

ENB Elite Master Program Neuroengineering (MSNE) Invited Presentation

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Nonlinear elastic resonance modes for efficient robot and biological locomotion

Abstract: Controlling motion at low energetic cost, both from mechanical and computational point of view, certainly constitutes one of the major locomotion challenges in biology and robotics. We attempt to demonstrate that robots can be designed and controlled to walk highly efficient by exploiting resonance body effects, increasing the performance compared to rigid body designs. To do so, however, legged robots need to achieve limit cycle motions of the highly coupled, non-linear body dynamics. This led us to the research of the still not very well understood theory of nonlinear system intrinsic modal oscillation control. I will present current theoretical and experimental results therewith. One of the striking results is that biomechanics, in particular kinematics, visco-elastic and inertial properties of biological limbs are such that coordinated resonant motions of multiple joints intrinsically emerges and is therefore easy to excite and sustain. This can be also achieved by careful design for robotic systems. Some of the basic robotics control functions we developed for locomotion strikingly resemble neural functionalities and structures. For example, Hebbian learning, one of the most basic principles of synaptic plasticity, is mathematically equivalent to robotic controllers which adapt to previously unknown resonance properties of the body. Based on the robot control approach, we propose an equivalent neural model involving neural plasticity in the spine and the serotonergic loop in the brain-stem. This hypothesis is supported by numerous experimental evidences from neuroscience.



Biography: Alin Albu-Schäffer received his M.S. in electrical engineering from the Technical University of Timisoara, Romania in 1993 and his Ph.D. in automatic control from the Technical University of Munich in 2002. Since 2012 he is the head of the Institute of Robotics and Mechatronics at the German Aerospace Center (DLR), which he joined in 1995. Moreover, he is a professor at the Technical University of Munich, holding the Chair for "Sensor Based Robotic Systems and Intelligent Assistance Systems". His research interests range from robot design and control to robot intelligence and human neuroscience. He is an author of more than 250 peer reviewed journal and conference papers and received several awards, including the IEEE King-Sun Fu Best Paper Award of the Transactions on Robotics in 2012 and 2014.

The Talk is hosted by Prof. Gordon Cheng (Institute For Cognitive Systems)

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All talks in the MSNE Invited Speaker Series are open to students, staff, and members of the public. Attendance is free.

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