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HealthTech Innovation Conference

Zabrze, 10 – 11th October 2022

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SURFACE ELECTROMYOGRAPHY AND MUSCLES FORCE

Keywords: EMG, Muscle Force, Muscle Excitation, MVC

Introduction: Electromyography (EMG) is a highly-sensitive tool for detecting depolarization and repolarization, that occur on the sarcolemma of muscle fiber. The emerging muscle action potential precedes the muscle contraction and relaxation. The surface EMG recording represents the algebraic sum of action of several motor units (motoneuron and all innervated muscle fibers). In order to increase muscle force, motor units are activated more often or additional motor units are recruited, which basically results in an increase in the amplitude of EMG signal. In this context arise a question: Can we conclude: the larger amplitude of EMG is observed the larger force is developed by the muscle? Our studies show that not necessarily. The interpretation of muscle function from EMG is a challenge because a lot of factors influence the amplitude of EMG signal (e.g., type of muscle fiber, muscle length, muscle velocity but also type of electrodes, electrodes location, signal processing, individual human features, etc.). In this work we present the comparison of chosen EMG signal parameters versus muscles force.

Method: The proposed method processes of the raw EMG signal to gain quantitative information from EMG recordings. Due to the fact that the EMG signal is usually affected by noise or different type of artifacts it requires proper filtering process. The filtering was performed by means of three types of digital filters: the high pass filter with a cut-of frequency set to 10 Hz, the high pass filter with a cut-of frequency set to 250 Hz and the band stop filter to attenuate the mains hum (50 Hz). Next to obtain the level of muscle excitation and other parameters (e.g., frequency parameters) the EMG is smoothed by method based on the moving average filter and square root calculation (RMS). In order to compare muscle force and the chosen parameters of EMG (e.g., amplitude or median frequency), the force values were synchronously recorded with the EMG signal by means of a specially prepared sensor module. The simultaneous recordings (EMG and force) were made during physical exercises used to get maximum voluntary contraction (MVC).

Results: An example results of envelope of EMG signals and determined level of muscles excitation and muscle force of rectus femoris (left side) and biceps femoris (right side) is shown in Fig. 1. Different excitations correspond to similar forces, different forces correspond to similar excitations.

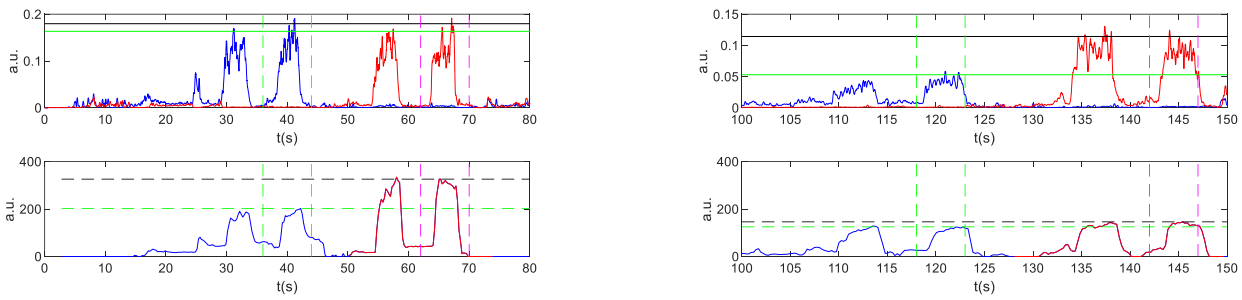

Fig.1. On the top the envelope of EMG and level of MVC, on the bottom the muscle force (blue-left, red-right muscle)

Conclusions: The preliminary analysis of correlation between muscle excitation and muscle force shows that the simple conversion from EMG amplitude or median frequency to muscle force is difficult to define (unrealistic). The presented experience and results could be interesting for most researchers in the field of human movement analysis and kinesiology.