Eye-hand coordination to improve grasp-type recognition in hand prostheses

Matteo Cognolato[1,2]*, Manfredo Atzori[1], Roger Gassert[2], Henning Müller[1]

[1] Information Systems Institute, HES-SO Valais, Switzerland
[2] Department of Health Sciences and Technology, ETH Zurich, Switzerland

Abstract

A hand prosthesis that can be controlled robustly and naturally in daily life tasks is still a challenge. Advanced control methods based on surface electromyography (sEMG) are poorly translated into clinical use, mainly due to insufficient robustness in unconstrained environments. A promising approach to overcome this limitation relies on the inclusion of complementary sources of information[1]. We recently released a dataset[2] containing sEMG, accelerometry, gaze, and first-person video collected from 15 transradial amputees and 30 able-bodied subjects performing 10 grasp types on several objects. We aim to improve the robustness of grasp-type classification by fusing information about the object a person wants to grasp with the information provided by the sEMG. The approach consists of continuously performing an sEMG-based grasp-type classification and, when a grasp intention is detected, relying on the eye-hand coordination parameters to identify the target object. The two modalities are then merged to obtain the final grasp type. The sEMG-based classification was performed at 10ms intervals using a Long Short-Term Memory (LSTM) network. Object detection and segmentation were performed with a Mask Region-based Convolutional Neural Network (Mask R-CNN) on the first-person video. The ability of the LSTM to distinguish rest from grasp was used to identify the grasp intention, taken as the first sample classified as non-rest. Afterwards, the target object was identified as the last object to have the gaze point closer than 20px within the previous 250ms. The final grasp type was selected as the one with the highest probability among the grasp types suitable for the target object, evaluated on the LSTM prediction vector. We investigated the approach on 10 static grasp types performed by 3 amputees and 3 able-bodied subjects. The average increase in accuracy with respect to the sEMG-based approach was of 9.86±7.52% and 9.03±8.48%, respectively. Although preliminary, these results indicate the potential of the approach to increase the robustness of grasp-type recognition and improve the control of hand prostheses.

References

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Short Biography

Matteo Cognolato obtained his master's degree in Bioengineering in 2015 from the University of Padova. He is currently working in the eHealth unit at HES-SO Valais and he is enrolled as an external PhD student in the Rehabilitation Engineering Laboratory at ETH Zurich.

* Presenting author   Attending author(s)