

# 3D Facial Action Units Recognition for Emotional Expression

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**Abstract**—The muscular activities caused the activation of facial action units (AUs) when a facial expression is shown by a human face. This paper presents the methods to recognize AU using a distance feature between facial points which activates the muscles. The seven AU involved are AU1, AU4, AU6, AU12, AU15, AU17 and AU25 that characterizes a happy and sad expression. The recognition is performed on each AU according to the rules defined based on the distance of each facial point. The facial distances chosen are computed from twelve salient facial points. Then the facial distances are trained using Support Vector Machine (SVM) and Neural Network (NN). Classification result using SVM is presented with several different SVM kernels while result using NN is presented for each training, validation and testing phase. By using any SVM kernels, it is consistent that AUs that are corresponded to sad expression has a high recognition compared to happy expression. The highest average kernel performance across AUs is 93%, scored by quadratic kernel. Best results for NN across AUs is for AU25 (Lips parted) with lowest CE (0.38%) and 0% incorrect classification.

**Index Terms:** 3D AU recognition, facial action unit's recognition, facial expression, Support Vector Machine, Neural Network

## I. INTRODUCTION

Facial expressions are significant to non-verbal communications as they provide varies information such as emotional state, attitudes, personality and age. The analysis of facial expression plays a major role in emotional recognition that contributes toward the development of the Human-Computer Interaction (HCI) system, which could be applied in the area such as neurology, lie detection, intelligent environments and paralinguistic communication [1]. As machines become more involve in human daily life, they need to become more intelligent to understand human moods and emotions [29].

Facial expression is initiated by the contractions of distinct facial muscles that caused temporary deformation of the facial surface, including the geometry and texture characteristics [2]. Action Unit (AU) defined in the Facial Action Coding System (FACS) [6] is a component of facial expression triggered by distinctive facial muscle that lies below the facial skin.

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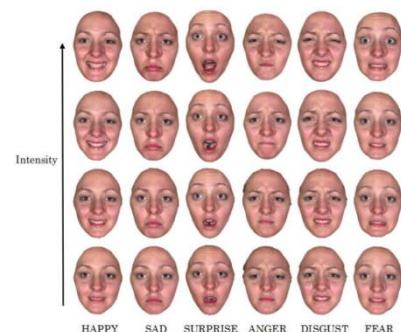
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There are six basic emotional facial expressions acknowledged by psychologists; happy, surprise, angry, fear, sad and disgust. However, the six emotions partially represent only several human facial expressions. Due to this, AU recognition is preferable so that the activated muscles are recognized rather than the expression itself.

Apart from recognizing facial expressions, another interesting study in face processing area is facial expression intensity estimation. Human tend to show simple facial motion such as tightening the lips in anger or obliquely lowering the lip corners in sadness [18]. This is because of human facial expressions can vary much in intensity e.g.: from uneasiness and mild fear to angst and panic [31]. Lower intensity of certain facial expression might not be familiar to some people. Besides, intensity level of a facial expression is important as it will lead to a false impression of people's emotion if misinterpreted. For example, the smiling face with low intensity can be easily misinterpreted as a neutral facial expression [19]. [20] listed several reasons on why we need to estimate facial expression intensity. One of the reasons is there are differences in terms of the way that different individuals express the same facial expression, such as transition speed, magnitude and duration. However, the task of facial expression intensity estimation remains less focused compared to facial expression classification itself. Through AU recognition, facial expression intensity could be measured accordingly as AU is related to the facial muscle. Fig. 1 shows six basic facial expressions with different four intensity levels. As we go up the intensity level, the facial expression is more intense and the facial points' displacement is apparent.



**Fig. 1. Intensity Level of Facial Expression in BU-3DFE Database [28]**