expression. We believe recognition of human facial expression by computer is a key to develop such technology. In recent years, much research has been done on machine recognition of human Facial expressions. Conventional methods extract features of facial organs, such as eyes and a mouth and recognize the expressions from changes in their shapes or their geometrical relationships by different facial expressions when we watch two photos of a human face, we can answer which photo shows the facial expression more strongly. Accordingly, as extending the step of facial expression recognition, we think it is important to develop a measurement method of the strength of facial expressions. One of the key remaining problems in face recognition is to handle the variability in appearance due to changes in pose, expression, and lighting conditions. There has been some recent work in this direction. The increasing progress of communication technology and computer science has led us to expect the importance of facial expression in future human machine interface and advanced communication, such as multimedia and low-bandwidth transmission of facial data In human interaction, the articulation and perception of facial expressions form a communication channel, that is additional to voice and that carries crucial information about the mental, emotional and even physical states of the conversation. Face localization, feature extraction, and modeling are the major issues in automatic facial expression recognition.

### PROPOSED ALGORITHM:

In this work, face expression method proposed uses Viola and Jones algorithm and principal component analysis that tries to match an image with respect to expression of the face. Proposed method considers an image to be resized to  $N \times N$  (Original image  $I$  having  $N$  value of pixel). The image considered is then changed into grayscale with two dimensions for 2-D image. Steps taken in extracting the image expressions are as briefed in the section below.

1. Detect feature points of face with the help of equation 1.

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

2. Find edges of image using equation 2:

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

Where  $V$  denote the number of vertices,  $F$  denote the number of faces and  $E$  denote the number of edges 3. Mapping of image from the values in  $I$  to new value in  $J$  is done using equation 3. The value  $s$  are mapped in to values between  $low\_in$  and  $high\_in$  map to value between  $low\_out$  and  $high\_out$  for lighting compensation.

$$J = imadjust(I, [low\_in; high\_in], [low\_out; high\_out]) \quad (3)$$

4. After the the Skin segmentation (using the RGBYCbCr model) of the image is done.

5. After this Principal Component Analysis of the image is performed using equation 4:

$$[C, S, L] = princomp(I) \quad (4)$$

Where  $C$  is  $p$ -by- $p$  matrix, each column containing coefficients for one principal component  $S$  is Representation of  $X$  is principal comp. Space rows of score correspond to observation, columns to components  $L$  is Eigen values of the covariance matrix of  $I$ . It is the variance of Score

6. Then eigen values and eigen vectors of image are found using this equation 5:

$$(A - \lambda I)Kv = 0 \quad (5)$$

7. Mean values of the imaged used for training is calculated.

8. Euclidean Distance from neutral in an image is measured using equation 6:

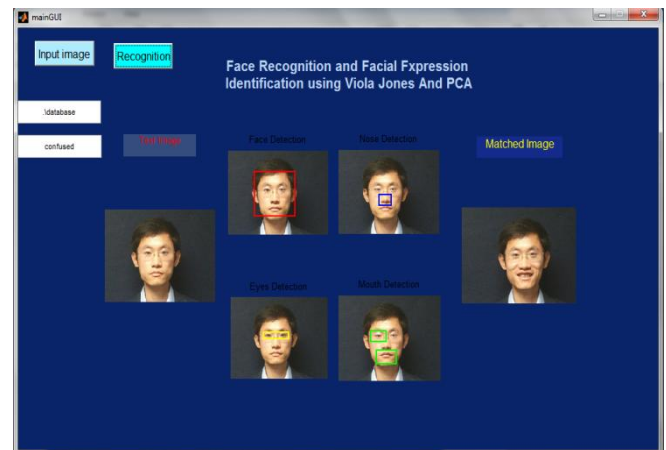
$$Euclidean\ Distance(x, y) = \frac{1}{\sqrt{(x1 - y1)^2 + (x2 - y2)^2 + \dots + (xn - yn)^2}} \quad (6)$$

9. Calculation of accuracy rate id then done on the basis of Euclidean distance and mean error using equation 7:

$$acc = \left( (Dist_{frmNeutral} - error) * Dist_{frmNeutral} \right) * 100 \quad (7)$$

10. Emotions of the test images are then detected and the results are stored in Results.text file.

### RESULTS:



### CONCLUSION:

In this paper we discussed Face Detection Technique based on Viola and Jones algorithm and principal component analysis with the help of this technique, we can recognize an accurate and high speed emotion detection system.

The techniques used in this work detect human facial expressions and recognize them on the basis of accuracy and computational time. Some of them contain drawbacks in term of detection rate, accuracy or timings. The most optimum detection rate can be obtained through combination of given techniques, extract the features from the images as per ones need and final comparison can be done to find out the results. The success of implementation depends on pre-processing stage on the images because of illumination and feature extraction.

#### REFERENCES:

- [1] Ms. Aswathy.R ,IOSR Journal of Computer Engineering (IOSR-JCE) e- ISSN: 2278-0661, p- ISSN: 2278-8727 Volume 11, Issue 1 (May. - Jun. 2013), PP 61-64
- [2] Neeraj, Rajesh and Dr. Shwetank “International Journal for Science and Emerging Technologies with Latest Trends” 10(1): 1-6 (2013),
- [3] N. Gupta and Prof. N. Kaur,”Design and Implementation of Emotion Recognition System by Using Matlab”, International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 Vol. 3, Issue 4, Jul-Aug 2013, pp.2002-2006
- [4] G. Mehta ,S. Vatta “An Introduction to a Face Recognition System using PCA, FLDA and Artificial Neural Networks”, IJARCSSE Volume 3, Issue 5, May 2013
- [5] V. Kumar J. Mistry, M. M. Goyani, International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-2, Issue-4, April 2013
- [6] L. Zhang, Student Member, IEEE, and D. Tjondronegoro ,”Facial Expression Recognition Using Facial Movement Features” IEEE Transaction on Affective Computing, VOL. 2, NO. 4, October-December 2011
- [7] G. Donato, M. S. Bartlett, J. C. Hager, P. Ekman, and T. J. Sejnowski, “Classifying facial actions,” IEEE Trans. Pattern Anal. Mach. Intell., vol. 21, no. 10, pp. 974–989, Oct. 1999.
- [8] Y. Li, S. Wang, Member, IEEE, Y. Zhao, and QiangJi “Simultaneous Facial Feature Tracking and Facial Expression Recognition” , Senior Member, IEEE Transactions On Image Processing, VOL. 22, NO. 7, July 2013
- [9] <http://ai.ucsd.edu/Tutorial/matlab.html>
- [10] R. Chellappa, C. L. Wilson, S. Sirohey, “Human and Machine Recognition of Faces: A Survey,” Proceedings of the IEEE, vol. 83, no. 5, 1995, pp. 705 – 740
- [11] A. Mehrabian, “Communication without words”, Psychology today, vol. 2, no. 4, pp. 53-56, September 1968
- [12] P. Ekman, E. R. Sorenson, and W. V. Friesen, “Pan cultural elements in Facial displays of emotion” Science, New Series, vol. 164, no. 3875, pp. 86-88, April 4,1969
- [13] S. M. Lajevardi and H. R. Wu, “Facial Expression Recognition in Perceptual Color Space” IEEE Transactions on Image Processing, vol. 21, no. 8, pp. 3721-3732, August 2012.