International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 04 | Apr-2016 www.irjet.net p-ISSN: 2395-0072

Facial Expression Recognition A Survey

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Abstract - *The automatic Facial Expression Recognition has been one of the latest research topic since 1990's. Face Expression plays an important role in human communication. This paper presents a high-level overview of automatic expression recognition; it highlights the main system components and some research challenges like variation in the illumination ,head pose and occlusion. Facial Expression Recognition is process performed by computer which consist of detect the face in the image and pre-process the face region, extracting facial features from image by analyzing the motion of facial features or change in the appearance of facial features and classifying this information into facial expression categories like facial action coding system or prototypic facial expression.*

Key words: Facial expression Recognition(FER), Face detection, Feature Extraction, Feature Classification, Action units(AUs), Prototypical Facial Expression

1.INTRODUCTION

Facial expression is a visible manifestation of the affective state, cognitive activity, intention, personality, and psychopathology of a person[1]; it plays a communicative role in interpersonal relations. Facial expressions, and other actions, convey non-verbal communication cues in face-to-face inter actions. These cues may likewise complement speech by helping the listener to generate the intended meaning of spoken words. Paul Ekman and Freisen have produced FACS-Facial Action Coding System for describing visually distinguishable Facial movements[7]. Using the FACS, Action Parameters are designated to each of the Expressions which classifies the Human Emotions[7]. As cited in[2], Mehrabian reported that facial expressions have a considerable impact on a listening interlocutor; the facial expression of a speaker accounts for about 55 percent of the effect, 38 percent of the latter is conveyed by voice intonation and 7 percent by the spoken words.

With the development of artificial intellect and pattern recognition, people pay more and more attentions to facial expression recognition which is usually a significant technology of intelligent human-interactive interface[3]. Ekman and Friesen defined six basic emotions: happiness, sadness, fear, disgust, surprise, and anger[7]. Human can easily recognize a wide of different expressions. However it is a challenging task for a computer vision system to recognize an individual across different expression.

Facial expression analysis has many applications in areas such as in social psychology, video conferencing, user profiling, image retrieval, psychological area, synthetic animation[4], facial nerve grading in medicine[5]. Facial expressions help coordinate conversation, and have considerably more effect on whether a listener feels liked or disliked than the speaker's spoken words[6]. Facial expressions have been studied by cognitive psychologists, social psychologist, neurophysiologists, cognitive scientist and computer scientists. Computer vision based approaches to facial expression analysis discriminate among a small set of emotions.
In this paper , facial expression recognition system is introduced, that is, the various stages of the various methods used for which is described in section 2.Section 3 provides conclusion.

2.FACIAL EXPRESSION RECOGNITION SYSTEM

Facial Expression Recognition System consist of mainly three stages as shown in fig.1.However the specifics of the techniques utilized vary by the techniques that have been used at the different stages. In first face image is acquired and detect the face region from the images and pre-processed the input image to obtain image that have a normalized size or intensity. The 2nd stage is where the facial feature extraction . In 3rd stage extracted features are given to classifier. Recognition of facial expression to overall features are removed at the end of the last step in classification. Facial expressions of input image are then recognized[8].
There is various group for representing input image: Holistic where face is dealt with overall unit, analytic where co-event of characteristic facial element is

concentrated on and mix of these two group is called hybrid approach.

Framework can work on static images where the methodology is called face localization or video where we are dealing with face tracking. An image sequence contains potentially more information than a still image, because the former also depicts the temporal characteristics of an expression.

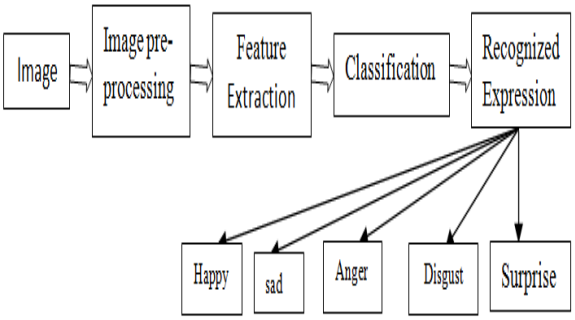

Fig-1: Block Diagram of Facial Expression recognition system

facial expression are formed by smallest changes in the movements of the muscles of face image and features of face(like nose, lips, eyebrows, eyes).

2.1 Face Detection and Pre-Processing

Face detection is the process of detecting face region from images or image sequence. significant issues which can be experienced at this stage are different scale and orientation of face. They are usually caused by subject movements or changes in separation from camera. Significant body movement can likewise bring about remarkable changes in position of face in back to back frames what makes tracking harder. what is more, complexity of background and variety of lightning condition can be also quite confusing in tracking. For instance, where there is more than one face in the image system should be able to distinguish which one is being tracked. Last but not least, occlusion which generally show up in unconstrained response should be taken care of also. For that pre-processing step is required.

