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Review Article

# A REVIEW ON FACIAL EXPRESSION RECOGNITION SYSTEMS

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**Abstract**
Facial expression is one of the most important form of non-verbal communication. Facial expressions emit the feelings of a person, and it allows judging that person by others. Some can understand facial expressions of underlying emotions to some extent, whereas many of us cannot. Facial Expression recognition (FER) system is a system to recognize expressions from a person's face. It plays an important part in today's world in fields of mental disease diagnosis, and human social/physiological interaction detection. Various methods of FER exist. This paper provides a summary of various processes involved in FER.

***Keywords:*** Facial Expression Recognition, Convoluted Neural Network, Machine Learning.


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## INTRODUCTION

Facial expression is an important way of communicating human emotions. Darwin in 1872 proposed that facial expressions of emotion may have a link to evolution of species. Sir Charles Bell and G.B. Duchenne anatomically examined human facial expressions. Mehrabian et al showed that 55% of feelings and attitudes are expressed via the facial features [1]. Dampened facial expressions, avoiding direct eye contact are few symptoms of depression [2]. Ekman, a pioneer in studying facial expression has classified them as various states like Happiness, Anger, sadness, surprise, disgust and fear [3] which are given in figure 1.

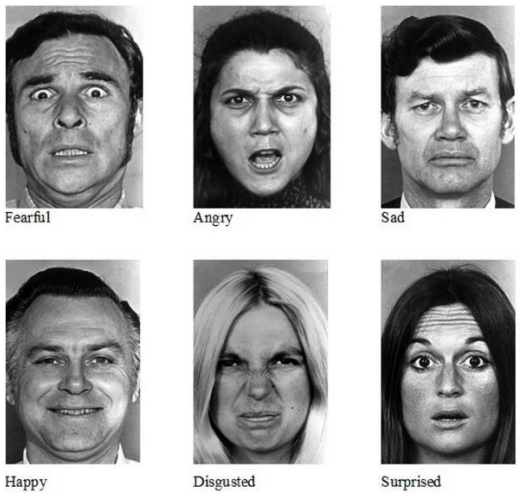


**Fig. 1: Different facial expressions [4]**

FER has applications in fields of Human-computer Interaction, Virtual reality, Augmented reality, Education, audience analysis in marketing and entertainment [5]. Also, it has applications in driver safety such as drowsiness detection, Pain analysis in health care, video conferencing, credit card verification, criminal identification, facial action synthesis for animation industry and cognitive sciences. This review aims to explain the history, importance, and procedures of FER systems.

## STEPS OF FER SYSTEM

FER systems have four important steps like signal acquisition, Pre-processing, Extraction of features, selection of features and their classification (Fig 2).

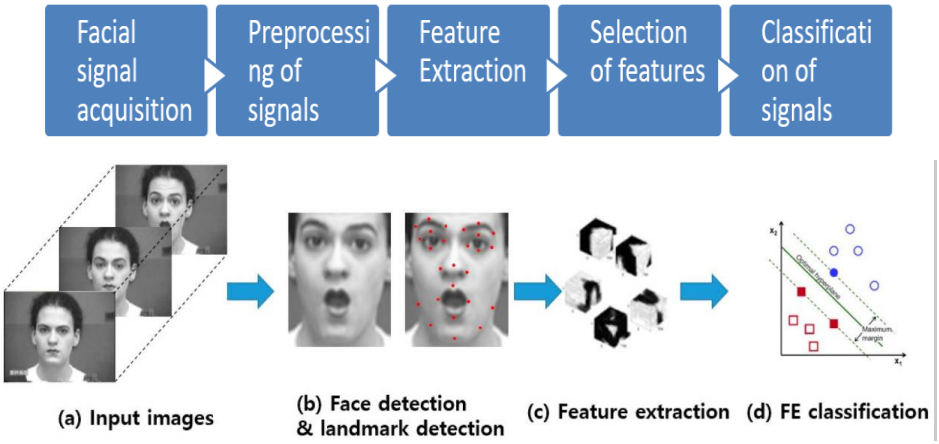


**Fig. 2: Steps of FER [6]**

**INPUTS OF FER SYSTEM**

Various inputs to study FER are facial images taken by camera or video camera, facial action coding, facial electromyogram, Electroencephalogram, and Electrocardiogram. But commonly static (frame-based) and dynamic (video-based) inputs are commonly used [2]. Static FER depends on facial features obtained using expressions of face from images like photos. Dynamic FER utilizes spatio-temporal features for obtaining dynamics of facial expression. Dynamic FER has higher recognition rate than static. But the disadvantage is that the extracted dynamic features varies from face to face in transition duration and individual differences in facial expressions of same emotions.

