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# Different techniques of Automatic Facial Expression Recognition: A Survey

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*Abstract*— **Emotion recognition through facial expression detection is one of the important fields of study for human-computer interaction. To detect a facial Expression one system need to come across different variability's of human faces such as color, posture, expression, orientation, etc. To detect the expression of a human face first it is required to detect the different facial features such as the movements of eye, nose, lips, etc. and then classify them comparing with trained data using a suitable classifier for expression recognition. This paper provides a survey report of implementation of different techniques for expression recognition along with their advantages and drawbacks which will help in further development and improvement of the system.**

***Index Terms*— Facial Expression, Image Processing, Human behavior.**

## I. INTRODUCTION

A facial expression is one or more motions or positions of the muscles beneath the skin of the face. These movements are used to convey the emotional state of an individual to observers. Facial expressions are a form of nonverbal communication. Facial expression Human facial emotion recognition software if carefully equipped in an analysis center, it can produce valuable outcomes. Recognition or emotion recognition is one of the new concepts which is getting momentum in the field of research on intelligent systems. Though facial expressions obviously does not necessarily convey emotions, in the computer vision community, the term "facial expression recognition" often refers to the classification of facial features into one of the six so called basic emotions: happiness, sadness, fear, disgust, surprise and anger, as introduced by Ekman [2]. This concept of interpretation is based on the assumption that the appearance of emotions is universal across individuals as well as human ethnics and cultures.

Recognizing human emotion can have numerous applications in various contexts. While the most promising one is probably the man-machine interaction, patient monitoring, studying a suspect for anti-social motives etc. might be other useful areas for emotion recognition. With emotion recognition system the center can analyze customer's reaction on seeing certain product or advertisement or upon receiving a particular piece of information or message. Based on the response whether they are happy or sad or disgusted, etc. the service center can modify their approached.

In a generalized form of a facial expression recognition system, an input sensing device such as a webcam obtained the input image from a subject and then it communicates with the computer. After detection of the facial area, representative features from the emotionally expressive face image are extracted, it is then preprocessed and a classifier is used to classify them into one of the emotion classes such as anger, fear, surprise, happy, neutral etc. There are several detection method as well as classifier algorithms that can be used in the detection and classification.

## II. THE ROLE OF FACIAL EXPRESSION

Eye is considered an important part of the face for facial expression recognition. In addition muscle movement of the mouth and lip regions plays a significant role in conveying the emotional state of a being**.** Fasel and Luttin define facial expressions as temporally deformed facial features such as eye lids, eye brows, nose, lips and skin texture generated by contractions of facial muscles [3]. They observed typical changes of muscular activities to be brief, "lasting for a few seconds, but rarely more than five seconds or less than 250ms." [3]. They also pointed out the important fact that felt emotions are only one source of facial expressions besides others like verbal and non-verbal communication or physiological activities.

People often use numerous nonverbal signs such as facial expressions, vocal nuances, hand and body gestures, and body posture to communicate their emotions. It acts as our most natural and direct means of communicating and understanding other humans' emotional state and intentions. This is supported by the experiments conducted in [1] which show in everyday interaction, 7% of the communication happens through language, 38% via paralanguage whereas facial expressions contribute to the 55% of the communication. Indeed, the study of human facial expressions has many aspects, from computer simulation and

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analysis to understanding its role in art, nonverbal communication, and the emotional process.

## III. BACKGROUND AND LITERATURE REVIEW

Emotion detection through facial expression recognition is becoming quite popular for its increasing scope of applications in human-computer interactive systems. Though several method of emotion recognition, including facial expression, voice, gesture and posture has been studied in the literature, emotion recognition mainly comprises two fundamental steps involving feature extraction and classification. Feature extraction refers to determining a set of features/ attributes, preferably they are independent, which together represents a given emotional expression. While classification maps emotional features into one of several emotion classes such as happy, anger, sad, disgust, etc. The set of features that are considered for extraction and the classifier that is used for the task of classification are equally important to determine the performance of an emotion recognition system. For a poorly selected set of features, sometimes, even a good classification algorithm cannot give a good result. Thus, selecting good features is always a pre-requisite for high classification accuracy and good result. Several methods of emotion recognition from facial expression have been developed over the last three decades.

