Dr. Aleš Holobar
University of Maribor,
Faculty of Electrical Engineering and Computer Science,
Maribor, Slovenia

Understanding motor control of human movement by means of noninvasive motor unit identification

Alpha motor neurons in the spinal cord combine the inputs from supraspinal centers and afferent feedbacks and transform them into a neural code which drives the muscles. There is a one-to-one correspondence between the discharge of a motor neuron and motor unit action potentials propagated by the innervated muscle fibers. Thus, the neural drive to a muscle, i.e. the cumulative discharge of the active motor neurons innervating the muscle, can be assessed by decomposing electromyogram (EMG) recordings into contributions of individual motor units. The extracted information is vital for investigations of motor control strategies and motor unit morphological and functional properties, along with their adaptation to specific conditions such as injury, pathology, fatigue, pain or exercise.

In a classic setup, motor unit discharges are identified from invasively acquired intramuscular EMG. While acceptable and largely established in clinical practice, this procedure has drawbacks in neurorehabilitation, ergonomics, sport sciences and in many other cases where the acquisition conditions cannot be strictly controlled or where the invasive nature of indwelling EMG prevents its everyday use. This lecture will focus on novel approaches for noninvasive identification of individual motor units from surface EMG acquired during isometric or dynamic muscle contractions. The requested experimental setup and signal processing will be discussed, along with the representativeness of identified motor units and techniques for automatic assessment of the accuracy of motor unit identification. The use of identified motor unit discharge patterns will be demonstrated in representative case studies and the extracted information compared to commonly used EMG metrics, such as surface EMG amplitude and frequency estimators.