Automatic pain detection in video sequences for neuro-rehabilitation

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Keywords: Pain Estimation, Facial Expression, Face Alignment, Supervised Descent Method (SDM), Support Vector Machine (SVM) Classifier

Abstract. Adaptive and interactive mental engagement combined with positive emotional state are requirements for an optimal outcome of the neuro-rehabilitation process for patients with brain damage usually caused by TBI (traumatic brain injury), stroke or brain disease such as cancer, epilepsy, and Alzheimer's disease. We propose a method for automatic pain recognition in video sequences using the landmarks data from Supervised Descent Method and applying Support Vector Machine (SVM) for data classification. This method is suitable for being part of assistive medical system for neuro-rehabilitation of patients with TBI. The experiments with a video dataset with patients with shoulder pain show very good recognition rate (95,7%) for recognizing the painful facial states of the subjects.

1. Introduction

Brain damage in humans can have multiple causes such as brain injuries as a result of motor vehicle crashes, sports injuries, or simple falls on the playground, at work or in the home or diseases such stroke, cancer, epilepsy, Alzheimer's disease, Parkinson's disease, multiple sclerosis and others. According to [1] there are 2 million TBI cases each year. 70,000 - 90,000 of those who survive will have lifelong disabilities and will require 5 to 10 years of intensive services such as vocational rehabilitation and physical therapy. TBI is an enormous burden for the public health services and has an important socio-economic weight throughout the world.

Standard rehabilitation methods for patients with different disabilities or injuries currently used are struggling to provide consistently meaningful improvements to patient abilities. To improve the chances of the patient's recovery new methodologies and technologies from different fields of medicine, psychology and engineering must be incorporated in the rehabilitation process. Manual monitoring of patients' pain makes it difficult for the medical personnel or rehabilitators to respond quickly in critical situations when using a remote assistive system. Thus, it is desirable to design such a system that can automate this task.

The use of emerging technologies such as robotics, virtual reality, brain-computer interfaces etc. for enhancing their user's independence will lead to better living by allowing remote assistance from the medical personnel, which in turn may reduce the stress of a visit to the hospital [2] or the pain in patients with mobility impairments [3]. The patients will benefit from the possibility of remote interaction with their doctors without going outside their comfort zone, and also carry out the training from their home, under remote supervision, reducing the cost to the health care system. For doctors, these types of assistive rehabilitation systems provide online remote monitoring of both the rehabilitation process and the physiological state of the patient [4]. So for an intelligent medical system being able to recognize that the patient suffers and feels in pain is of essence.

In recent years significant progress has been made in machine learning to automatically recognize facial expressions related to emotion, more specifically painful expressions [5, 6]. But many of the proposed algorithms require manual labeling of facial action units or other observational measurements by highly trained observers. Most must be performed offline, which makes them ill-suited for real time applications in clinical settings. Different authors present