# Plenary Session

## A Closed-loop Hybrid Brain-Computer Interface System for Intelligent Neuroprostheses Control

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***BIOGRAPHY***

Zied TAYEB received his diploma in electrical engineering from the National Engineering School of Tunis (ENIT), Tunisia in 2015. From 2016 to 2017, he was a researcher in the Human Brain Project (HBP), a H2020 FET Flagship Project ( www.humanbrainproject.eu). In April 2017, he was awarded a PhD fellowship by the German Academic Exchange Service (DAAD). He is currently a doctoral candidate and a teaching assistant at the Institute for Cognitive Systems at the Technical University of Munich. His current research interests include brain-computer interfaces, neuroprosthetics and deep reinforcement learning. https://www.ics.ei.tum.de/en/people/tayeb/. In early 2019, Zied launched ortho-hand a German-Tunisian startup whose mission is to develop cutting-edge software solutions for neuro-engineering (prostheses, exoskeletons and smart wheelchairs systems).

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***ABSTRACT***

A neuroprosthesis is a device that has a direct interface with the nervous system and supplements or substitutes functionality in the patient's body. Regarding the increasing consumer base of amputees, neuroprosthetic research has gained momentum over the last decades. However, current neuroprostheses still exhibit various drawbacks, such as low controllability, high power consumption, and lack of sensory feedback. This research project investigates the design of a closed-loop control system for upper-limb hand prostheses using hybrid brain-computer interfaces [1, 2]. First, motor imagery movements from electroencephalography (EEG) signals as well as different hand poses from electromyography (EMG) signals are decoded in real-time[3,4]. Second, a prosthetic hand is controlled to perform complex reach-to-grasp movements using decoded information from EEG and EMG. Thereafter, measured sensory information from the prosthetic hand is encoded and translated into vibro-tactile and/or electro-tactile stimulation to provide a more natural sensation spanning a range of tactile stimuli. Different physical properties of grasped objects, such as grasping force, texture, shape are encoded and sent back to the user to restore the sense of touch. Finally, we use EEG activity in somatosensory regions to confirm phantom hand activation during stimulation and to differentiate between the different stimulation sites. Ultimately, this research project envisions to accelerate the next generation of portable, closed-loop, and intelligent prosthetic hand devices.

***References:***

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