INVITATION to the
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Hybrid Activation for the Enhancement of Muscle Force

Invited lecture by

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Short CV

Professor Joseph Mizrahi is with the Faculty of Biomedical Engineering at the Technion-Israel Institute of Technology, Haifa where he is the incumbent of the Pearl Milch Chair of Biomedical Engineering Sciences. He received the B.Sc. degree in Aerospace Engineering (1967), the M.Sc. degree in Mechanics (1970) and the D.Sc. degree in Biomechanics (1975), all from the Technion. He recently terminated a 5-year term as Dean of the Technion BME Faculty. For 18 years, he was head of the Biomechanics Laboratory at the Loewenstein Rehabilitation Center in Israel. He also held several visiting professorships, including with the Harvard Medical School (1989/90), the University of Cape Town (1991) and the Hong Kong Polytechnic University (1998/99). He is principal author of some 200 publications, and he presently holds several editorial responsibilities. His major research interests are in skeletal muscles, in Orthopaedic Biomechanics and Rehabilitation Biomechatronics.

Abstract

Enhancement of muscle force in Humans with partially deficient muscles can be accomplished by the Hybrid Activation of these muscles, whereby the volitional activation is augmented by electrical stimulation (ES). In Hybrid Activation the enhanced muscle force generally results from the combined volitional and ES-induced contributions. Nevertheless, the nature of this added effect is unclear and the specific share between these two components is not known. While in the presence of ES alone the muscle is known to exhibit a characteristic recruitment curve, relating the stimulating current intensity to the resulting muscle force, in hybrid activation of the muscles,

the response to ES is not readily predictable. Thus, despite the fact that during hybrid activation force enhancement is usually observed, the separate contribution of each of the two activation components to the total muscle force is not straightforward.

We have developed a computational approach to parcel out the volitional and ES-induced components of the joint torque generated during Hybrid Activation based on EMG filtering and on pre-measured calibration curves of volitional torque versus EMG. The algorithms conceived are based on experimental protocols involving muscle activation of subjects in the following modes: (a) ES alone, (b) volitional activation alone, and (c) Hybrid Activation.

The results have demonstrated that the desired overall torque output determine the required ES intensity profiles, thus providing means of designing an adaptive rehabilitation device for the hybrid activation of deficient muscles. The results of this work have direct implications on the development of hybrid muscle activation rehabilitation systems for the enhancement of weakened muscles.