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Conference Abstract

Application of automatic energy-based pain recognition in functional electrical stimulation

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Abstract

Purpose: Validate and test a method for automatic detection of painful electrical stimulation using computer vision techniques.

Context: In rehabilitation of stroke patients with motor deficits, functional electrical stimulation (FES) of muscles and nerves is a method used for activating the muscles and assisting body movements [1]. The stimulation can be painful, e.g. if the intensity is too high, electrode positioning is wrong or if the electrode/skin contact becomes poor. This is not desirable as it, most likely, discourages the patient to continue using the system. Therefore, a tele-rehabilitation FES system should incorporate methods for automatic detection of painful stimulation and ask the patient to reassess electrode contact and/or positioning upon detection.

Methods:
Two electrodes (Pals Platinum Round 3.2cm, Axelgaard Ltd., USA) were placed on the forearm, targeting the finger extensor muscles. Initially, the pain threshold (PT) of the subject was assessed, followed by 20 stimulation trains of 5 seconds (30Hz pulse train, 200µs pulse duration) with an intensity of 1.5×PT. Subjects were asked to rate each stimulation interval [0 10] (0=no perception, 3=PT, 10=worst imaginable pain), while being filmed by a Logitech 310 webcam. For automatic detection of the pain level, we applied the algorithm of [2], which is based on energy released by facial expressions. The estimated pain intensity was divided into 3 levels (<1=no pain, 2-5=weak and >5=strong pain). Eight healthy subjects (20-42 years) participated in the study. Signed consent was obtained from all subjects and the Declaration of Helsinki was respected. The study was approved by the local ethical committee (N-20130053).

Results and discussion:
The system successfully detected pain responses from changes in facial expressions with an accuracy of 79%. Changes in facial expressions due to stimulation varied greatly between subjects and were not always occurring even though the stimulation was rated as being painful, which might explain why the system did not always detect a behavioral pain response. The proposed work builds on the state of the art pain recognition system of [2] which is able to detect the pain level with accuracy of 75.25% [3]. It means that the overall recognition rate of the pain perception in the proposed system has been improved by 3.74%.

Keywords

functional electrical stimulation; pain detection; computer vision

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