Estimating Emotions Using Geometric Features from Facial Expressions

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INTRODUCTION

Emotions are the emergent property of the human mind like consciousness and are emerging from the interaction among various core cognitive processes. Cognitive models are available for other core cognitive processes such as problem solving, decision making, memory, reasoning, etc. Though it is not clear about the origin of emotion, through emotional response, it is possible to create cognitive models of emotion. One kind of physiological or emotional response to the particular event via face is the facial expression. Human face plays an important role in interpersonal communication and considered as important channel compared to other communication channels while conveying mixed mode of information. Facial expression provides more visual cues about internal mental states of human being and is caused by muscle contraction to facial skin. As a result, there is a change in the appearance of facial features, say facial components such as the eyebrows, nose, and mouth. As facial expressions are natural feedback to others, it can be used in a wide variety of computer applications in which the system can recognize the human internal emotional state from the visual cues and can react accordingly. By developing valid and reliable methodologies to measure facial behavior, it can be used as a natural interface in various applications such as human–computer interaction, computer surveillance, gaming, entertainment, teleconference, medical field, education, etc. In this article, the emotion of human is estimated using suitable geometric features from the facial expressions. The obtained geometric feature based pattern to recognize the expression can be effectively used as a feedback mechanism in a classroom to measure the mental state of the students. Also, a suitable feedback scheme can be devised to improve the teaching-learning process.

Facial Action Coding System (FACS) proposed by Ekman and Friesen (1978) has been used for the manual interpretation of facial expression. This is the standard code followed by most of the researchers for facial behavioral study. This approach contains facial muscle movements in terms of 46 Action Units (AU) and a combination of these action units are used to identify various expressions. Based on the description of AUs, six common facial expressions such as angry, disgust, fear, happy, sad and surprise across various cultures are identified (Ekman & Friesen, 1971). This recognition is purely based on the changes to facial features like eyes, nose, mouth, etc. After FACS, this research issue has gained much interest on related fields like image processing for face detection, facial feature point extraction and tracking, etc. Various solutions are proposed for this issue and it can be broadly classified into two, namely, geometric and appearance based methods. Because of the facial configuration, which is not common for all, early works started to use the geometric deformation of features to recognize an expression in which, facial feature changes are measured in terms of relative distance and angle with reference to neutral face. Similar geometric deformation vectors are used in face modeling technology to create personalized avatars in virtual world. The talking head system has been proposed (Liu, Zhang, Jacobs, & Cohen, 2001), with linear combinations of AU stored as a mesh deformation vector. A facial expression is generated by adding

the deformation vector to neutral face mesh. Similar approaches have also been proposed using geometric method (Jeng, Liao, Liu, & Chern, 1998; Lin & Wu, 1999), which uses a priori information for expression recognition. The limitation of these methods is that it is not suitable for handling multiple faces. Also, the temporal information has not been considered and variant to illumination and head pose make the priori information useless.

In contrast to geometric method, appearance based method considers shape and texture information of the facial feature. Active Shape Model (ASM) and Active Appearance Model (AAM) are the two popularly known appearance based feature point localization models. Some of the recent works based on appearance details for facial feature point localizations are discussed in Park, Shin and Kim (2008), Luo, Huang, and Hsiao (2011), Tian, Kanade, and Cohn (2001), and Wen and Huang (2003). Disadvantages of all these approaches are that it is difficult to capture subtle changes, not suitable for profile view, the computational cost is high and requires huge training to improve recognition rate. Since appearance based method handles the whole face, to reduce the dimensionality complexity of extracted texture details, subspace learning methods like principal component analysis, linear discriminant analysis, local binary pattern analysis, etc., has been used. Even though appearance based method performs better using subspace learning methods, time and space cost is high compared to geometric method. One more option is to use a hybrid method, which combines the advantages of both appearance and geometric methods for expression classification. However, it is necessary to develop better fusion algorithms to automate all phases of facial expression analysis system.

In recent times, Neuro-Linguistic Programming (NLP) has fetched attention from researchers in the area of cognition. It is the one of the technique to understand and reprogram the structure of our neurological and linguistic systems to achieve desired results. It uses both verbal and non-verbal languages with which we communicate. Since the role of non-verbal communication is so important in interpersonal communication, NLP can be used effectively to understand and evaluate the internal emotional state of others through the facial expression system. By a suitable feedback mechanism, neurological and linguistic system can be designed based on an application domain, say teaching-learning process. For facial expression recognition,

static image or image sequence can be used. Static images contain only three states of information like on, apex and off state. To capture subtle changes to facial region and temporal related information image sequence can be used.

In this article, we propose a geometric based method to discriminate all expressions from the lower portion of the static facial image. Displacement of feature points with reference to the neutral face is viewed as the combination of primitive geometry transformations such as translation, rotation and scaling. These primitive operations are used to construct the feature vector, which uniquely identifies the emotions from muscle movement. The facial expressions are not always symmetric and the asymmetric nature of the expression is handled by the skew angle of the geometric shape. Person invariant expression recognition system is developed by using a suitable classification tool with a notable recognition rate for most of the basic expression only from the lower face.

BACKGROUND

Recent years have seen cognitive science beginning to grapple with the topic of emotion. There is an extensive ongoing research in the emotion and the structures involved in terms of their associations with cognitive processes. Emotions differ from thought processes and its responses involve the body and not just the brain. These physical changes include alterations in body temperature, hormonal secretion, heart rate, and muscle tension. Any account of emotions must therefore take into consideration the wider physiological changes that occur outside the brain. Studying how humans recognize emotions and use them to communicate information are important topics in anthropology (Friedenberg & Silverman, 2006). And the emotion automatically estimated by a computer is considered to be more objective than those labeled by people and it can be used in clinical psychology, psychiatry and neurology. Facial expression is one of the outward sign of the emotion. Computer vision based methods on this research domain are based on observing facial deformation of specific facial regions or movement of characteristic points.

Because of irrationality and needless complexity of emotion, it is not much concentrated in the earlier

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