

# Real Time Facial Expression Analysis Using PCA

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**Abstract:** *Face recognition has been very important issue in computer vision and pattern recognition over the last several decades. One difficulty in face recognition is how to handle the variations in the expression, pose and illumination when only a limited number of training samples are available. In this project, we performed Real Time Facial Expression Analysis Using PCA. Initially the Eigen space was created with Eigen values and eigenvectors. From this space, the Eigen faces are constructed, and the most relevant Eigen faces have been selected using Principal Component Analysis (PCA). With these Eigen faces the input test images are classified based on Facial Expression Classifier. The proposed method was carried out by taking the picture database. The database was obtained with 10 photographs of each person at different expressions. These expressions can be classified into some discrete classes like happy, anger, disgust, sad and neutral. Absence of any expression is the "neutral" expression. There are 30 persons in database. The database is kept in the train folder which contains each person having all his/her photographs.*

**Keywords:** Facial expression recognition, PCA, geometric feature, SVM, Eigen face.

## 1. Introduction

Face is the primary focus of attention in social intercourse, playing a major role in conveying identity and emotion. Although the ability to infer intelligence or character from facial appearance is suspect, the human ability to recognize face is remarkable. We can recognize thousands of faces learnt throughout our lifetime and identify familiar faces at a glance even after years of separation. This skill is quite robust, despite large changes in the visual stimulus due to viewing conditions, expression, aging and distractions such as glasses or changes in hair style or facial hair [1]. Computational models of face-recognition, in particular, are interesting because they can contribute not only to theoretical insights but also to practical applications. Computers that recognize faces could be applied to a wide variety of problems, including criminal identification, security systems, image and film processing, and human computer interaction. Unfortunately, developing a computational model of face recognition is quite difficult, because faces are complex, multidimensional and meaningful visual stimuli. The user should focus his attention toward developing a sort of early, pre attentive pattern recognition capability that does not depend on having three-dimensional information or detailed geometry. He should develop a computational model of face recognition that is fast, reasonably simple, and accurate. Eigen face is a face recognition approach that can locate and track a subject's head, and then recognize the person by comparing characteristics of the face to those of known individuals. The computational approach taken in this system is motivated by both physiology and information theory, as well as by the practical requirements of near-real-time performance and accuracy.

## 2. Our contributions

In this paper, we aim to improve the effectiveness and efficiency of facial expression analysis [12]. A novel

learning framework is proposed to recognize the expression categories of the facial [13] images in real time.

The main steps of our method can be described as follows:

- (1) Face detection [2]. We first process the images captured by camera and extract 'Haar-like' features [5].
- (2) Expression feature extraction. Since most of the expression information is on or near the eyes and mouth, we first use grey integral projection in the vertical direction and some prior knowledge to locate these informative areas. After the extraction of the geometric features, we use PCA [3] to extract texture feature. The number of features will increase in 10 times as PCA is used.

## 3. Methodology

In this Project, we present the details of our learning framework for automatic facial expression [14] analysis in real time. We divide the task into three steps, i.e., face detection and location, facial expression feature extraction and facial expression classification.

### 3.1 Face Detection and Location

Face recognition research started in 1970s. The research at that time usually adopt template, spatial methods to identify faces in an image [7]. The method adopts Haar - like rectangle features and combines them with cascaded Adaboost learning algorithm to detect face.

### 3.2 Facial Expression Feature Extraction

The facial expression feature extraction method should satisfy:

- (1) Extract the facial expression features in a short time.
- (2) Eliminate light, noise and camera-related information that is not related to facial expression.

(3) Eliminate redundant facial features and store the features in a compact way.

In this paper, we first transform each image into grey scale and normalize the pixel value to obtain binary balanced grey values after filtering the noise.

### 3.2.1 Procedure

The proposed algorithm involves the following operations:

Step1: Using Training image and sample data set to preprocess the images (training) in database.

Step2: Apply segmentation using face Detection to extract the features from images and store the desired values in feature vector [6].

Step3: Classify the training images into subgroups for the features in feature vector and store the group value in one of the columns of feature vector.

Step4: Get input test image.

Step5: Apply feature extraction and group classification on test image as in step number 2 and 3.

Step6: Training images in same group as of test image are loaded in the image set.

Step7: Apply PCA to recognize the test image on obtained image set.

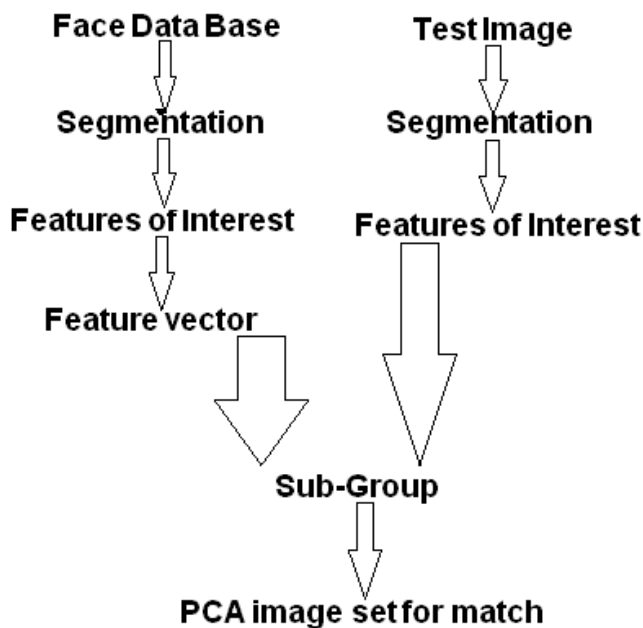


Figure 1: Proposed Algorithm

The most significant parts account for facial [8] expression is the eyes and the mouth. These two regions contain most informative facial expression features. Therefore, we first locate the regions of eyes and mouth then extract features from this region. This method improves the efficiency of feature extraction by reducing the complexity of pixel analysis and improves the quality of features as well. But this method may lose some important facial expression information by only considering the mouth and eye regions.

