

# MULTI-LEVEL COMBINATION OF ELECTROMYOGRAM AND INERTIAL MEASUREMENTS FOR IMPROVED MYOELECTRIC PATTERN RECOGNITION

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## ABSTRACT

Advanced pattern recognition-based myoelectric prosthetic hands are currently limited due to the inadequate real-time control performance and the lack of classification robustness. In one direction of research, the extraction of accurate and efficient descriptors of muscular activity has been a major focus for improved myoelectric control while another direction considers the electromyogram (EMG) signal inadequate for reliable control and suggests that the use of inertial measurement (IM) data is needed. We propose to address the current limitations by considering a combination of robust feature extraction methods and a fusion of EMG and IMs. Our feature extraction algorithm employs the orientation between a set of descriptors of muscular activities and a nonlinearly mapped version of it. It also shifts the voting step from the classifier to the feature extraction stage by fusing the EMG signal power spectrum characteristics derived from each analysis window with the descriptors of previous windows for robust activity recognition. The proposed idea can be summarized in the following three steps: 1) extract power spectrum moments from the current analysis window and its nonlinearly scaled version in time-domain through Fourier transform relations, 2) compute the orientation between the two sets of moments, and 3) apply data fusion on the resulting orientation features for the current and previous time windows and use the result as the final feature set. We collected and analysed a dataset comprising of 20 able-bodied and two amputee participants executing 40 movements. In our experiments, we firstly show that the well-known methods can only achieve an average of 25% classification error across all subjects with 150 ms windows, and by using our proposed features we achieved significant reductions in error rates of up to 16% across all subjects ( $p < 0.001$ ). The inclusion of the IM data further significantly enhanced the results by shrinking the classification error rates to an average of  $< 5\%$  across all subjects ( $p < 0.001$ ).

We consider that the implications of our study could help improve the usability of upper-extremity prostheses in real-life applications.