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Action Unit recognition in still images using graph-based feature selection

Teodora Sechkova
Faculty of Telecommunications
Technical University of Sofia
Email: tsechkova@tu-sofia.bg

Krasimir Tonchev
Teleinfrastructure R&D Lab
Technical University of Sofia
Email: k_tonchev@tu-sofia.bg

Agata Manolova
Faculty of Telecommunications
Technical University of Sofia
Email: amanolova@tu-sofia.bg

***Abstract*—Facial expressions are universal and independent of race, culture, ethnicity, nationality, gender, age, religion, or any other demographic variable. These facts are the main reason for automatic facial expression recognition being one of the hot topics of many research efforts and being useful in so many commercial and scientific fields. The most well-known and probably the most used anatomically based method of defining facial activity is Facial Action Coding System (FACS). In this paper, we propose a Facial Action Unit recognition algorithm using graph-based feature selection in unsupervised and supervised setting. The proposed algorithm is based on a state of the art algorithm for facial key points detection - Supervised Gradient Descent method, the classification is carried out using the well know Support Vector Machines classifier. Built this way, the algorithm works on still images where the human expressions are expected to be in their apex phase. Using leave one person out evaluation methodology we achieve average accuracy of 90.1% for unsupervised and 92.7% for supervised feature selection on 12 Action Units.**

***Keywords*—Action Unit recognition;Supervised Gradient Descent Method;Graph based feature selection;Scale Invariant Feature Transform; Facial Action Coding System**

I. Introduction

Facial expressions play an important role along with voice and posture in the social live of every human being no matter if in real life or in virtual reality. The facial behavior is visually observable by others by expressing the current focus of attention, regulating the conversation by gazing or nodding, clarifying what has been said by lip movements, and displaying the affective states and intentions by different facial muscle movements. Facial expressions are universal and independent of race, culture, ethnicity, nationality, gender, age, religion, or any other demographic variable. All people express emotions on their faces in exactly the same ways. Facial expressions are immediate, automatic, and unconscious reactions to the emotions felt by the person. So automatic facial expression recognition is useful in many commercial and scientific fields such as security, behavioral science, medicine, driver safety, communication, and education. In security contexts, facial expressions can play a significant role in detecting deception or evaluating truthfulness [1]. In medicine and behavioral science, facial expressions are the direct means to identify when specific mental processes such as pain, depression, stress, fatigue or anxiety are occurring [2]. In education, students' facial expressions can give information to the teacher if they pay attention to the presented content [3]. Facial expressions also provide a way to communicate basic information for the human computer interface for building more intuitive communication channel between the human user and the machine.

Many research efforts are concentrated in the task of facial expression recognition as this can be seen in the multiple published papers in recent years [4]. According to [5] facial expressions (i.e., contractions of facial muscles) induce movements of the facial skin, also changes in the position and appearance of facial components (e.g., mouth corners are pulled up in smile) and changes in facial transient features (e.g., crow-feet wrinkles around the eyes deepen in genuine smile).

The most well-known and probably the most used anatomically based method of defining facial activity is Facial Action Coding System (FACS) [6]. This system defines 44 basic action units (AU) for representing contraction or relaxation of one or more facial muscles. Each AU is anatomically related to a specific facial muscle or a combination of muscles so that subtle changes in facial appearances caused by the associated contractions can be determined. Furthermore, the system identifies lots of different combinations of facial muscular actions in a large number of facial expressions. FACS coders can pinpoint the AUs which are present on the face when viewing still images or videos.

In general the AU recognition topic can be classified depending on the general approache such as holistic or local, classification approaches and data type: still images or video sequences [7]. Since this work is dedicated to AU recognition in still images, the following review focuses primarily on similar previous works. The authors of [8] incorporated spatial-independent feature extraction and statistical spatial shape and texture information. Combining the best of both features, they propose to use multi-kernel SVMs which can help in selecting the most accurate information. The authors

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