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# A Survey on Human Facial Expression Recognition System

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**ABSTRACT:** Facial expressions play a vital role in emotional awareness and that is why they are used for non-verbal communication, and also in identification of people. They are especially important for day to day emotional communications, close to the voice tone and also help in indicating feelings and allows a person to express his/her state of emotions. Humans, on the other hand, can quickly detect a person's emotional state. As a result expression on faces plays an essential role in various areas including but not restricted to security, production of robots, clinical investigations, and multimedia.

Facial expression recognition (FER), an important area of research for interaction of humans with machines, is the role of finding emotion by analyzing the facial expressions that acts as an important role in social interaction and conveying clear and vivid details about people's feelings. As a result of which most of the computer vision systems have used FER where they were trained using various facial data.

This paper describes a survey on various Facial Expression Recognition (FER) techniques. For any FER, the initial step is to extract the features from the face which can further be processed to detect the expressions. Hence, this paper also aims at giving an overview on how a facial expression system works and a comparative study of the various processes that has been used.

**KEYWORDS:** Face detection, Facial Expressions, Feature Extraction

## I. INTRODUCTION

A person's emotions in a variety of non-verbal symptoms such as facial expressions, gestures, body language, or tone of voice. Out of all these facial expressions are the easiest to obtain. The 7 basic categories of human facial expressions are neutral, surprise, fear, sadness, anger, happiness, disgust (fig.1). The generalized procedure to determine the facial expression has three major steps (fig.2). Once the image having a human face is given as an input to the system, the first step is the detection of the face in the give input image that is done by extracting important features and then the face is recognized. Secondly, the facial feature are extracted from the input image. Finally, these facial features will be given asinput to the classifier for identifying the respective expression which is the final output.



Fig. 1 Categories of Human Facial Expressions

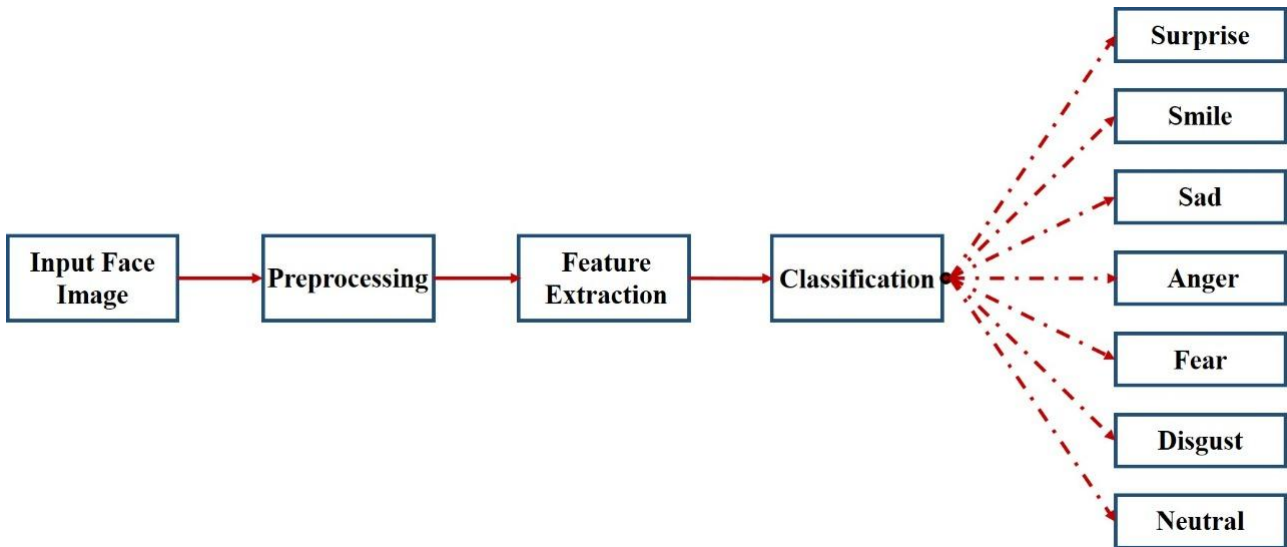


Fig. 2 Architecture of a Facial Expression Recognition System

## II. STAGES IN FACIAL EXPRESSION RECOGNIZER

The three essential steps in the expression recognizer are explained below.

