Human Face Expression Recognition: A Review

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***Abstract*— A system that could automatically analyze the facial actions in real time has applications in a wide range of different fields. However, developing such a system is always challenging due to the richness, ambiguity, and dynamic nature of facial actions. Although a number of research groups attempt to recognize facial action units (AUs) by improving either the facial feature extraction techniques or the AU classification techniques. Facial expressions are the most powerful and natural means of communication among human beings. A large percentage of the approaches on facial expression analysis attempt to recognize six basic facial expressions such a happiness, sadness, surprise, disgust, fear, and anger. The most commonly used system for facial behaviour analysis. This paper analyzes the various techniques to for recognizing face expression with emotion.**

***Keywords*— Face Action Coding System, Face Expression, Face Detection, Facial Action Unit, CERT, Degree Estimation.**

I. Introduction

Facial expression analysis has been attracted considerable attention in the advancement of human machine interface since it provides natural and efficient way to communicate between humans [2]. Some application area related to face and its expression includes personal identification and access control, video phone and teleconferencing, forensic application, human computer application [5]. Facial expression analysis has been attracted considerable attention in the advancement of human machine interface since it provides natural and efficient way to communicate between humans [2]. Some application area related to face and its expression includes personal identification and access control, video phone and teleconferencing, forensic application, human computer application [5].

Most of the facial expression recognition methods reported to date or focus on expression category like happy, sad, fear, anger etc. For description of detail face facial expression, Face Action Coding System (FACS) was design by **Ekman**[8]**.** In FACS motion of muscles are divided into 44 action units and facial expression are described by their combination. Synthesizing a facial image in model based image coding and in MPEG-4FAPs has important clues in FACS. Using MPEG-4 FAPs, different 3D face models can be animated. Moreover,MPEG-4 high level expression FAP allows animating various facial expression intensities. However, the inverse problem of extracting MPEG-4 low and high level FAPs from real images is much more problematic due to the fact that the face is a highly deformable object [1].A system that can recognize AUs in real time without human intervention is more desirable for various application fields including automated tools for behavioral research, videoconference, affective computing, perceptual human-machine interfaces, 3D face reconstruction and animation, and others[8].

II. Literature Review

There are several approaches taken in the literature for learning classifiers for emotion recognition [2] [6]. In the static Approach, the classifier classifies each frame in the video to one of the facial expression categories based on the tracking results of that frame. Bayesian network classifiers were commonly used in this approach. Naïve Bayes classifiers were also used often. Because of this unrealistic approach some used Gaussian classifiers. In the Dynamic Approach, these classifiers take into account the temporal pattern in displaying facial expression. Hidden Markov Model (HMM) based classifiers for facial Designer of FACS, Ekman himself as pointed out some of these action units as unnatural type facial movements.[3] Detecting a unit set of action units for specific expression is not guaranteed. One promising approach for recognizing up to facial expressions intensities is to consider whole facial image as single pattern [4]. Kimura and his colleagues have reported a method to construct emotional space using 2D elastic net model and K-L expansions for real images [7]. Their model is user independent and gives some unsuccessful results for unknown persons. Later Ohba proposed facial expression space employing principle component analysis which is person dependant [9].

A. The Facial Action Coding System

The facial action coding system (FACS) (Ekman and Friesen, 1978) is arguably the most widely used method for coding facial expressions in the behavioral sciences. The system describes facial expressions in terms of 46 component movements, which roughly correspond to the individual facial muscle movements. FACS provides an objective and comprehensive way to analyze expressions into elementary components.analogous to decomposition of speech into phonemes.[1] Because it is comprehensive, FACS has proven useful for discovering facial movements that are indicative of cognitive and affective states. See Ekman and Rosenberg (2005) for a review of facial expression studies using FACS. The primary limitation to the widespread use of FACS is the time required to code. FACS was developed for coding by hand, using human experts. It takes over 100 hours of training to become proficient in FACS, and it takes approximately 2 hours for human experts to code each minute of video. The authors have been developing methods for fully automating the facial action coding system (e.g. Donato et al., 1999; Bartlett et al., 2006). In this paper we apply a computer vision system trained to automatically detect FACS to data mine facial behavior under two conditions: (1) real versus fake pain, and (2) driver fatigue

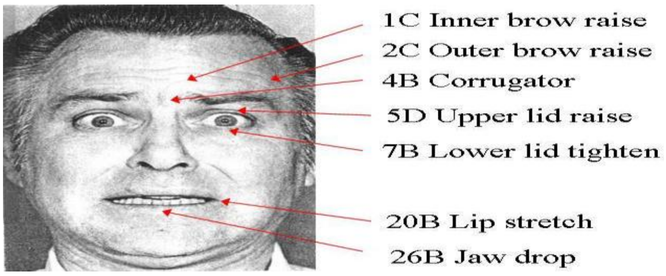

Fig.1. Example facial action decomposition from the facial action coding system. A prototypical expression of fear is decomposed into 7 component movements. Letters indicate intensity. A fear brow (1+2+4) is illustrated here.

