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ROS-Neuro, a common middleware for neural interfaces and robotic applications

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Introduction: The last years have seen great technological advancements in the field of neural human-machine interfaces (HMI) to control robotic devices [1]. However, the uptake of these technologies in real-world applications represents a challenge still unmet. The reasons are three-fold: (i) lack of a common development platform to facilitate the sharing of methods among the scientific community; (ii) lack of well-defined common standards, leading to heterogeneous and home-made solutions; (iii) lack of common technical tools to integrate neural interfaces and robotics, thus neglecting the potential benefits of introducing existing artificial intelligence (AI) solutions in neurorobotic applications.

Fig. 1 ROS-Neuro logo

Materials, Methods and Results: We spotlight ROS-Neuro, the first middleware explicitly designed for neurorobotics, based on the Robot Operating System (ROS), the software framework for robotics now a *de facto* standard [2]. ROS-Neuro exploits the modularity and the standard communication infrastructure of ROS to develop all the components required by a closed-loop neural interface (i.e., acquisition, processing and decoding). These are implemented at the same conceptual and implementation level of the software controlling the robot. ROS-Neuro provides interfaces, in the form of ROS packages, for neurophysiological signals acquisition and recording from several EEG and EMG commercial amplifiers, as well as the possibility to integrate custom biosignal acquisition systems [3]. The current version of ROS-Neuro includes also standard modules for implementing the most common processing algorithms (e.g., temporal, spatial filters) and provides a graphical interface for visualizing in real-time neural signals at the different steps of the processing pipeline.

Discussion: ROS-Neuro is distributed fully open source (https://github.com/rosneuro) as this project aims at creating a wide community sharing the latest advancements in HMI and robotics, exploiting ROS-Neuro as a robust and flexible ecosystem to evaluate and compare different approaches.

Significance: We firmly believe that the use of ROS-Neuro as a common development platform for the community represents the key for boosting the performance of neurorobotic technologies and pave the way for their use in the everyday life to improve the quality of life of people with disabilities.

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