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Title

Mutual learning for robust brain-machine interface-actuated devices

Proposer / Main Organizer

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Biography

Gloria Beraldo received the M.Sc. degree cum laude in Computer Science Engineering in 2017 and a PhD in Information Engineering in 2021 from the University of Padova. She is currently research fellow at Istituto di Scienze e Tecnologie della Cognizione, Italian National Research Council. Her research is focused on designing novel shared autonomy approaches with particular attention to the case of brain–machine interface driven robotics devices. In 2019, she was a visiting researcher at École polytechnique fédérale de Lausanne. She won the Cybathlon BCI Series as a member of the WHI Team in 2019 and the 2020 Cybathlon Global edition.

Stefano Tortora received the M.Sc. degree cum laude in Biomedical Engineering from Politecnico di Milano in 2017 and a PhD in Information Engineering from the University of Padova in 2021. He is currently a postdoctoral researcher at the Department of Information Engineering of the University of Padova. His research is focused on the development of novel machine learning and artificial intelligence algorithms for hybrid Human-Machine Interfaces integrating multimodal neurophysiological signals and robotic sensors' data. He was visiting researcher at Eidgenössische Technische Hochschule (ETH) in and at École polytechnique fédérale de Lausanne (EPFL), in 2016 and 2019 respectively. He won the Cybathlon BCI Series in 2019 and the 2020 Cybathlon Global edition as a member of the WHI Team.

Luca Tonin received the Ph.D. degree in robotics from the École Polytechnique Fédérale de Lausanne in 2013. He then pursued six years of postdoctoral research at the University of Padova and at the EPFL. Since 2019, he is Assistant Professor at the Department of Information Engineering of the University of Padova. His research is currently focused on exploring advanced techniques for brain–machine interface driven robotics devices. In 2016, Dr. Tonin won the Cybathlon event as a co-leader of the BrainTweakers team. In 2019, Dr. Tonin won the Cybathlon BCI Series event and the 2020 Cybathlon Global edition as a leader of the WHi Team.

Emanuele Menegatti is a Full Professor working in the field of Robot Perception. In particular, he is working on neurorobotics, RGB-D people tracking, and service robotics. He was coordinator of the European Project "Thermobot" and local investigator of another five European Projects. He served as Project Reviewer for the European Commission in FP7 and H2020. He authored more than 50 journal publications and more than 120 conference publications. He is co-founder of two start-ups: IT+Robotics (industrial robot vision) and EXiMotion (educational robotics and service robotics). His team, the WHI Team (University of Padova), won the Cybathlon BCI Series in September 2019 and the 2020 Cybathlon Global edition.

IEEE Member or SMC Society Member

All proposers are IEEE Members and SMC Society Members

Category
Human-Machine Systems

Number of Expected Paper Submissions:
5 or more

Keywords
Human-Machine Interface, Human-Computer Interaction, Brain-based Information Communications, Human-centered Learning, User Interface Design

Brief Description and Justification:

Brain-machine interfaces (BMIs) allow communication with external devices (e.g., computer applications or robotic actuators) using human neural signals. In the last decades, we have seen a growing interest and a rapid development of assistive solutions as an alternative communication channel for people with severe motor impairments. Several prototypes have demonstrated the feasibility of exploiting BMI to control different robotic devices, from mobile robots to wearable neuroprostheses. However, BMI for long-term usage is still an open challenge due to the intrinsic nature of this interface, characterized by noise and non-stationarity of the neurophysiological signals.

While some researchers have followed the strategy of increasing the decoding performance by identifying optimal pattern recognition algorithms, others hypothesized that the performance could be improved if the user and the machine both engaged in learning from each other.

This special issue is focused on the efficacy of the mutual learning methodology to promote the use of the brain-machine interfaces for controlling external devices, including wheelchairs, telepresence robots, exoskeletons, prostheses, and games.

We are looking for contributions related to the mutual learning achieved at the three levels:

- novel approaches of machine learning (feature extraction, signal processing), which highlights the role of mutual learning in the decoding of neural features;
- novel approaches for augmenting the interaction between the device and the BMI by learning through the experience and the context (e.g., adaptability, sensor fusion, learning from context);
- novel approaches for enhancing the user's learning, including new interfaces, feedback, and training procedures.