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ScienceDirect

Procedia Computer Science 108C (2017) 1175–1184

Procedia Computer Science

International Conference on Computational Science, ICCS 2017, 12-14 June 2017, Zurich, Switzerland

Emotion recognition using facial expressions

Paweł Tarnowski, Marcin Kołodziej, Andrzej Majkowski, Remigiusz J. Rak
Warsaw University of Technology, Warsaw, Poland.
pawel.tarnowski@ee.pw.edu.pl, marcin.kolodziej@ee.pw.edu.pl,
andrzej.majkowski@ee.pw.edu.pl, remigiusz.rak@ee.pw.edu.pl

Abstract
In the article there are presented the results of recognition of seven emotional states (neutral, joy, sadness, surprise, anger, fear, disgust) based on facial expressions. Coefficients describing elements of facial expressions, registered for six subjects, were used as features. The features have been calculated for three-dimensional face model. The classification of features were performed using k-NN classifier and MLP neural network.

Peer-review under responsibility of the scientific committee of the International Conference on Computational Science

Keywords: facial expression, emotion recognition, action units, computer vision, k-NN, MLP

1 Introduction

Facial expressions play an important role in recognition of emotions and are used in the process of non-verbal communication, as well as to identify people. They are very important in daily emotional communication, just next to the tone of voice [1]. They are also an indicator of feelings, allowing a man to express an emotional state [2,3]. People, can immediately recognize an emotional state of a person. As a consequence, information on the facial expressions are often used in automatic systems of emotion recognition [4]. The aim of the research, presented in this article, is to recognize seven basic emotional states: neutral, joy, surprise, anger, sadness, fear and disgust based on facial expressions.

Man's face, as the most exposed part of the body, allows the use of computer vision systems (usually cameras) to analyze the image of the face for recognizing emotions. Light conditions and changes of head position are the main factors that affect the quality of emotion recognition systems using cameras [5]. Especially sensitive for these factors are methods based on 2D image analysis. Methods in which 3D face models are implemented are far more promising.

In our experiments we used Microsoft Kinect for 3D face modeling mainly because of its low price and simplicity of operation. Kinect has small scanning resolution, but a relatively high rate of image registering (30 frames/s). It has an infrared emitter and two cameras. One of the cameras record visible light, while the other operates in infrared and is used for measuring the depth [6]. Infrared rays reflected from the user's body allow creating a 3D model of a face. The model (Candid3 [7]) is based

1877-0509
Peer-review under responsibility of the scientific committee of the International Conference on Computational Science
10.1016/j.procs.2017.05.025

on 121 specific points of the face, recorded by the Kinect device. These points are arranged on characteristic positions on the face such as the corners of the mouth, nose, cheekbones, eyebrows, etc. A set of characteristic points of the face registered in 2D space is shown in Fig. 1.

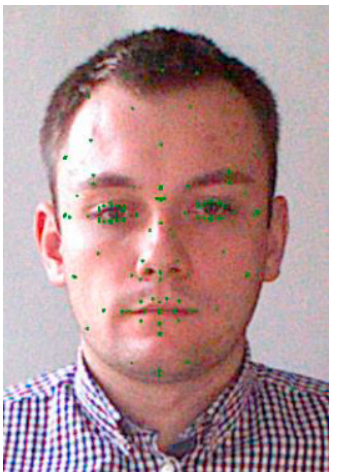

Figure 1: Characteristic points on the face

Spatial coordinates of the points are stored in a form of a matrix. Coordinate system (x, y, z), as defined in Kinect device, is shown in Fig. 2. Changes in facial expressions resulting from the activity of specific muscles [8] have been defined in the developed by Ekman and Friesen FACS system (Facial Action Coding System) [9] in the form of special coefficients - Action Units (AU). For example, the movement of the inner part of eyebrow, for which frontal cranial vault muscle is responsible, is described by the coefficient "Action Unit 1" called *Inner Brow Raiser*.

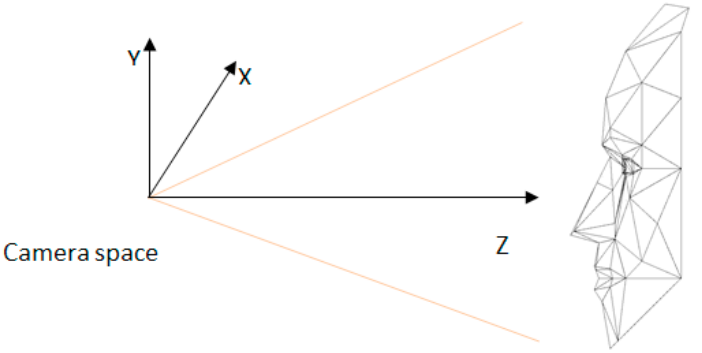

Figure 2: Kinect coordinate system **[10]**

Kinect device provides six Action Units (AU) derived from the FACS system. The Action Units may be used to describe emotions either separately or in combinations. AU take values between –1 and +1, and carry information about: AU0 - upper lip raising, AU1- jaw lowering, AU2 - lip stretching, AU3 - lowering eyebrows, AU4 - lip corner depressing, AU5 - outer brow raising.