RGB-D methodologies for Face Expression Recognition

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# RGB-D methodologies for Face Expression Recognition

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# Summary

In last years, application fields for face analysis have considerably increased, phenomenon that has been fed by a significant improvement of depth acquisition technologies. In this work, the focus is pointed on face expression recognition, which aims to recognize user's feelings through the analysis of facial data. Data considered in this research are those acquired from RGB-D cameras, a family of devices that allows to obtain both color and depth information.

Some examples of fields using face expression recognition are security, for instance face analysis can reveal criminal's truthfulness during an interrogation; automotive, to properly adapt the environment modifying music, lights and alerts of the vehicle monitoring the driver's mood or to adapt the driving style of an autonomous vehicle to passenger's emotional state; culture, to monitor and to react to changes in audience's mood, but also videogames and, as the reader will be able to read later on, emotional design.

This study aims to investigate the context of facial expression recognition and suitable sensors to acquire the human face, in order to develop an automatic procedure able to perform real-time face expression recognition using RGB-D cameras. In order to achieve this goal, work has been split in steps that have been briefly presented in the next few lines and described in different chapters.

First, a literature review has been conducted to understand differences about the main facial applications that have been identified in face detection, face authentication, face identification and face expression recognition. RGB-D cameras have been studied and compared to identify the most suitable technology and, subsequently, the most suitable camera for face expression recognition. RGB-D cameras have been chosen for our purposes to include the third dimension, increasing reliability and robustness. The research has led us to identify structured light as the most suitable depth acquisition technology for the purpose of this work, so Intel RealSense SR300 has been selected to be used during the experiments. This part of the research has been described in Chapter 1.

Chapter 2 introduces a Support Vector Machine methodology aiming to identify the activation level of a subject's emotion. SVM relies on an automatic landmarking procedure involving geometrical descriptors and on geometrical descriptors themselves used as features for the classification. The method has been applied to a case study designed to make use of depth maps provided by the camera.

Chapter 3 introduces the usage of deep learning to obtain face expression recognition. This project has been conducted jointly with a team of Politecnico di Milano and aims to identify spontaneous emotions of people during an experiment and to build an ecological dataset. The experiment consists in showing some pictures belonging to public databases and validated to arouse specific emotions to the viewer. Meanwhile, an RGB-D camera records people reactions and data are stored for a later analysis through Convolutional Neural Network (CNN).

Chapter 4 describes the real-time procedure set up to obtain face expression recognition. The procedure consists of acquisition, data processing and recognition through CNN. In this chapter, the focus is on data processing, since all the operations (RGB and Depth alignment, face detection on depth map, cropping and resizing) have been automatized and optimized to obtain real-time.

Chapter 5 shows the work produced in collaboration with EURECOM, France. The study of women facial proportions has benefitted from the know-how of two different research groups regarding human face geometry and the concept of *standard face* and has resulted to be core to consolidate the background for the comprehension of feature extraction techniques. A ranking of the most significant measures (Euclidean distances, angular measures, and ratio between distances) has been drawn up.