Abstract: Measuring Muscle Contractions from Single Element Transducer Ultrasound Data using Machine Learning Strategies

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Being aware of the correct execution of certain fitness exercises (e.g. squats) is important for rehabilitation and sports athletes alike. Thus, being able to non-invasively distinguish between contracted and relaxed muscle states is crucial. Measurements using optical systems (movement tracking) or kinetic approaches (muscle circumference) only provide information from the body surface with varying accuracy. Ultrasound measurements and imaging, however, can provide a more detailed view on muscle activity. In this work we present our solution using single element and array transducer ultrasound data in combination with an artificial neural net (ANN) to classify muscle contractions. The Fraunhofer Ultrasound Research Platform *DiPhAS* [1] was used to acquire ultrasound array data, while the pulser-receiver Olympus 5800PR was used with Panametrics transducers to obtain single element ultrasound A-scans serving as input data for our algorithm. Several experiments were performed on the calves of healthy volunteers. The retrieved data was used as input for our ANN and the efficiencies of different parameter choices (such as different cost functions, different minimization algorithms for the cost function, different activation functions for each neuron, etc.) were analysed. Using this approach, it is possible to distinguish between rest and knee bends with its corresponding muscle contractions. Therefore, it is shown that ultrasound measurements combined with ANNs can be used to detect certain muscle activities in the human body without relying on surrogates. The presented approach will be tested to analyse muscle activities in the forearm to control artificial hand prostheses.

References

1. Risser C, Welsch HJ, Fonfara H, et al. High channel count ultrasound beamformer system with external multiplexer support for ultrafast 3D/4D ultrasound. Proc IEEE IUS. 2016.