Professor Stanisa Raspopovic - Ecole polytechnique fédérale de Zürich

Stanisa Raspopovic's research interest is focused on the development of innovative medical devices for treatment of neurologically disabled (amputees and diabetics) persons. In particular, he develops mechatronic systems directly interfacing the environment with the residual nervous system. Patients with diabetic neuropathy and amputees suffer lack of sensory feedback, which partially excludes the central nervous system from the correct sensorimotor integration. These cause serious problems as: falls due to unexpected perturbations, asymmetric walking and balance, higher power consumption (with occasional heart failures), and neuropathic pain occurrence. Recently, huge advancements have been achieved in the development of sophisticated neuro-prosthetic devices. This can be potentially achieved via electrical communication with the residual nervous system of users. Nerve interfaces can have different geometries, number of stimulating contacts, placement within the nervous system, and stimulation protocols. This high-dimensional problem is not tractable by brute-force approach, but should be faced by exact computational models, which exploit our accumulated knowledge. For this reason, he and his team developed a new conceptual framework to assist the design of smart technologies for neurorehabilitation, based on exact modeling and continuous validation and tuning. It consists of:

i) Physical understanding of an interaction between the electrical field and nerve cells through the development of computational Electro-Neuro-Models, anatomically and biophysically realistic. These are used for a solution of electrical field generated by stimulation and a corresponding neural response within the targeted nerve;

ii) Construction of mechatronics devices that enable the bidirectional connection between artificial sensors/actuators and implanted/skin stimulating devices; and

iii) Clinical validation and optimization of such devices. Together with health benefits, the goal of this framework is to increase our basic understanding about how the nervous system bidirectionally control limbs and internal organs, especially post-injury, and to deep-understand the involved physiological decoding and encoding.