

# Facial Expression Recognition: A Literature Survey

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**Abstract**---Facial expression recognition is becoming increasingly popular because of the need for human machine interaction. The recognition of facial expressions is not an easy problem for machine learning methods, since different people can vary in the way that they show their expressions. And even an image of the same person in one expression can vary in brightness, background and position. We conducted an extensive literature survey to compare the efficiencies of the various facial expression recognition techniques. The two popular databases used in most techniques are: 1) Cohn-Kanade AU-coded database and 2) JAFFE database. This paper aims at identifying the techniques used for the recognition of the six basic expressions: Joy, neutral, anger, sad, surprise and disgust.

**Keywords** – Face detection, facial expressions, expression recognitions, expression classification, datasets.

## I. INTRODUCTION

“Your Face speaks louder than your voice”, to support this sentence one communication research says that during face to face communication nonverbal communication have 55% impact on the message conveyed between two parties so analysis of facial expression and cognition is necessary for effective communication. Creation of effective interaction between human and machine needs effective techniques for automatic facial behavior recognition. In general, facial behavior recognition, can be defined as the process of identifying the human mental state or feelings from the analysis of movement of the facial parts such as eye blinks and lips opening and closing count.

Face expression detection is an attractive field of research nowadays because it has wide application areas such as Human Machine Intelligent Interaction, Smartrooms, Advance Driver Assistance Systems, Intelligent Robotics, Monitoring and Surveillance, Gaming, Research on pain and depression, Health support appliances, Deception Detection etc., As it has a wide application range it is challenging task to make a robust system that works under different circumstances. Facial behavior recognition is an application of computer vision that uses technology like image processing, and artificial intelligence, and expert knowledge of psychology. From the application point of view, computer vision is concerned with the theory behind artificial systems that extract information from images.

The human Facial behavior depends on many uncertain entities such as mind, facial muscle, situation, environment. Soft computing techniques are applicable in the problem whose solution is uncertain and answer is always an approximation.

In general, Automatic facial behavior recognition is divided in three major phases face detection, feature extraction and classification of expression. Face detection is a process of identifying face area from the input image. Feature extraction refers to the identification of facial feature points such eyes and lip contour which are responsible for particular facial behavior. And final step is the identification of that facial expression using information gathered in the second phase.

This paper contains the survey on different approaches facial behavior recognition using image processing and soft computing techniques. And last section concludes this survey.

## II. LITERATURE SURVEY

The process of facial expression recognition is classified into three stages:

1. Preprocessing of input images
2. Face detection
3. Facial expression recognition and classification

This literature survey paper gives an outline of the techniques and algorithms used to implement the above mentioned stages of facial expression recognition.

### A. Face detection:

For facial feature extraction in static images first a static image is taken. Then, skin region is extracted from that image using Hue Saturation Value (HSV). After extraction, the eyes and themouth part are isolated and the unwanted skin region is removed. [2]

In [4] & [8] Viola-Jones face detection algorithm popularly known as cascade face detector is used for face detection. P. Viola and M. Jones observed that the nose bridge formed a bright vertical line, in comparison, to the eye sockets which form a horizontal dark band since they are hollow. Thus, the algorithm searches for a bright vertical band and a dark horizontal band in a given front images. After this cubic Bezier curve has been applied to obtain facial features. A cubic Bézier curve is formulized by the function  $P(u)$ , given points  $p_0$ ,  $p_1$ ,  $p_2$  and  $p_3$ . The

two intermediate points  $p_1$  and  $p_2$  are used to assign the end point tangent vectors while  $p_0$  and  $p_3$  are starting point tangent vectors [8]. In [4] facial feature localization is done by using morphological operations and facial feature extraction i.e. finding distance of mouth and mean and standard deviation, using statistical formula.

Another face recognition method "expression removal vector" is proposed by [4] that can be integrated into any face and expression recognition system to improve the overall recognition accuracy even under limited training samples. The expressive face is considered as a combination of its neutral and expression component, the neutral face is obtained by removing the expression, such that the expression invariant face recognition system can be implemented. It is assumed that the expression component is same among different subjects under the specific expression therefore a wrapping is performed to ensure that the particular expressive images of all subjects are mapped to a common face template and variation between individual and different subjects are removed.