Mainly, detection can be classified into two groups as Knowledge-Based Methods and Image-Based Methods. Knowledge-Based methods use information about Facial Features, Skin Color or Template Matching. Facial Features are used to find eyes, mouth, nose or other facial features to detect the human faces. Skin color is different from other colors and unique, and its characteristics do not change with respect to changes in pose and occlusion. Face has a unique pattern to differentiate from other objects and hence a template can be generated to scan and detect faces. Image-Based methods use training/learning methods to make comparison between face and non-face images. For these methods, large number of images of face and non-face should be trained to increase the accuracy of the system

2.2 Expression Feature Extraction

After the face has been located in the image or video frame, it can be analyzed in terms of facial action occurrence. A facial feature extraction technique computes significant and distinctive features from the face with a purpose to shrink the amount of data to be processed. The choice(alternatives) of the feature extraction relates to the recognition quality and computational effort, several approaches to extract these facial points from digital images or video sequences of faces were proposed, which falls into two categories: geometry and appearance based techniques.

2.2.1 Geometric Features

It measure the displacements of certain parts of the face such as brows or mouth corners. The facial feature points from a feature vector that represents the face geometry. The geometric based approach calculates the geometric distance between the extracted facial action units. The significant facial features are extracted by using relative positions and sizes of the components of face. Apart from feature type, FER systems can be divided by the input which could be static images or image sequences. The task of geometric feature measurement is usually connected with face region analysis, especially finding and tracking crucial points in the face region. Examples of such algorithms are Elastic Bunch Graph Matching[9], Active Shape Model[10] and Active Appearance Model [6][27], Optical Flow[3]. AAM is statistical model of shape and gray scale information. relationship between AAM displacement and the image difference is analyzed for expression detection[11]. Developed geometric features based system in which the optical flow algorithm is performed only in 13x13 pixel surrounding facial landmarks[12].

2.2.2 Appearance Features

It describe the change in face texture when particular action is performed such as bulges, forefront, wrinkles, region surrounding the mouth and eyes. The appearance based technique uses and processes the whole face by using transformation and sometimes statistical

approaches to find the basic feature vectors to represent the face.

Examples of such algorithms are Principle Component Analysis[13], Local Binary Pattern[14] , Independent Component Analysis[15], Linear Discriminate Analysis[15], Gabor Wavelets[16].

2.3 Expression Classification

The last part of the FER system is the classification based on extracted features. Expression categorisation is performed by a classifier, which often consists of models of pattern distribution, coupled to a decision procedure. A wide range of classifiers, covering parametric as well as non-parametric techniques, has been applied to the automatic expression recognition problem [17]. The input to the classifier is a set of features which were retrieved from face region in the previous stage. The set of features is formed to describe the facial expression. Classification requires supervised training, so the training set should consist of labelled data. Once the classifier is trained, it can recognize input images by assigning them a particular class label.

The most commonly used facial expressions classification is done both in terms of Action Units, proposed in Facial Action Coding System and in terms of universal emotions: joy, sadness, anger, surprise, disgust and fear. The two main types of classes used in facial expression recognition are action units (AUs)[18], and the prototypic facial expressions defined by Ekman [19].

2.3.1 Facial Action Coding System(FACS)

In 1978, Ekman et al. [2] introduced the system for measuring facial expressions called FACS – Facial Action Coding System. FACS was developed by analysis of the relations between muscle(s) contraction and changes in the face appearance caused by them. The Face can be divided into Upper face and Lower Face Action units[20] and the subsequent expressions are also identified. The Figures shows some of the combined action units.

Contractions of muscles responsible for the same action are marked as an Action Unit (AU). The task of expression analysis with use of FACS is based on decomposing observed expression into the set of Action Units. There are 46 AUs that represent changes in facial expression and 12 AUs connected with eye gaze direction and head orientation. Action Units are highly descriptive in terms of facial movements, however, they do not provide any information about the message they represent. AUs are labeled with the description of the action (Fig.2).