### Step 1: FACE DETECTION

This step is to find out that whether the particular input image has a face that we require to explain the basic facial structure. Here, we extract the face from the background (as shown in fig.3) because images with background illuminations can make the identification of the facial expression difficult. Fortunately, human faces do not differ from each other, as all humans have eyes, nose, chins, mouth; and all of these together form the structure of a face. Face detection one of the special cases of object detection. Various methods of face detection is shown in fig.4.

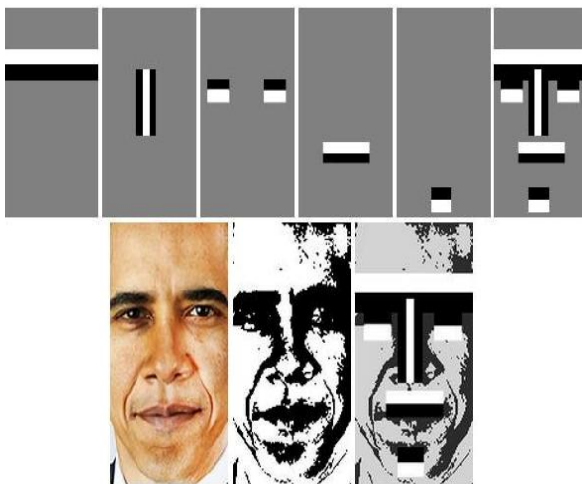


Fig. 3 HAAR- like Feature detection

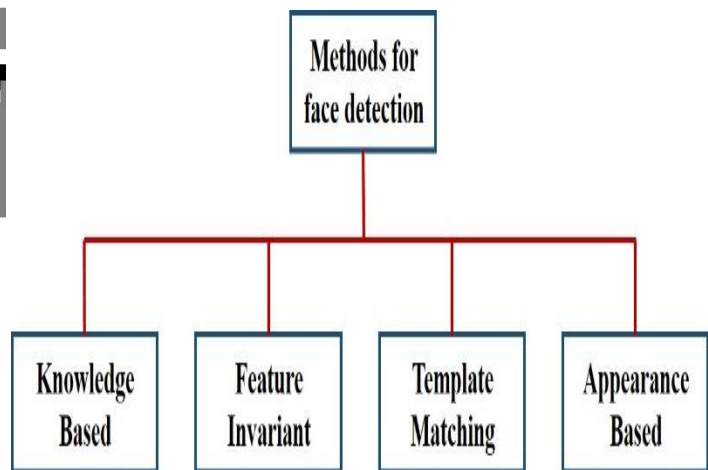


Fig. 4 Face Detection Methods

### Step 2: IMAGE PREPROCESSING

Raw input images may contain noise with various unwanted effects. Recognition of face fails when the test image has a different lighting pattern than that of the training images. Hence, facial points will be detected incorrectly. The main goal of pre-processing the input image is to get an image having intensity that is normalized such that the changes in the environment shall not have any effects.

**Step 3: FEATURE EXTRACTIONS**

The procedure of converting an input image to some sets of feature is known as feature extraction which will help in the reduction of the great amount of data into small data which can help in making the model computationally efficient. Some set of points are selected representing the features of a human face such as eyes, lips, cheeks, etc., through pixel intensities. There are various techniques for feature extraction as shown in the Fig. 5.

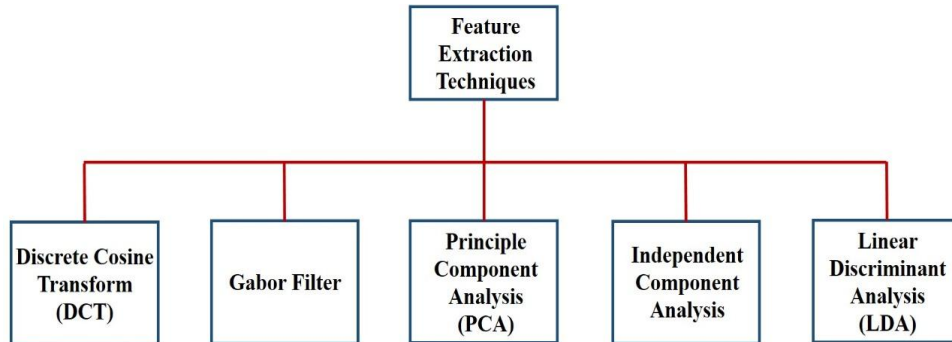


Fig. 5 Feature Extraction Techniques

**Step 4: CLASSIFICATION**

The final stage of the FER System is the classification of the expressions into various categories like happy, sad, angry, etc. The facial expression classification is done using supervised learning. Using the training data set the classifier will first be trained and will then be tested on the test data to recognize the facial expression of the images. There are various classification techniques that can be used to extract expressions from an image and is shown in Fig.6.

