

# Facial Action Point Based Emotion Recognition by Principal Component Analysis

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**Abstract.** This paper proposes an alternative approach to emotion recognition of a subject from selected 36 facial action points marked at specific locations on their faces. Facial expressions obtained by the subjects enacting them are recorded, and the corresponding changes in marked action points are measured. The measurements reveal that the action points have wider variations in facial expressions containing diverse emotions. Considering 10 instances for each facial expression, and carrying the same emotion, experimented over 10 subjects, we obtain a set of 100 distance matrices, representing the distance between any two selected action points. The 100 matrices for each individual emotion are averaged, and the first principal component, representing the most prominent features of the average distance matrix is evaluated. During the recognition phase, the first Principal component obtained from the distance matrix of an unknown facial expression is evaluated, and its Euclidean distance with the first Principal component of each emotion is determined. The unknown facial expression is classified into emotion class  $j$ , if the Euclidean distance between the obtained principal component and that of  $j$ -th emotion class is minimum. Classification of 120 facial images, containing equal number of samples for six emotion classes, reveals an average classification accuracy of 92.5%, the highest being in relax and disgust and the least in fear and anger.

**Keywords:** Action points, Emotion Recognition, Principal Component Analysis (PCA).

## 1 Introduction

Emotion recognition is currently gaining importance for its increasing scope of application in human-computer interfaces. Several modalities of emotion

recognition, including facial expression, voice, gesture and posture have been studied in the literature. However, irrespective of the modality, emotion recognition comprises of two fundamental steps involving feature extraction and classification [1]. Feature extraction refers to the determination of a set of features/attributes, preferably independent, which together represent a given emotional expression. Classification aims at mapping emotional features into one of the several emotion classes. Among the well-known methods of determining human emotions, Fourier descriptor [2], template matching [3], and neural network techniques [4], [5] deserve special mention. Other important works undertaken so far for recognition of emotions through facial expressions by selecting suitable features include [2], [6], [7], [8], [9], [10], [11], and by identifying the right classifier include [3], [4], [5], [10], [12], [13], [14], [15], [16], [17].

Human facial expressions as well as facial movements change for different emotions. The significance of facial movements can be understood from the biological point of view. Human face comprises of several muscles that are responsible for the movement of every part of the face. For instance, facial attributes, such as mouth- and eye-opening, commonly used for emotion recognition in the literature, have good correlations with specific muscles in the face. Naturally, detection of motion of the muscles carries more fundamental information than their aggregation, such as smiling or raising of eyebrows. The paper aims at detecting motion of the muscles involved in smiling, raising of eyebrows, partial and total opening of the eyes, constriction of eyebrows and temporal wrinkles formed due to muscle movements in the face while experiencing a specific emotion.

The first research on emotion recognition from facial action points/units is by Ekman (1975) [11], followed by Ekman and Frisen [21]. In [22], the authors considered 46 basic facial action points to represent the movements of cheek, chin and wrinkles. Unfortunately, since its foundation, the action point features did not receive much attention, as most of the researchers emphasized on high level features comprising joint movement of several muscles rather than the primitive action points. Recently, researchers are of the views that high level features are more person-specific, and have wider variations because of cultural traits and are not always free from gender and region-bias. The action points being more fundamental and localized, offer culture-, race- and gender-independent features, containing sufficient information for automatic recognition of emotions. The only difference between the action unit based emotion recognition scheme and the others is probably that the action point based recognition is easier for machines, while high level features are a common source of recognition by humans.

Recently Pantic and her research team [17], [18], [19], [20] employed action units in emotion recognition, and noted that the performance of their methods outperformed other high level feature based emotion recognition schemes. Among other interesting works on action point based emotion recognition, the works undertaken in [21], [22], [24], [25], [26], [27] need special mention.

The paper provides an alternative approach to emotion recognition of a subject from selected 36 facial action points marked at specific locations on their faces