## IV. EMOTION TAXONOMY

Emotion theorists and psychologists have defined several models for emotion classification ranging from universally displayed basic emotions to culturally specific complex ones. Out of the various models in emotion research, there are two that have dominated facial expression research: Ekman's basic set of emotions [11], and Russell's circumplex model of affect [12]. Ekman and Freisen in 1971 [11] proposed six prototypical (basic) emotions - anger, disgust, fear, joy, sadness, and surprise - which are universally displayed and recognized from facial expressions. The universality of these basic emotions, having its roots in the universality thesis proposed by Charles Darwin, was further supported by the cross-cultural studies in [9]. This categorical description has gain popularity and possesses an advantage from the fact that facial expressions pertaining to basic emotions are easily recognized and described by humans. This model of emotion subspace has become the most prevalent model for measuring emotion, and the facial expressions associated with these basic emotions have dominated the studies related to facial expression recognition over the last four decades. An alternative description model of human emotion was proposed by Russel[12] where emotional states are represented by circle as in two dimensional bipolar space (Pleasantness-unpleasantness, arousal-sleep) rather than specific discrete categories. For example anger might be perceive as conveyance of extreme displeasure and moderately high arousal.

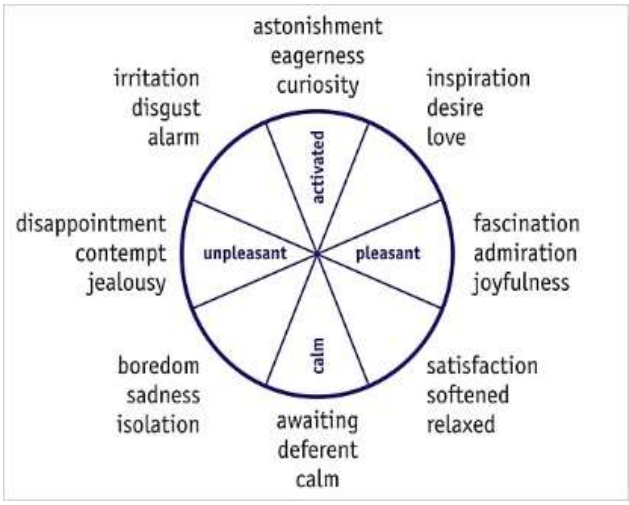


Fig 1. The Circumflex Model of Russell

## V. RELATED WORK ON EMOTION RECOGNITION

Although there is a vast literature on emotion recognition, it is still now considered a complex problem for the following reasons. First, the level of ambience of individuals differs significantly. Further, a subject experiencing similar emotions at different time is often found to have significant differences in his/her external manifestations of emotions. Naturally, identification of one's correct emotional state from the measurements of the physiological conditions is also difficult. More subjects excited with stimulus responsible for arousal of a specific emotion, have a manifestation for mixed emotions. Emotion recognition becomes more complex, when subjects arouse mixed emotions. Among interesting works on emotion recognition, the work by Ekman and Friesen [8] needs special mention. They forwarded a scheme for recognition of facial expression from different regions of face, e.g. cheek, chin, and wrinkles. It reports a direct correlation of facial expression with the eyes, the eye-brows, and the mouth. Pushpaja V. Saudagare and D.S Chaudhari[4] came forward with a technique to detect expression from emotions through neural networks. It reviews the various techniques of expression detection using MATLAB (neural network toolbox). Hamit Soyel and Hasan Demiral[5] also implemented the techniques of facial expression detection using 3D facial feature distances. They detected basic emotions such as anger, sadness, surprise, joy, disgust, fear and neutral which are successfully recognized with an average rate of 91.3%.Andrew Ryan[6] and six more scientists also came up and developed an Automated Facial Expression Recognition System(AFERS) which is basically used to detect the presence of deception during the interview process. Mandeep Kaur,Rajeev Vashisht and Nirvair Neeru[7] developed a facial expression recognition system using Pricipal Component Analysis and Singular Value Decomposition techniques. Muid Mufti and Assia Khanam[10] developed a fuzzy rule based emotion recognition technique using facial expression recognition.

# VI. COMPARISON BETWEEN DIFFERENT ALGORITHMS OF EMOTION RECOGNITION PROPOSED BY DIFFERENT AUTHORS

### A. *Automated Facial Expression Recognition System, 2009- by Andrew Ryan, Jeffery F. Cohn, Simon Lucy, Jason Saragih, Patrick Lucy, Fernando De la Torre and Adam Rossi.*

The proposed algorithm is:

**Step 1:** Video processing: It is responsible for sequencing the inputted video into individual frames.
**Step 2**: Shape and Appearance Modelling
**Step 3**: Expression Classification
**Step 4**: After Classification of expression during runtime the AFERS offers operators with many real-time output of the expression recognition process such as snapshot generation and interrogation reporting, etc. It is done by the Analytics Engine.

