A novel transfer learning scheme for robustly extracting the user intended motion in bionic prostheses control

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Abstract

Intuitive interfaces for controlling hand prostheses are based on residual muscle signals, which can be recorded via surface electromyography (sEMG), and subsequently classified to infer the intended motion. Although modern prostheses feature up to 20 active degrees of freedom (DoF) [1], current commercially available interfaces can only control a single DoF at a time [2]. While machine learning algorithms can be applied to simultaneously control several DoFs, these algorithms require related sEMG signals to be constant over time. This is, however, not given in practice due to several sources of disturbance such as electrode shifts, posture changes, sweat, fatigue [2]. A novel approach to counteract such disturbances is transfer learning, which has the goal of adapting the trained model to a situation where data has a different representation [3, 4].

This work extends the former approach by presenting a novel algorithm for linear supervised transfer learning, which optimizes a linear function to map disturbed data (e.g. due to an electrode shift) back to the initial domain such that the original model is applicable again. This scheme is based on optimizing the fit of the transferred data to a prototype-based model using an expectation maximization algorithm.

The proposed approach is evaluated on artificial data as well as on real-world sEMG data as used for bionic prosthesis control. If few data points are available for transfer learning and/or if not all classes are contained in the training data, our proposed approach is able to outperform all tested baseline algorithms.

References