### 3.3 Texture Feature Extraction

The texture features of face [9] contain significant expression [10] information and can represent some subtle facial expression [11] changes. The texture features are informative and the number of them is various. The PCA is widely applied to computer vision due to its capability to simulate the vision contour of the mammal's vision neural cells. The Gabor analysis can preserve the spatial and spectral property of an image, which is similar with the analysis of human vision system. Moreover, the Gabor transformation is not sensitive to light condition. Hence, we adopt the PCA to extract the texture features for facial expression recognition.

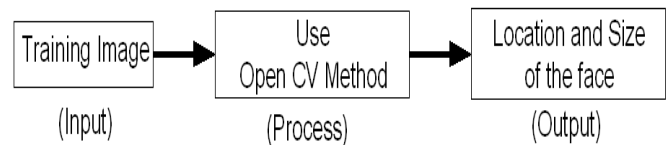


Figure 2: Training and Test Data Set Process

Using the PCA to extract facial expression features is indeed to calculate the convolution of the Gabor filter and facial image. To analyze the image using Gabor filter, we usually adopt a group of Gabor filters with different frequencies in various directions.

### 3.4 Facial Expression Classification

The last step of facial expression recognition is to classify the emotion of each facial expression. We can train classifier based on the resulting PCA features. In this paper, we adopt Support Vector Machine (SVM) due to its robustness and intuitive theory using maximal margin optimization. SVM [4] is an effective statistical learning model in machine learning [5] and data mining. It has been widely applied to biological information, speech recognition, text and image classification, and etc. However, the basic SVMs only deal with the binary classification tasks, but in real facial expression recognition tasks, there are more than two categories of facial expressions. We hence should use extended SVMs to meet the requirement of multi-class classification. In this paper, we use DDAG-SVM. DDAG-SVM generates  $n(n-1)/2$  classifiers, which is the same as the one-versus-one SVM. They also have the same training process. But in the classification process, we need to construct a directed acyclic graph. There are  $n(n-1)/2$  nodes and  $n$  leaf nodes where each non-leaf node is a classifier each leaf node is an category of the samples. The classification is processed from the root to a leaf node to get the category of a sample.

### 4. Experimental Results

We present the experimental results on real-world facial expression dataset. The experimental environment is as follows:

- CPU: Intel(R) Core(TM) Duo CPU 1.66GHz
- Memory: 1.0 GB
- Operating System: Windows XP 2002 Service 2
- Software: MATLAB R2010a.

### 5. System Overview

Real time facial expression recognition system should effectively process the image that is captured by camera and

classify the type of the emotion that the facial expression indicates. The facial expression classifier training process in our proposed framework is illustrated in below fig.

In this process, we mainly extract facial expression features and associated the facial expressions to specific emotion type. In the real time recognition process, we capture face image using cameras, then use the classifier learned in the training process to identify the category of the facial expression associated with the specific emotion. The classification results are then output in real time.

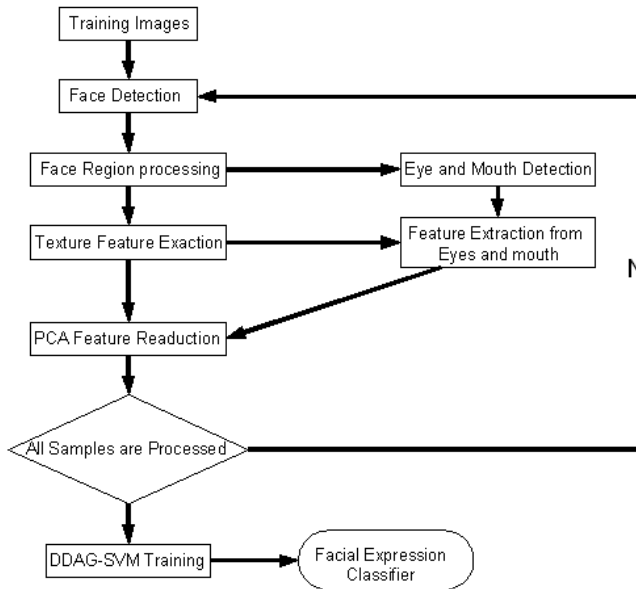


Figure 3: Framework of training facial expression classifier

### 5.1 Dataset

In the experiments, we consider the popular Indian face dataset. Indian faces are contains facial images. The 8 facial expressions are 6 basic facial expressions (happiness, sadness, fear, disgust, surprise and anger) plus 1 neutral, as shown in below Fig. Each Indian face model has 3 or 4 images.



Fig : An sample of Indian images

### 6. Conclusions and Future Work:

In this paper, we aim to build a real time leaning framework for effective facial expression recognition of images. We proposed a method to extract the texture features and geometric features from face image that are discriminative for expression classification. Based on the features, we train DDAG-SVM to classify the category of emotion each facial expression belong to. Experimental results on Indian FACE database demonstrate the effectiveness of our proposed

learning framework. There are several interesting future directions. One is extending our model to image sequence data such as video. In real world, facial expression is 3D and 3D information can help the recognition task. We plan to focus on the informative feature extraction from 3D face images in the future.

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