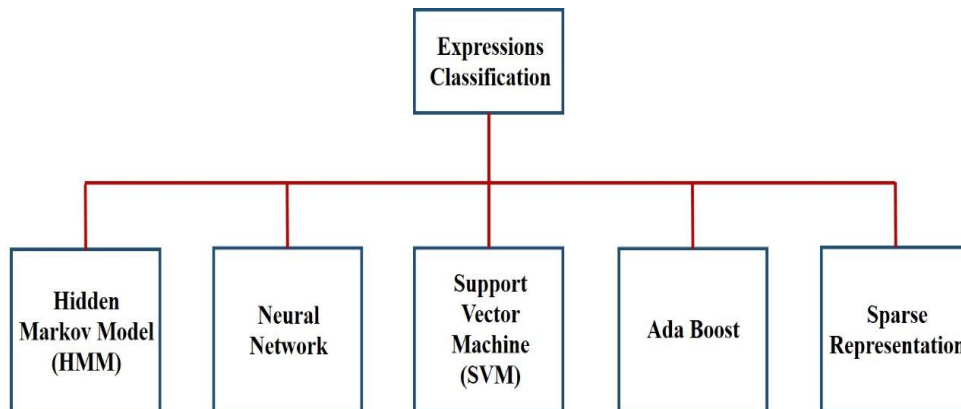


Fig. 6 Expression Classification Techniques

**III. LITERATURE SURVEY**

This section basically deals with various technologies and algorithms used to recognize different facial expressions on human images. Various papers describing this is illustrated and discussed here. Table 1 gives an overall summary of few of the facial expression recognition systems and also gives a remark on their performance.

**A. Kuan Chieh Huang, ShengYu Huang, 2010 [1]**

In this paper, a triangular facial feature extraction method based on a Modified Active Shape Model (MASM) is used. The process involves the processing of all the facial features, removal of all the affection of environmental changes as well as the noise in the facial features, and also reduction of feature dimensions. Using the feature points extracted by MASM, two methods, one based on mathematical analysis and the other based on a genetic algorithm, are proposed to produce a good set of triangular facial features for visual recognition. A neural network classifier is selected by using the JAFFE database to detect emotions with the triangular facial features that has been extracted. The test result then shows that according to statistical analysis an estimated 65.1% recognition rate has been found, and according to the genetic algorithm an estimated 70.2% recognition rate has been found.





**B. Wenming Zheng, Xiaoyan Zhou, Li Zhao, 2006[2]**

In this paper, the author addresses the FER system through kernel canonical correlation analysis (KCCA). The process starts by locating 34 facial points from each image and then converting these facial points into a labeled graph (LG) vector by using the Gabor wavelet transformation method in order to represent the facial features. Then for each training data i.e. facial images, the semantic ratings showing the common expressions are merged into a 6D Semantic expression vector. The correlation between the LG Vector and the semantic expression vector is calculated by the KCCA. Using this correlation, we calculate the semantic expression vector for the test image and then classify the expressions for that image according to the semantic expression vector that has been evaluated. The entire experiment is done on the Japanese female Images database.

**C. Jiawei, Congting, Hongyun, Zilu [14]**

This paper proposes an effective FER algorithm which is based on sparse representation and completed local binary pattern (CLBP). This approach performs sparse representation on both CLBP and gray facial images. Later, we get results of expression recognition on both the images by the sparse representation classification (SRC) method. Hence the final expression recognition is obtained by merging both results through comparison between the residues of the sparse representation classification (SRC) method. This method estimates an accuracy of 69.52% recognition rate.

**D. Ying Zilu, Zhang Guoyi [15]**

In this paper a novel approach to FER is proposed which is based on the combination of Support Vector Machine (SVM) and non-negative matrix factorization (NMF). One of the most important steps in FER is the extraction of expression features from the actual facial images. NMF is one of the best approaches for extracting expression features as NMF decomposition facilitates the reconstruction of expression images in a non- invasive way and is almost similar to the process of building unity form various parts. The first step in this algorithm is to process the facial image using histogram equalization operator. Then SVM is used for classification and NMF for reducing feature dimensions. Finally, the algorithm was implemented using the facial image database. An accuracy of 66.19% recognition rate was obtained after using this method.

