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A Study on Modern Era of Diverse Facial Expression Recognition Techniques

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Abstract — **Facial expression is one of the most prevailing, likely, and instantaneous means for human being to converse expression of their emotions and intentions. The face can articulate emotion sooner than people verbalize or even comprehend their stance. Facial idiom recognition has recently become a promising research area. Its applications include human-computer interfaces, human emotion investigation, behavioral science, and medical care and cure. Thus there is obvious need of unfailing recognition and identification of facial users. In this paper, we empirically demonstrate the overview of various feature representation and expression classification schemes to recognize facial expressions.**

Key Words —**Facial Expression , Face Recognition and Face Recognition System.**

I. INTRODUCTION

Human communication has two main aspects; verbal (auditory) and non-verbal (visual). Facial expressions are an important component of interpersonal communication. Despite their non-verbal nature, they convey a lot of information about the person and the person's affective state, intention and personality. Particularly for the recognition of the affective state, humans rely heavily on analyzing facial expressions [10, 18]. Facial expressions also support verbal communication due to their complementary nature to the acoustic side of the spoken words. Unlike humans, current computer systems can hardly recognize the affective state of a human user.

The last decade has witnessed a trend towards an increasingly ubiquitous computing environment, where powerful and low-cost computing systems are being integrated into mobile phones, cars, medical instruments and almost every aspect of our lives. This has created an enormous interest in automatic processing of digital images and videos in a number of applications, including biometric authentication, surveillance, human-computer interaction, and multimedia management. Research and development in automatic face recognition follows naturally. Face recognition is a visual pattern recognition problem where a three-dimensional object is to be identified based on its two-dimensional image. in recent years, significant progress has been made in this area; owing to better face models and more powerful computers, face recognition system can achieve good results under constrained situations. However because face images are influenced by several factors: illumination, head pose, expression and so on, in general conditions, face recognition is still challenging. From a computer vision point of view, among all these "noises" facial expression maybe the toughest one in the sense that expressions actually change the three-dimensional object while other factors, such as illumination and position, only affect imaging parameters. To get rid of expression "noise", one first needs to estimate the expression of an image , this is called "Facial Expression Recognition". Another, maybe more important motivation of facial expression recognition is that expression itself is an efficient way of communication: it's natural, non-intrusive, and [12] has shown that, surprisingly, expression conveys more information than spoken words and voice tone. To build a friendlier Human Computer Interface, expression recognition is essential.

The importance of facial expression system is widely recognized in social interaction and social intelligence. The system analysis has been an active research topic since 19th century. The facial expression recognition system was introduced in 1978 by Suwa et. al. The main issue of building a facial expression recognition system is face detection and alignment, image normalization, feature extraction, and classification.

There are number of techniques which we use for recognizing the facial expression. Some of the researchers [1] introduced the system can recognize the different human gesture in color image. In this paper Viola and Jones describe the face detection technique using Add Boost Haar classifier. After performing the pre-processing operation the recognition is performed, the simplicity and robustness of the system is significant. Depending on threshold value the researchers system can recognize the facial expression. The approach of this system can be adapted to real time and it briefly describes the schemes of capturing the image and to recognize the gestures. Robert Axelrod has also shown the ability to recognize those they have met before and distinguish them from strangers is one of the bases for humans to form cooperation [3].

II. Face Recognition System

The main approaches [22] embedded in the components of an automatic expression recognition system are reviewed below.

A. Image Acquisition: Images used for facial expression recognition are static images or image sequences. An image sequence contains potentially more information than a still image, because the former also depicts the temporal characteristics of an expression. With respect to the spatial, chromatic, and temporal dimensionality of input images, 2-D monochrome (grey-scale) facial image sequences are the most popular type of pictures used for automatic expression recognition. However, color images could become prevalent in future, owing to the increasing availability of low-cost color image acquisition equipment, and the ability of color images to convey emotional cues such as blushing.

B. Pre-processing: Image pre-processing often takes the form of signal conditioning (such as noise removal, and normalization against the variation of pixel position or brightness), together with segmentation, location, or tracking of the face or its parts. Expression representation can be sensitive to translation, scaling, and rotation of the head in an image. To combat the effect of these unwanted transformations, the facial image may be geometrically standardized prior to classification. This normalization is usually based on references provided by the eyes or nostrils. Segmentation is concerned with the demarcation of image portions conveying relevant facial information. Face segmentation is often anchored on the shape, motion, color, texture, and spatial configuration of the face or its components [13]. The face location process yields the position and spatial extent of faces in an image; it is typically based on segmentation results. A variety of face detection techniques have been developed [13]. However, robust detection of faces or their constituents is difficult to attain in many real-world settings. Tracking is often implemented as location, of the face or its parts, within an image sequence, whereby previously determined location is typically used for estimating location in subsequent image frames.

