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Surface Normals with Modular Approach and Weighted Voting Scheme in 3D Facial Expression Classification

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Abstract— **A crucial part for facial expression analysis is to capture a face deformation. In this work, we are interested by the employment of 3D facial surface normals (3DFSN) to classify six basic facial expressions and the proposed approach was employed on the Bosphorus database. We constructed a Principal Component Analysis (PCA) to capture variations in facial shape due to changes in expressions using 3DFSN as the feature vector. A modular approach is employed where a face is decomposed into six different regions and the expression classification for each module is carried out independently. We constructed a Weighted Voting Scheme (WVS) to infer the emotion underlying a collection of modules using a weight that is determined using the AdaBoost learning algorithm. Our results indicate that using 3DFSN as the feature vector of WVS yields a better performance than 3D facial points and 3D facial distance measurements in facial expression classification using both WVS and a Majority Voting Scheme (MVS). Our work is different with the existing works as they used the dataset with facial intensity information while we used dataset with no intensity. New insight in facial expression analysis is found particularly when no intensity information is provided. Surface normals does has a potential to be used as the feature vectors to classify six basic expressions.**

Keywords-component; Facial expression classification; 3D facial features; Principal Component Analysis; Support Vector Machines;Weighted Voting Scheme

I. INTRODUCTION

Facial expression recognition and classification is an emerging research area spanning several disciplines such as pattern recognition, computer vision and image processing. It brings benefits in human centred multimodal human-computer interaction (HCI) whereas the user's affective states motivate human action and enrich the meaning of human communication. In HCI, affective computing employs human emotion to build more flexible and natural multimodal [1]. The automatic human affect recognition system will change the ways we interact with computer systems. With efficient automated face expression classification, perhaps it will be an aid to the affect-related research community to carry out clinical psychology, psychiatry, and neurosciences research. Such systems could improve the quality of the affect-related research by improving the reliability of measurements and speeding up the currently tedious task of processing data on human affective behaviour [2].

Following the success in 3D face recognition, the face processing community is now trying to establish good 3D facial expression classification. There is a great demand for representing facial expression classification in 3D space which allows us to examine the fine structure change for universal and complex expressions [3]. 3D geometry contains ample information about human facial expression [4]. 3D scanners offer 3D geometrical data which is suitable for 3D face processing studies. 3D facial data removes the problems of illumination and pose that are inherent to 2D modality. In addition, the 3D dynamics facial data also offer out-of-plane movement that cannot be captured with 2D as well as 3D surface features which play a critical role in distinguishing subtle facial expressions.

We propose the use of 3D facial surface normals (3DFSN) to capture facial deformation caused by facial expression. Instead of using the raw 3D facial points (3DFP) which is normally provided by most of the 3D scanners, we extracted 3DFSN from the 3DFP. Surface normals are considered to be more accurate in describing facial surface changes compared to using facial points due to the fact that a surface normal depends on a facial point as well as its neighbouring facial points. We constructed a statistical model for variations in facial shape due to changes in six basic expressions Anger, Disgust, Fear, Happy, Sad and Surprise using 3DFSN as the feature vectors. In particular, we are interested in how such facial expression variations manifest themselves in terms of changes in the field of 3D facial surface normals.

Each of the basic facial expressions has levels of intensity which depend on the level of intensity of each facial feature. 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 [5]. A facial expression involves deformation of a collection of facial features and muscles. Classifying a facial expression from one