**PRE-PROCESSING OF SIGNALS**

Facial expressions captured by photos can be studied using facial landmarks namely alae of nose, corner of of eyebrows, mouth corners which are the emotional highlights of the face and varies with six expressions of emotions (Fig 3). Confounding factors such as variation in illumination during signal acquisition, subject dependence, head-pose changing affects the FER system's reliability. The various pre-processing that are required are Noise reduction using filters; face detection by localising and extracting facial region; Normalisation of colour & size of images; and enhancement of image by Histogram Equalisation.

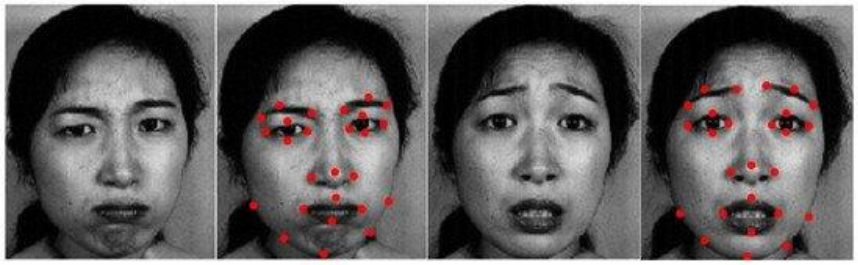

**Fig. 3: Facial landmarks [7]**

**FEATURE EXTRACTION**

Extracting useful information from the image/input signals is called feature extraction. Gabor feature extraction, local binary pattern, optical flow method, feature point tracking and many such techniques employed for the same. These can be classified as geometric and appearance based. Geometric FER systems extract not only shape and positions but also angles between various face elements like eyes, ears, mouth and nose. Their geometrical relationship illustrates the feature vectors. Appearance based FER uses appearance and employs the texture information of face as feature vector. Appearance based FERs are more popular since they provide higher recognition rate. Another disadvantage of Geometric system is the difficulty in finding accurate and proper geometric features of face in real-life settings [8].

**CLASSIFICATION OF SIGNALS**

Common classifiers used for this purpose are k-nearest neighbours, Support vector machine, Adaboost, and Probabilistic neural networks. But nowadays, these classifiers are replaced by "Deep Learning" (DL) methods. DL, a branch of Machine learning is widely used in FER systems. Convolutional Neural Network (CNN) among other Neural networks is the most popular among researchers in this field. Here, the input images are convolved through filters in the convolutional layers so by producing a feature map. All these feature maps are integrated to further networks, so that facial expression given as output (fig 4).

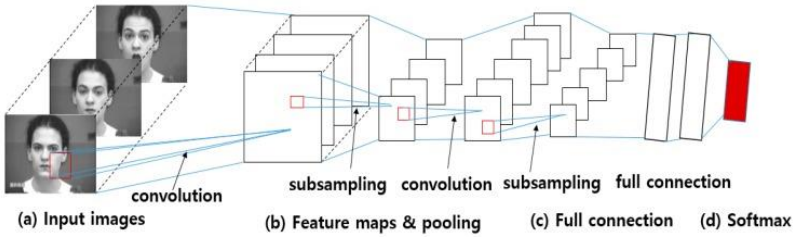


**Fig. 4: CNN in FER [6]**

Jung and others in 2015, studied two types of CNN for this purpose. One which can extract the temporal appearance of facial features and another for geometric features [9]. This successfully boosted facial expression recognition. Another method is a Deep region and multi-label learning (DRML). This is a deep neural network which uses feed-forward functions. This approach is easily trained and it can also learn automatically [10]. Better than these two a LSTM (long term short memory), a type of RNN (Recurrent Neural Network), which is easy to fine tune when combined with other models such as CNN and it also supports both fixed and variable length inputs and outputs.

**CONCLUSION**

Even though facial expression recognition has attracted many scientists, real world applications have rarely evolved. This is because these systems have to evolve more and more to provide better accuracy than today's average accuracy of 50%. Since people are from various races, colour, skin textures, they may differ in facial expressions, it is very difficult to create a FER removing all these differences. We sincerely hope that further researches in this field may tackle these issues providing us with robust, easy to use and widely applicable facial expression recognition systems.

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