An efficient algorithm for accurate detection and extraction of facial features has been proposed. The color image is converted into a gray scale image. Then pre-processing is performed by applying contrast equalization. To find the eye, the dark regions are found using two methods: 1) rule detection method and 2) morphological method [4], result of both is combined and using the location of the eyes and the distance between them, face region in an image is determined. Three different morphological operations are performed on the image to enhance the required feature regions i.e. contrast stretching, Gray level or Intensity level slicing and Gamma intensity correction method [9]. The face region is divided into a number of windows by applying the geometric relationship of features where each window contains a facial feature such as eyes, nostrils and mouth etc. The features are extracted from the respective windows.[9]

### ***B. Facial expression recognition:***

There are two types of face representations for face expression recognition i.e. holistic template based methods and geometric feature based method. In holistic method the whole face image is processed to obtain a template which is either a pixel image or a feature vector. In the geometric feature based method, the shape and location of facial components are used to obtain feature vector.

The Local binary pattern (LBP) summarizes local structures of images efficiently by comparing each pixel with its neighboring pixels. In this technique, all the pixels of image are labeled by LBP operator by thresholding the 3X3 neighborhood of each pixel with the center value. The result obtained is known as LBP

code. For the facial recognition, the face is divided into number of local regions and many histograms are extracted and concatenated to produce single enhanced histogram. The LBP operator performs well and known as an excellent texture descriptor but its operator produces very long histograms making it difficult to use it as a region descriptor. CS-LBP is better as region descriptor and produces small and compact binary patterns. In this technique, the pairs which are center symmetric are only compared. It has been observed that CS-LBP yields better results than LBP [1].

Another method named "Thermal Image Processing and Neural network" for recognition of facial expression is based on 2D detection of temperature distribution of face, using Infrared Rays. The front view face is first normalized in terms of size and location and the local temperature difference between averaged neutral and unknown expression faces are measured. The local temperature difference caused by rearrangements of face muscles and the inner temperature change is used as input data for Neural Network. [5][6]

In Fuzzy logic based emotion recognition system the system compares an image of interest to a neutral expression baseline image to determine the expressed emotion. The system consists of two stages: 1) Image processing and 2) emotion recognition. In first stage the subjects face and facial features are extracted and then the relevant identifying points are extracted from each feature using which relevant information for each AU is calculated. In the second stage the identifying points are used to fuzzify and determine the strength of different facial actions. These strengths are then used to determine the subject's emotion [7].

### ***C. Facial expression classification:***

Six categories of emotions are used in the classification stage: neutral, joy, anger, surprise, sadness and disgust. Facial expressions can be classified by using some face parts such as eyes and mouth. Different classification methods are used to classify facial expressions in still images. A classifier also known as distance metric or matching criteria, is used to retrieve the similar face image from a large dataset. Some types of classifiers are Euclidean distance, histogram intersection distance, chi square distance, Support Vector Machine (SVM) etc. Euclidean Distance measures the summation of difference among the paired values of the feature set. After taking the square root of the summation the closest distance measure is taken as the final result for that particular image [1].

The histogram intersection distance is a very simple method and is very useful in similarity measure where a large database is involved and quick replies are required [1].

Chi-Square Distance metric is a non-parametric test to measure the goodness of fit for data specific to a class.

The minimum distance found between two feature set gives the maximum similarity measure between them [1].

The classification algorithm is divided into three phases of processing: training, validation and testing. [3] In the training phase, the important characteristic properties of the image features are taken. The input images and the database images can be trained by using a classifier. They are then compared to find out the final expression. Using Support Vector Machine (SVM) classifier, images are trained by finding the Eigen faces which is detected by calculating the Eigen values [2].

#### **D. Databases:**

The databases used in the above mentioned methods are:

##### **1. Cohn-Kanade database:**

This database consists of 593 images and 7 expressions: neutral, sadness, surprise, happy, anger, fear and disgust. The images present in this database are mostly gray and it is a database consisting of American faces. 123 subjects were used to create this database

##### **2. JAFFE database:**

This database consists of 213 images and 7 expressions: neutral, sadness, surprise, happy, anger, fear and disgust. The images present in this database are all gray and it is a database consisting of Japanese faces. 10 subjects were used to create this database

### **III. CONCLUSION**

This paper shows a survey of the different facial recognition techniques currently in use. Some of these techniques are as follows: Local Binary Pattern (LBP), Center Symmetric Local Binary Pattern (CSLBP), Fuzzy System, Thermal Image Processing, Morphological Processing etc. The facial expression recognition process takes place in 3 steps: 1. Preprocessing 2. Face detection 3. Facial expression recognition and classification. The efficiencies of the survey techniques were found to be 75-95%.

We will be using this literature survey as a basis for implementing Intelligent Tutoring System in future.

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