B. Spontaneous Expressions

The machine learning system presented here was trained on spontaneous facial expressions. The importance of using spontaneous behavior for developing and testing computer vision systems becomes apparent when we examine the neurological substrate for facial expression. There are two distinct neural pathways that mediate facial expressions[4], each one originating in a different area of the brain. Volitional facial movements originate in the cortical motor strip, whereas spontaneous facial expressions originate in the sub cortical areas of the brain (see Rinn, 1984, for a review). These two pathways have different patterns of innervations on the face, with the cortical system tending to give stronger innervations to certain muscles primarily in the lower face, while the sub cortical system tends to more strongly innervate certain muscles primarily in the upper face[4].

C. The Computer Expression Recognition Toolbox

Here we extend a system for fully automated facial action coding developed previously by the authors (Bartlett et. Al, 2006; Littlemore et al., 2006). It is a user independent fully automatic system for real time recognition of facial actions from the Facial Action Coding System (FACS). The system automatically detects frontal faces in the video stream and codes each frame with respect to 20 Action units. In previous work, we conducted empirical investigations of machine learning methods applied to the related problem of classifying expressions of basic emotions. We compared image features (e.g. Donato et al., 1999), classifiers such as AdaBoost, support vector machines, and linear discriminate analysis, as well as feature selection techniques[10]. Best results were obtained by selecting a subset of Gabor filters using AdaBoost and then training Support Vector Machines on the outputs of the filters selected by AdaBoost.

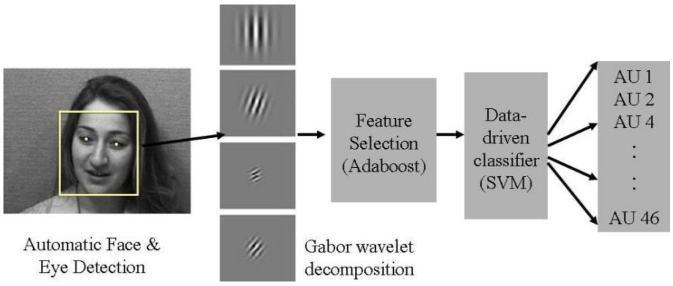

Fig 2 Overview of the automated facial action recognition system.

D. Real Time Face and Feature Detection

We employed a real-time face detection system that uses boosting techniques in a generative framework and extends work by Viola and Jones (2001). Enhancements to Viola and Jones include employing Gentle boost instead of AdaBoost, smart feature search, and a novel cascade training procedure, combined in a generative framework. Accuracy on the CMU-MIT dataset, a standard public data set for benchmarking frontal face detection systems (Schneiderman & Kanade, 1998), is 90% detections and 1/million false alarms, which is state-of-the-art accuracy. The CMU test set has unconstrained lighting and background. With controlled lighting and background, such as the facial expression data employed here, detection accuracy is much higher. All faces in the training datasets, for example, were successfully detected. The system presently operates at 24 frames/second on a 3 GHz Pentium IV for 320x240 images. The automatically located faces were rescaled to 96x96 pixels. The typical distance between the centers of the eyes was roughly 48 pixels. Automatic eye detection (Fasel et al., 2005) was employed to align the eyes in each image. The images were then passed through a bank of Gabor filters 8 orientations and 9 spatial frequencies (2:32 pixels per cycle at 1/2 octave steps). Output magnitudes were then passed to the action unit classifiers.

E. The Facial Expression Degree Estimation System

The facial expression recognition & degree estimation system[13] involves four major steps

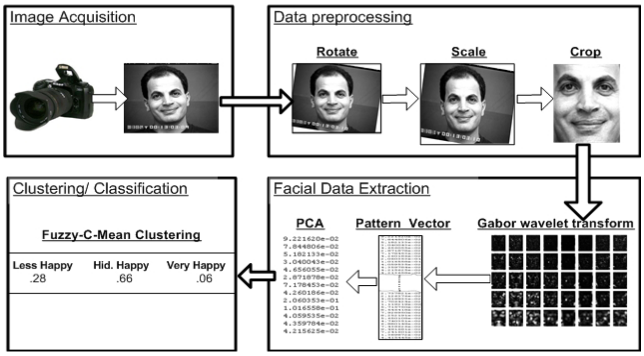

Fig. 3. The facial expression degree estimation system

➢ *Facial Data Acquisition*

The training and testing data for our experimental facial expression recognition &degree estimation system is collected from the Cohn-Kanade AU-Coded Facial Expression Database [13].

