Emotion Recognition Approach Using Multilayer Perceptron Network and Motion Estimation

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ABSTRACT

Man-machine interaction is an interdisciplinary field of research that provides natural and multimodal ways of interaction between humans and computers. For this purpose, the computer must understand the emotional state of the person with whom it interacts. This article proposes a novel method for detecting and classify the basic emotions like sadness, joy, anger, fear, disgust, surprise, and interest that was introduced in previous works. As with all emotion recognition systems, the approach follows the basic steps, such as: facial detection and facial feature extraction. In these steps, the contribution is expressed by using strategic face points and interprets motions as action units extracted by the FACS system. The second contribution is at the level of the classification step, where two classifiers were used: Kohonen self-organizing maps (KSOM) and multilayer perceptron (MLP) in order to obtain the best results. The obtained results show that the recognition rate of basic emotions has improved, and the running time was minimized by reducing resource use.

KEYWORDS

Action Units, Bloc Matching, Emotion Recognition, Facial Expression, FACS, Interest, Kohonen, MLP, Neural Network

1. INTRODUCTION

In recent years there has been a growing interest in improving all aspects of interaction between humans and computers. This new field has been a research interest to scientists from several different school tracks, i.e., computing, engineering, psychology and neuroscience (Sebe et al., 2004). An effective and intelligent human-computer interaction (HCII) requires that the computer be able to interact naturally with the user similar than human-human interaction. This interaction mainly through speech, face expression and through body gestures in order to emphasize a certain part of the speech, and displayed emotions (Abboud, 2004). Emotions are expressed by visual, vocal, and other physiological means. (Markus, 1991) There is growing amount evidence showing that emotional skills are part of what is called “intelligence”. There are many ways that humans display their emotions, the most natural way to display emotions is using facial expressions. In the last 20 years there has been much

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research developed on emotion recognizing based on facial expressions. The first one was pioneered by Ekman and Friesen.

In the present work we will identify six basic emotions of EKMAN: sadness, joy, anger, fear, disgust, surprise, using actions units of “Facial Action Coding System”: FACS system, described in section 3.3, and we introduce a seventh emotion called “Interest’s emotion” as a basic emotion. In order to code this emotion, we use our system described in (Belhouchet et al., 2015). This last based on two neural network models, such as: Kohonen neural self-organizing map (KSOM) and Multilayer perceptron (MLP).

2. EMOTION RECOGNITION APPROACHES

There are various studies using different methods in emotion recognition domain. Several between them are based on speech processing, such as voice analysis using statistical methods (Mohanty et al., 2010) and those using spectral features such as Mel-frequency cepstral coefficients (MFCCs) as clearly explained by (Samal et al., 2013).

The second emotional recognition source is the neurological signals, like is developed by Kumar (Kumar et al., 2019), their system used an EEG to recognize emotions. Another source in emotion recognition is the facial expression which is the most natural and significant way to express emotions. Hai has proposed a model of facial expression classification using artificial neural network ANN and KNN (Hai et al., 2015). This model has a classifying accuracy equal to 92.38% but a significant amount of data has been used, for each face, six feature vectors: one global feature representing the whole face and five local feature vectors representing the eyebrow, eye and mouth of the face. (De et al., 2015) have modeled Eigen face approach to recognize the human facial expressions. This method uses the Hue-Saturation-Value color model to detect the face in an image, they used a statistical approach has been used for reducing the high dimensionality of the Eigen space and then by projecting the test image upon the Eigen space and calculating the Euclidean distance between the test image and mean of the Eigen faces of the training dataset the expressions are classified. The principal disadvantages, those statistical methods are computationally expensive and complex with the increase in data size and time complexity is high (R. Khan & Sharif, 2017). (Yu & Liu, 2015) have combined the appearance descriptors and geometric features of the image for facial expression recognition. They have employed by orthogonal wavelet entropy to extract multi-scale features and used fuzzy multiclass support vector machine to be the classifier. Alhussein has used multi-scale Weber local descriptor (MS-WLD) and Support Vector Machine (SVM) (Alhussein, 2016). Chao has enhanced the performance of the popular Local binary patterns (LBP) feature. (Chao and Frank, 2015) concentrated on the recognition of units of facial action (AUs). They have adopted independent component analysis (ICA) as the extraction method and SVM as the model classifier. IN the field of emotion recognition, multilayer perceptron is widely used. Let’s mention the work of (Danisman et al., 2013; Hayet et al., 2014; Palo et al., 2015).

All cited works present acceptable results for a high computation time but used a high amount of data. So, there is an important obstacle to develop a real-time application. To solve this problem, our work proposes a new approach for basic emotions recognition, described below, where we have minimized the computation time using a very limited data. We have also used a very specific approach based on motion estimation of facial muscles and for classification step we use two classifiers: KSOM and MLP, the first is an unsupervised neural network but the second is a supervised one.

3. PROPOSED APPROACH

FACS system is developed by the psychologist Paul Ekman, it’s based on coding of the basic emotions (joy, sadness, fear, disgust, surprise and angry) with the associated facial motions; each movement is named action unit: AUs (Figure 1). So, there is a prototype for each emotion (Table 1, Table 2).
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