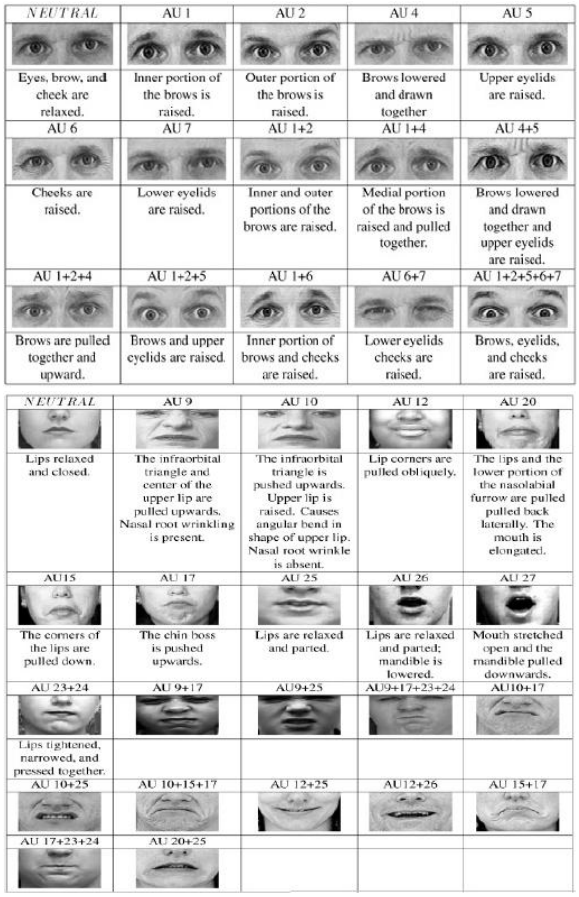

Fig 2: Action Units and combinations

2.3.2 Prototypical Facial Expression

A relatively small subset of seven basic expression categories that is found to be recognizable across culture. for use by FER systems . According to the Ekman's theory [21], there are six basic emotion expressions that are universal for people of different nations and cultures. Those basic emotions are anger, neutral, disgust, fear, happy, sad and surprise as shown in fig 3.

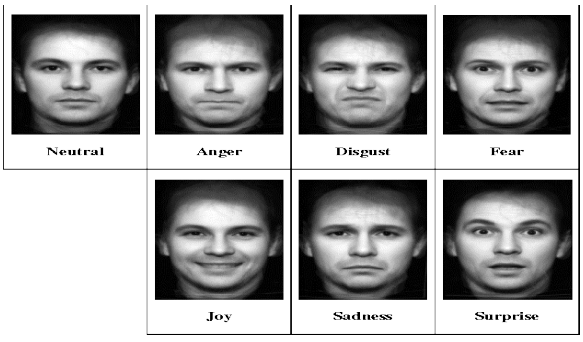

Fig 3: Six Universal Emotions

Instead of describing the detailed facial features most facial expression recognition system attempt to recognize a small set of prototypical emotional expressions.
Some facial expressions are a blend of more than one expression as, say a combination that occurs for the case of fear, sorrow and disgust. To overcome the above problem some approaches have been used. There are two main categories of Feature Classification approach:
1) Statistical non-machine learning approach such as Euclidean and linear discrimination analysis [22].
2) Machine learning approach such as Feed forward Neural Network[23], Hidden Markov Model[26], Multilayer Perception[], Support Vector Machine[25], K-Nearest Neighbours[24], etc.

2.4 Challenges in facial expression recognition system

In spite of the fact that humans recognise facial expressions virtually without effort or delay, reliable expression recognition by machine is still a challenge. The issues that have haunted the pattern recognition community at large (see[8]) still require consideration. A key challenge is accomplishing ideal pre-processing, feature extraction or selection, and classification, especially under conditions of input data variability. To attain successful recognition performance, most current expression recognition approaches require some control over the imaging conditions. The controlled imaging conditions typically cover the following aspects.

2.4.1 View or pose of the head

In spite of the fact that limitations are frequently forced on the position and orientation of the head in respect to the camera, and the setting of camera zoom, it should be noted that some processing techniques have been developed, which have great lack of care interpretation, scaling, and in plane rotation of the head. The effect of out-of-plane pivot is more difficult to lighten, as it can achieve in wide variability of image points of view. Further research is required into change invariant expression recognition. As shown in fig 4 mage which is used for feature extraction having different pose is intricate.

Fig 4: Different Pose in an Image

2.4.2 Environment clutter and illumination

Complex image background pattern, occlusion, and uncontrolled lighting have a possibly negative effect on recognition. These factors would commonly make image segmentation more difficult to perform reliably. Hereafter, they may possibly bring about the spoiling of feature extraction by data not related(data not identified with) to facial expression. Face image taken with various lights is shown in fig 2.

Fig 5: Illuminated Image

This factor would commonly make feature extraction more hard. To repay the variation of illumination in an input image , image pre-processing techniques like DCT normalization, Histogram Equalization, Rank Normalization can be applied before feature extraction.

2.4.3 Occlusion

Faces may be partially occluded by other objects. In an image if face is occluded by some other faces or objects such as mask ,hair, glasses as shown in fig 3.For that image extraction of expression features are complex.

Fig 6: Occluded Image

3. CONCLUSION

Automatic expression recognition is a difficult task, which is afflicted by the usual difficulties faced in pattern recognition and computer vision research circles, coupled with face specific problems. As such, research into automatic expression recognition has been

characterised by partial successes, achieved at the expense of constraining the imaging conditions, in many cases.

In this paper has brief overviewed the methodology of facial expression recognition. Feature extraction is main stage of expression recognition system. Geometric features extraction is more difficult because it depends on the shape and sizes of features so appearance base feature are easy to extract. Extracted feature aims to capture static or dynamic facial information specific to individual expression.

Extracted features are used for classification stage. Extracted features are used to detect the Action units occurrence and then AU combinations were translated into emotion categories. This process required much effort because the analysis was done manually and more training time is require for building a FACS coder. There is many techniques for develop FAC system which are easier and efficient.

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