Personalized Closed-loop Neurostimulation for Functional and Cognitive benefits

Staniša Raspopović

Abstract— **Advances in peripheral nervous system (PNS) interfacing present a promising venue for rehabilitation of individuals with different neurological disabilities. Subjects with diabetes or lower-limb amputation frequently do not engage fully in everyday activities because they are afraid of falls. They also tend to have reduced mobility, which can induce a sedentary lifestyle that promotes disease development and hinders reinsertion into society, while the neuropathic pain is also common and poorly managed with current medications. Despite a wide range of possibilities for human-machine interfacing, among which I was participating in development of several, the nature of the optimal human-machine interaction remains poorly understood. Knowledge gained from in-silico modelling of targeted neural structures can inform an optimized design of such interfacing, therefore we develop the exact models of different nerves, enabling for personalized treatments. We have pioneered a human-machine systems that translates prosthetic sensors' read-outs into "language" understandable by the nervous system, using a detailed computational model. A "sensing leg," for lower- limb amputees, by connecting sensors from the prosthetic knee and under the foot to the residual PNS, transduces the readout of the sensors into stimulation parameters. Their effects at the brain level were evaluated, observing important benefits. These studies not only provided clear evidence of the benefit of neuromodulation for neurologically disabled subjects but also provided insights into fundamental mechanisms of supraspinal integration of the restored sensory modalities.**

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 ISBN 978-86-7466-970-9