Advantage(s):

The AFERS helps in automating the manual practice of FACS(Facial Action Coding System) developed by Paul Ekman and Wallace V. Friesen and acts as a portable near real-time system to detect seven universal expressions of emotions(Disgust, Fear, Anger, Contempt, Sadness, Surprise and Happiness) and also providing investigators with indicators to detect presence of deception during interview process. It also includes various features to allow users to re-evaluate interviews later such as full-video support, snapshot generation and case-management utilities, etc.

Drawback(s):

The present AFERS system detects the presence of deception during interview or interrogation processes but it cannot directly detect the presence of deception for which it need further research and refinement along with introduction of contextual models.

### B. *Fuzzy rule based facial expression recognition, 2006- by Muid Mufti, Assia Khanam.*

The proposed algorithm is:

**Step 1:** Input Video
**Step 2:** Frame Extraction
**Step 3:** Feature Point Extraction
**Step 4:** FAP Extraction
**Step 5:** Fuzzification
**Step 6:** Expression Detection

Advantage(s):

The work successfully employs and implements fuzzy logic principles to recognize emotions from expressions in video image and because of the very robustness of the fuzzy systems, the system is thus robust to various fluctuations in image processing results. The system can be applied in medicine science, cognitive science, education and even entertainment.

### C. *Recognition of Facial Expression using Principal Component Analysis and Singular Value Decomposition, 2010- by Mandeep Kaur, Rajeev Vashisht, Nirvair Neeru.*

The proposed algorithm is:

In this paper they have proposed PCA (Principal Component Analysis) for emotion classification using singular value decomposition.
**Step 1:** Input image is given for pre-processing.
**Step 2:** The features are extracted and fed to the classifier.

- Simultaneously the image from the expression database is preprocessed and feature extracted and given to knowledge base for training and then fed to classifier.

**Step 3:** Then the two images are compared and the expression desired to be recognized is detected or recognized.

Advantage(s):

Excellent classification results are found for all principal emotions along with the neutral emotion from the training database. The image is enhanced, localized and its features are extracted using Singular Value Decomposition technique. The algorithm can effectively detect different emotions.

Drawback(s):

The major drawback of this work is that the elimination of errors due to reflections in the image such as the person is wearing glasses is not implemented and the algorithms used are computationally efficient.

### D. *Facial expression recognition using neural network - An overview, 2012-by Pushpaja V. Saudagare, D.S. Chaudhari.*

The proposed algorithm is:

In this paper they have presented a basic face gesture recognition arrangement and a generic face detection arrangement and gives an overview of some of the facial expression recognition system thereby proposing a system consisting of the following module or step**s:**
**Step 1**: The input image is obtained through webcam
**Step 2**: Face detection using optical flow method
**Step 3**: Image preprocessing
**Step 4:** Principle component analysis is performed
**Step 5**: Classification is using Artificial Neural Network (feed –forward back propagation network)

Advantage(s):

Provides practical solution to problems of facial expression recognition in a constraint environment.

Drawback(s):

Poses problem in unconstraint environment.

***E. Facial expression recognition using 3-D facial feature distances, 2007- by Hamit Soyel, Hasan Demirel.***

The proposed algorithm is:

- 3D distribution of the facial feature points (11feature points) are used for the estimation of six characteristic distances in order to represent the facial expressions.
- Distance values are used to describe the fundamental facial expressions including surprise, joy, happiness, sadness, anger, and neutral.
- In this experiment, data captured form 60 subjects for each of the expression is used.

**Step 1**: Extraction of the characteristics distance vector as defined in a table containing the six characteristic distances is done.
**Step 2**: The distance vector is classified based on a neural network that is trained using the back propagation algorithm.
**Step 3**: A sixth distance is used to normalize the first five distances.

Advantage(s):

- The distance measures extracted from the 3D facial features provide very reliable and valuable information for robust recognition of facial features. 3D facial expression database is used which is more reliable
- Using neural network classifier provide better performance
- Facial expression analysis experiments carried out is person independent which is more challenging then experiment carried out in a person dependent manner
- This 3D method is superior and have higher recognition rate compared to 2D facial feature based method
- Using neural network classifier outperform other method such as using LDA (Linear Discriminant analysis)classifier

Drawback(s):

Average recognition rate is lesser for anger class due to confusion with neutral and anger classes.

# VII. CONCLUSION

Facial expression recognition is a challenging problem in the field of image analysis and computer vision that has received a great deal of attention over the last few years because of its many applications in various domains. Research has been conducted vigorously in this area for the past two decades or so, and though huge progress has been made, encouraging results have been obtained and current facial expression recognition systems have reached a certain degree of maturity. This paper we have presented an extensive survey on various techniques of facial expression recognition such as using neural networks, automatic facial expression recognition system using fuzzy rule based approach, PCA for classification and singular value decomposition which will help us for further work in this area.

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