➢ *Data Preprocessing*

Two main issues in image processing will affect the recognition results: the brightness distribution of the facial images and facial geometric correspondence to keep face size constant across subjects. To ensure the above-mentioned criterions in facial expression images, an affine transformation (rotation, scaling and translation) is used to normalize the face geometric position and maintain face magnification invariance and also to ensure that gray values of each face have close geometric correspondence [7].

➢ *Facial Data Extraction*

The Gabor wavelets, whose kernels are similar to the 2D receptive field profiles of the Mammalian cortical simple cells, exhibit desirable characteristics of spatial locality and orientation selectivity and are optimally localized in the space and frequency domains [8].

➢ *Clustering and Classification*

Fuzzy C-Means (FCM) [13] is one of the most commonly used fuzzy clustering techniques for different degree estimation problems. Its strength over the famous k-Means algorithm [11] is that, given an input point, it yields the point's membership value in Each of the classes. In one dimension, we would expect the technique to yield a membership function as shown in Figure.

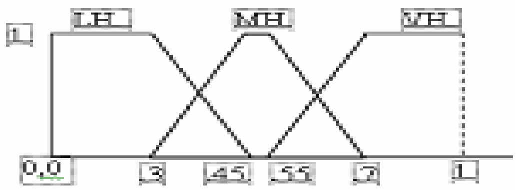

Fig..4. An ideal membership function for the degree of an emotion

Sr. No.	Methods	Image Type	Size	No. of Image tested	Face Detected	Features Recognized	Features Extracted	Accuracy achieved
1	FACS	JPG	200 × 280	20	96 %	100	96	96 %
2	Spontaneous Expressions	JPG	180 × 200	50	92 %	98	90	72 %
3	CERT	JPG	320 × 400	25	90%	82	75	57 %
4	Real Time Face and Feature Detection	JPG	320 × 400	30	90%	84	76	68 %
5	The Facial Expression Degree Estimation System	JPG	200 × 280	40	93 %	90	86	76 %

Table 1 Comparative Result Analysis

III Proposed Methodology

The following methods are used for proposed system

- Face detection based on skin color
- Face extraction and enhancement
- Face features extraction
- Curve formation using Bezier curve.
- Fuzzy Patterns
- Experiment Results

➢ *Face Detection Based on Skin Color:*

Skin color plays a vital role in differentiating human and non-human faces. From the study it is observe that skin color pixels have a decimal value in the range of 120 to 140. In this project, we are going to increase skin color pixels decimal value in the range of 120 to 180. It gives the more accuracy than previous one. We used a trial and error method to locate skin color and non skin color pixels. But many of the times, system fails to detect whether an image contains human face or not (i.e. for those images where there is a skin color background) an image issegmented into skin color and non-skin color pixels.

- *Face extraction and enhancement*

Literature review point out that, FACS system technique is based on face features extractions like eye, nose, mouth, etc. In this project, we minimize the number of features (i.e. only eyes and mouth) but given the more weightage for fuzzy rules formations from these extracted features. After face extraction white region pixels (i.e. skin pixels) are filled with skin color

- *Face features extraction*

Human face is made up of eyes; nose, mouth and chine etc. there are differences in shape, size, and structure of these organs. So the faces are differs in thousands way. One of the common methods for face expression recognition is to extract the shape of eyes and mouth and then distinguish the faces by the distance and scale of these organs.

- *Curve formation using Bezier curve*

This curve used in computer graphics to model smooth curves. In this system for curve formation we used Quadratic Bezier Curve. There are basically three types of Bezier curve i.e. Linear Bezier curve, Quadratic Bezier curve and Cubic Bezier curve. In this system for curve formation we used Quadratic Bezier Curve. It is studied that Bezier curve is parametric curve and widely.

- *Fuzzy Patterns*

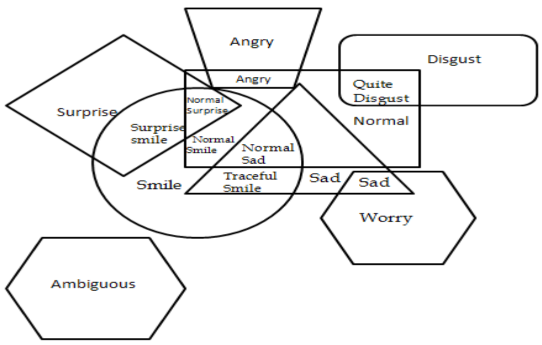

Fig 5 Fuzzy Expression Patterns

IV CONCLUSION

The Current system not sufficient for recognizing the accurate and more precise result. The propose a new approach for recognizing the category of facial expression an estimating the degree of continuous facial expression change from time sequential images. This approach is based on personal independent average facial expression using Fuzzy model .

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