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ASSESMENT OF MUSCLES EXCITATION DURING PHYSICAL ACTIVITY BASED ON SURFACE ELECTROMYOGRAPHY

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Introduction: The electromyographic recording (EMG) is a biomedical signal that measures the action potentials present on the membrane of muscle fibers as a result of depolarization and repolarization processes. Raw EMG is a complex signal controlled both by the nervous system and dependent on the anatomical and physiological properties of the muscles. Moreover, EMG signals are very sensitive to internal and external factors, therefore they need effective detection, decomposition, processing and classification methods to provide deep insight and understanding of the signal. Such an approach widens the possibilities of using this signal, which seems to be particularly attractive for medicine, rehabilitation and sport. One of the important problems is the normalization of the EMG signals, which is required for the correct interpretation of the standardized data. The aim of the study is to propose and illustrate the methodology and algorithms of EMG signal analysis of selected muscles during physical (sport) activity.
Method: The proposed method includes pre-processing of EMG, finding the signal envelope and threshold value connected to muscle activity. Due to the fact that the EMG signal is weak and can include a lot of artifacts the analysis of EMG requires appropriate preprocessing, that is proper filtering and artifacts removing methods. The used filtering method is able to filter the EMG signals by means of three types of digital finite impulse response filters (FIR): 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 suppress the mains interference (50 Hz). Next the EMG is smoothed by method based on the moving average filter and square root calculation (RMS). The RMS reflects the mean power of signal. Afterwards the threshold value of processed EMG is determined as the mean of the signal in the assumed window. In order to provide a fairly objective analysis of the muscle excitation the obtained results are normalized by using the maximum voluntary contraction (MVC).
Results: An example results of proposed EMG analysis is shown in Fig.1. The calculation of MVC level of left and right rectus femoris muscles (in blue and red lines, respectively) are presented on the left side of Fig.1, on the right side the normalization of EMG signal of left and right rectus femoris muscles recorded during deep squat is depicted.

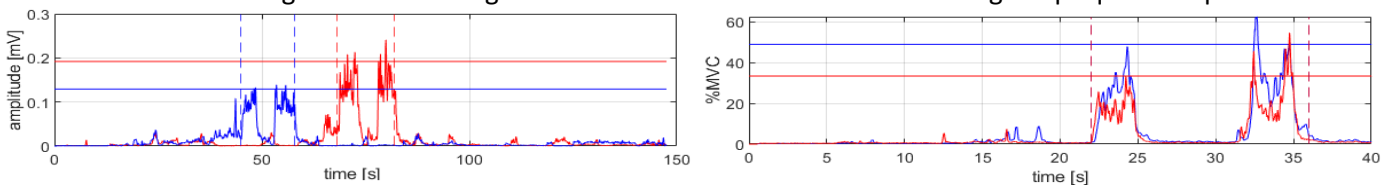

Fig.1. MVC level for left (in blue) and right (in red) rectus femoris muscles (on the left side), normalized EMG signal with MVC of left (in blue) and right (in red) rectus femoris muscles during deep squat (on the right side)
Conclusions: The presented method of EMG signal processing enables the assessment of muscle excitation, which in turn can be used to evaluate the condition of muscles during physical activity (e.g., athlete's training or rehabilitation). The discussed methodology can also help in assessing the effectiveness and correctness of training. However, proper normalization of EMG is required for the right estimation of muscle excitation. The method of determining the MVC value for normalization of EMG signal seems to be effective but the exercises dedicated to obtain MVC should be properly selected and carefully performed.