ISB 2021 Biorobotics Special Session: Do we need to be biologically faithful to do useful biorobotics?

Biorobotics is the design and construction of robots that leverages principles that evolved in organisms. The neuromechanical makeup of every extant or extinct invertebrate and vertebrate species is an evolutionary proof-of-principle in a given functional niche which biorobots can and should learn from. The spectrum of biological fidelity in biorobots, however, ranges widely and includes bio-inspiration (e.g., imitates a biological function like flight for airplanes), bio-mimetism (e.g., imitates a biological structure like locomotion and manipulation for robotic quadrupeds and hands) and bio-morphism (e.g., implements biological phenomena like neural spiking in neuromorphic computing).

The utility of each of these approaches is, of course, determined by the goals of the robotic application. This panel of three practitioners will define, discuss and debate these levels of biological fidelity in the context of the biomechanical, neuromuscular and clinical principles elucidated by the ISB community. Our goal is to catalyze and facilitate the translation of biological principles to machines such as robotic quadrupeds, bipeds, ornithopters, swimmers and humanoids, as well as functional augmentation technologies like rehabilitation robotics, assistive exoskeletons and functional multipliers. We are also interested in using biorobots as scientific tools to investigate principles of animal motor control.

Auke Ijspeert (École Polytechnique Fédérale de Lausanne - EPFL) will discuss how biorobots of different levels of biomimetism can be used as physical models to investigate how different components of the morphology and control circuits in vertebrates have evolved from aquatic to terrestrial locomotion during evolution. **Yulia Sandamirskaya** (Intel's Neuromorphic Computing Lab) will discuss how the information processing capabilities of neurons is a proof-of-principle for distributed, massively parallel, and adaptive neural networks for perception and learning for neuromuscular control that can and should be leveraged, even if not strictly faithful to neural function.

Chair, **Francisco Valero-Cuevas** (University of Southern California - USC) will discuss how biorobots that use strictly faithful biomechanical, physiological and neural principles are useful analogues that put our neuromechanical theories to the ultimate test of physical implementation—and improve our understanding of function, disability and treatment.

1) **Auke Ijspeert**

https://www.epfl.ch/labs/biorob/people/ijspeert/

Short Bio:

Auke Ijspeert is a professor at EPFL (Lausanne, Switzerland) since 2002, and head of the Biorobotics Laboratory. He has a BSc/MSc in physics from EPFL (1995), a PhD in artificial intelligence from the University of Edinburgh (1999). He is an IEEE Fellow. His research interests are at the intersection between robotics, computational neuroscience, nonlinear dynamical systems and applied machine learning. He is interested in using numerical simulations and robots to gain a better understanding of animal locomotion, and in using inspiration from biology to design novel types of robots and controllers. He is also investigating how to assist persons with limited mobility using exoskeletons and assistive furniture.

2) **Yulia Sandamirskaya**

https://www.intel.com/content/www/us/en/research/researchers/yulia-sandamirskaya.html

Short Bio:

Yulia Sandamirskaya leads the Application Research team of the Neuromorphic Computing Lab of Intel Labs (Munich, Germany). Her team develops spiking neuronal network based algorithms for neuromorphic hardware to demonstrate the potential of neuromorphic computing in real-world applications. Before joining Intel, Yulia led a group "Neuromorphic Cognitive Robots" in the Institute of Neuroinformatics at the University of Zurich and ETH Zurich. She was chairing EUCog—the European Society for Artificial Cognitive Systems and coordinated an EU project NEUROTECH, creating and supporting the neuromorphic computing technology community in Europe.

3) **Francisco Valero-Cuevas**

http://www.valerolab.org

Short Bio:

Is Director of the Brain-Body Dynamics Lab at USC (Los Angeles, USA). He has a BS in Engineering from Swarthmore College, and MSc and PhD in Mechanical Engineering from Queen's University, Canada, and Stanford University, respectively. He is a Senior Member of the IEEE, Fellow of the American Institute for Medical and Biological Engineering (AIMBE), and received an Honorary Doctor of Sciences in Biology from Swarthmore College. His research interests are at the intersection of mechanics, neuroscience and robotics to create versatile machines and understand the principles of neuromechanics that produce function and disability—especially for manipulation and locomotion. He is the founder of the medical device company Neuromuscular Dynamics and the nonprofit for diversity in education Acceso Academy.