**E. Yongsheng Gao, M.W. Tananda, Siu Cheung Hui [12]**

This paper presents a method for FER from a single static image using line-based caricatures and the process is completely automatic. This method matches the line edge map (LEM) descriptor of an input facial image by using geometrical and structural features of a user sketched expression model. A discrepancy measure which is robust to the variations in expression is also explained. The algorithm measures an accuracy of 86.6% recognition rate.

**Table 1.** A summary of some facial expression recognition systems

AUTHOR	TITLE	FEATURE EXTRACTION	EXPRESSION CLASSIFICATION	ACCURACY (%)
Sebe, M.S. Lew, et al. [18]	Authentic Facial Expression Analysis	MUs generated from the PBVD tracker	Bayesian nets, SVMs and Decision Trees. Used voting algorithms like bagging and Boosting to improve results.	70-73
Wang Zhen, Ying Zilu [20]	Facial expression recognition based on adaptive local binary pattern and sparse representation	Gabor filter	Sparse Representation Classification SRC	70



<b>Deepti, Archana, Dr. Jagathy [19]</b>	Facial expression recognition using ANN	Discrete Cosine Transform (DCT)	NEURAL NETWORK (NN)	90-92 (But recognized only 3 types of Facial expressions)
<b>Anagha, Dr. Kulkarnk [21]</b>	Facial detection and facial expression recognition system	Active Appearance Model (AAM)	(1)ANFIS (2)Euclidean distance method	(1)close to 100 (But recognized only 4-5 types of Facial Expressions) (2) 90-95
<b>Ms.Aswothy [22]</b>	A Literature review on Facial Expression Recognition Techniques	-	Fisher’s Linear Discriminant	Recognition rate is very low
<b>Ms.Aswothy [22]</b>	A Literature review on Facial Expression Recognition Techniques	-	Multi Linear Analysis	Recognition rate higher but only applicable on grayscale image
<b>Mohamed Dahmane, Jean Meunier [23]</b>	Prototype-Based Modeling for Facial Expression Analysis	Linear Discriminant Analysis (LDA)	Support Vector Machine (SVM)	83-85 (The Model is Highly Complex)

**IV. ISSUES IN THE PREVIOUS WORK**

- 1) Accuracy of recognition is low due to lack of training done in system.
- 2) Representation of data for some expressions are almost identical.
- 3) Previous analysis cannot deal with:
  - Faces having wrinkles.
  - Faces with changes in skin colour.
- 4) Few of the papers have also stated that their results and performance are dependent on the databases, e.g. JAFFE database.

**Issue 1:** Good parameter and feature selection process is inflexible [24]  
 Along with other improvements the feature selection steps should be optimized, and choosing good parameters should be considered for further experiments.

**Issue 2:** Drawbacks of the CMU Database [24]  
 Although CMU database was very efficient for other studies but it is found that it is not sufficient and appropriate to use it is FER because the facial expression images used to train the model is not equally divided which is an important requirement in the proposed methodology, for e.g. the “disgust” or “surprise” images are very less as compared to those of “fear” or “angry”.

**Issue 3:** Expensive Computation [12]  
 Although the algorithm gives a high accuracy but it results in recognizing only 3 facial expressions and the algorithm is computationally very expensive.

**Issue 4:** The biggest problem with doing this is that these semantic expression vectors [2] present very less information on expressions. Therefore, they may not give good results when they are used to predict all the seven facial human expressions.

## V. PROPOSED WORK

In light of the issues surveyed by comparatively analyzing through the papers studied in detail, we have chosen in our current work to overcome the following issues:

- 1) Developing the FER technique to identify features of faces under uneven lighting conditions.
- 2) Improving the performance rate of the model for recognizing the facial expressions.
- 3) Making the model database independent.

## VI. CONCLUSION

Facial expression recognition has growing implants day by day and so requires more reliability and accuracy in the FER Systems. This paper highlights the basic framework of a facial expression recognition system and also gives a literature survey on the various techniques that have been used in the FER systems. These techniques are compared based on the database used, their accuracy, computational complexity and the number of facial expressions recognized. A robust FER system should be upto the mark based on these parameters and should also satisfy pose-invariance, illumination variance.

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