C. Feature Extraction: Feature extraction converts pixel data into a higher-level representation of shape, motion, color, texture, and spatial configuration of the face or its components. The extracted representation is used for subsequent expression categorization. Feature extraction generally reduces the dimensionality of the input space. The reduction procedure should (ideally) retain essential information possessing high discrimination power and high stability. Such dimensionality reduction may mitigate the 'curse of dimensionality' [10]. Geometric, kinetic, and statistical- or spectral-transform-based features are often used as alternative representation of the facial expression prior to classification [14].

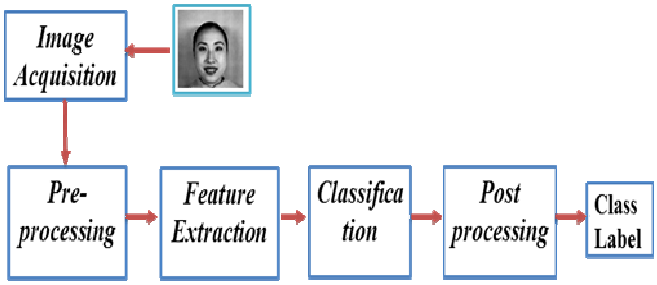

Figure 1: Facial Expression Processing Flow

D. Classification: Expression categorization 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 [14]. The two main types of classes used in facial expression recognition are action units (AUs) [6], and the prototypic facial expressions defined by Ekman [8]. The 6 prototypic expressions relate to the emotional states of happiness, sadness, surprise, anger, fear, and disgust [8]. However, it has been noted that the variation in complexity and meaning of expressions covers far more than these six expression categories [12]. Moreover, although many experimental expression recognition systems use prototypic expressions as output categories, such expressions occur infrequently, and fine changes in one or a few discrete face parts communicate emotions and intentions [6] [19]. An AU is one of 46 atomic elements of visible facial movement or its associated deformation; an expression typically results from the agglomeration of several AUs [6] [8]. AUs are described in the Facial Action Coding System (FACS) [7]. Sometimes, AU and prototypic expression classes are both used in a hierarchical recognition system ?? for example, categorization into AUs can be used as a low-level of expression classification, followed by a high-level classification of AU combinations into basic expression prototypes [15].

E. Post-processing: Post-processing aims to improve recognition accuracy, by exploiting domain knowledge to correct classification errors, or by coupling together several levels of a classification hierarchy, for example.

III. EXPERIMENTAL EVALUATION

In this paper we have presented an experimental evaluation of different face resolutions for each step of facial expression analysis: face acquisition, facial feature extraction, and facial expression recognition. For each experimental classifier, our performance measure was the recognition performance on a cross-validation set of unseen face and nonface examples withheld from the training set from DFAT; this measure seems appropriate since the classifiers were trained to minimize overall error. The DFAT subset of Cohn-Kanade expression database is used for our experiments. The database contains 704 image sequences from 97 subjects. Subjects sat directly in front of the camera and performed a series of facial behaviors which were recorded in an observation room. Image sequences with in-plane and limited out-of-plane motion were included. The image sequences began with a neutral face and were digitized into 640x480 pixel arrays with either 8- bit gray-scale values. The length of the image sequences are varying from 9 to 47 frames. Results of our experiment can be seen in the following tables.

Reference	**Pre-processing**	**Feature Extraction**	**Expression Classification**	**Recognition Performance**
Bourel et al. [1]	using a point tracker	Scalar quantisation of facial dynamics	rank-weighted k-nearest neighbour classifier.	Relatively little degradation in recognition under partial face occlusion or tracker noise.
Pantic and Rothkrantz [15]	multiple detectors (e.g. snakes, neural networks, …).	Extraction of static geometric measurements	rule-based expert system	91% recognition of basic expression prototypes.
Essa and Pentland [9]	View based and Modular Eigen space methods	(i) peak activation of each muscle. (ii) motion estimates	(i) maximum correlation with muscle activation template, (ii) minimum distance to motion energy template.	98% recognition of facial expressions.
Tian et al. [19]	Gaussian mixture model, Lucas-Kanade tracking algorithm	Continuous and discrete representation of magnitude and direction for motion of face	multi-layer perceptron for upper-face and lower-face	96.7% recognition of lower-face AUs, and neutral expression.
Alex Graves [25]	multitude of features with a multi-stage fitting approach	Feature-point tracking by optical flow discriminates	Recurrent Neural Networks	85.4% AU recognition
Philipp Michel[24]	Automatic Facial Feature Tracker	vector of displacements is calculated	Support Vector Machine	87.9% AU recognition

IV. CONCLUSION

Human beings naturally and intuitively use facial expression as an important and powerful modality to communicate their emotions and to interact socially [13]. There has been continued research interest in enabling computer systems to recognize expressions and to use the emotive information embedded in them in human-machine interfaces.

This paper presents a high-level overview of automatic expression recognition; it highlights the main system components and some research challenges. This work provided a framework for facial expression recognition that

can effectively maximize information gathered about the emotion change and minimize the impact of person identity. Experiment results reveal that recognition performance varies for different neural network techniques for expression classification. So we can take best feature extraction parameter and neural network technique for expression classification method to increase Recognition accuracy.

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