Tuesday July 28th

Online 28 – 30 July 2020
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#LivingMachines2020

**LIVING MACHINES**

9th International Conference on Biomimetic and Biohybrid Systems

Plenary Lectures, Poster Sessions and Workshops

**Plenary Speakers**

Auke Jan Ijspeert  
Swiss Federal Institute of Technology  
Lausanne, Switzerland

Holk Cruse  
Bielefeld University  
Bielefeld, Germany

Bas Overvelde  
AMOLF  
Amsterdam, The Netherlands

Li Zhaoping  
MPI for Biological Cybernetics  
Tübingen, Germany
1 GROWING STRUCTURES: BIOINSPIRED INNOVATION INSIGHTS FOR ARCHITECTURES AND ROBOTICS.

Barbara Mazzolai
Istituto Italiano di Tecnologia, Italy
Thomas Speck
University of Freiburg, Germany
Mirko Kovac
Imperial College London, United Kingdom
Fritz Vollrath
Oxford University, United Kingdom
Justin Werfel
Harvard University, USA
Nicholas Rowe
CNRS, France
Andreas Lendlein
Hemholtz-Zentrum Geesthacht at Teltow, Germany
Achim Menges
University of Stuttgart, Germany
Barbara Imhof
University of Applied Design Vienna, Austria
Robert Stuart Smith
University College London, United Kingdom

2 SHARED WORKSPACE BETWEEN HUMANS AND ROBOTS.

Apostolos Axenopoulos
Centre for Research & Technology Hellas
Dimitrios Giakoumis
Centre for Research & Technology Hellas
Anna Mura
Institute for Bioengineering of Catalonia (IBEC)
Vicky Vouloutsi
Institute for Bioengineering of Catalonia (IBEC)
Eva Salgado Etxebarria
TECNALIA, Spain
Sara Sillaurren
TECNALIA, Spain
Wednesday July 29th

CONFERENCE

Online via Zoom

09:00  Registration

09:20 - 09:30  Welcome

09:30 - 10:30  PLENARY TALK
Using Biorobots to Investigate Extant and Extinct Animal Locomotion
Auke Ijspeert

10:30 - 11:20  TALKS

10:30 - 10:55  Standing on the water: stability mechanisms of snakes on free surface.
Johann Herault, Etienne Clement, Jonathan Brossilon, Seth LaGrange, Vincent Lebastard, Frederic Boyer

10:55 - 11:20  Robophysical modeling of bilaterally activated and soft limbless locomotors.
Perrin Schiebel, Marine Maisonneuve, Kelimar Diaz, Jennifer Rieser, Daniel Goldman

11:20 - 11:40  Coffee Break

11:40 - 12:30  TALKS

11:40 - 12:05  Biomimetic Design of a Soft Robotic Fish for High Speed Locomotion.
Sander van den Berg, Rob Scharff, Zoltan Rusak, Jun Wu
12:05 - 12:30
**Biohybrid wind energy generators based on living plants.**
Fabian Meder, Marc Thielen, Giovanna Adele Naselli, Silvia Taccola, Thomas Speck, Barbara Mazzolai

12:30 - 13:30 **POSTER SESSION**

13:30 - 15:00 **Lunch Break**

15:00 - 15:50 **TALKS**

15:00 - 15:25
**Programming Material Intelligence: An Additive Fabrication Strategy for Self-Shaping Biohybrid Components.**
Tiffany Cheng, Dylan Wood, Xiang Wang, Philip Yuan, Achim Menges

15:25 - 15:50
**Multi-material 3D-printer for rapid prototyping of bio-inspired soft robotic elements.**
Stefan Conrad, Thomas Speck, Falk Esser

16:00 - 17:00 **PLENARY TALK**
**Adaptive Behaviour Through Decentralized Reinforced Learning in Soft Robotic Matter.**
Bas Overvelde
PLENARY TALK
09:30 - 10:30

AUKE IJSPEERT
USING BIOROBOTS TO INVESTIGATE EXTANT AND EXTINCT ANIMAL LOCOMOTION.

The ability to efficiently move in complex environments is a fundamental property both for animals and for robots, and the problem of locomotion and movement control is an area in which neuroscience, biomechanics, and robotics can fruitfully interact. In this talk, I will present how biorobots and numerical models can be used to explore the interplay of the four main components underlying animal locomotion, namely central pattern generators (CPGs), reflexes, descending modulation, and the musculoskeletal system. Going from lamprey to human locomotion, I will present a series of models that tend to show that the respective roles of these components have changed during evolution with a dominant role of CPGs in lamprey and salamander locomotion, and a more important role for sensory feedback and descending modulation in human locomotion. I will also present a recent project showing how robotics can provide scientific tools for paleontology to provide quantitative estimations of the likelihood of gaits of extinct animals.

Auke Ijspeert – Swiss Federal Institute of Technology, Switzerland. His research interests are at the intersection between robotics and computational neuroscience.
Researchers have started to explore the use of compliance in the design of soft robotic devices, that have the potential to be more robust, adaptable, and safer for human interaction than traditional rigid robotics. State-of-the-art developments push these robotic systems towards applications such as soft rehabilitation and diagnostic devices, exoskeletons for gait assistance, grippers that can handle highly diverse objects, and electronics that can be embedded in the human body. Despite these exciting recent developments, due to their inherent non-linear response, current soft robotic systems are difficult to scale, and are mainly passive: they typically do not adjust their behavior to changes in their environment. To enable modularly scalable and autonomous soft robots we have developed a new type of soft robot that is assembled from identical building blocks with embedded actuation, sensing and computation. In this robotic system, behavior emerges from local interactions, rather than being centrally controlled. Here we show that we are able to implement decentralized learning in this system. Using a stochastic optimization approach, the assembled soft robot achieves overall self-learned locomotion by having each individual building block update their phase only based on their own position. As such, this robotic system has material-like properties, e.g. it is scalable and not sensitive to damage; if we would cut the robotic system in two, both parts should maintain similar bulk behavior.

Bas Overvelde – AMOLF, The Netherlands. His research focuses on the design, fabrication and fundamental understanding of mechanical metamaterials and soft robots that are capable of autonomously adapting to – and even harnessing – variations in their environment.
Thursday July 30th

CONFERENCE

09:30 - 10:30  PLENARY TALK
“Looking” and “Seeing” in Vision and other Senses in Man, Animals and Machines.
Li Zhaoping

10:30 - 11:20  TALKS

10:30 - 10:55  Haptic Object Identification for Advanced Manipulation Skills.
Volker Gabler, Korbinia Maier, Satoshi Endo, Dirk Wollherr

Stefan Iacob, Johan Kwisthout, Serge Thill

11:20 - 11:40  Coffee Break

11:40 - 12:30  TALKS

11:40 - 12:05  Fast Reverse Replays of Recent Spatiotemporal Trajectories in a Robotic Hippocampal Model.
Matthew Whelan, Tony Prescott, Eleni Vasilaki

12:05 - 12:30  Modeling the Dynamic Sensory Discharges of Insect Campaniform Sensilla.
Nicholas Szczecinski, Sasha Zill, Chris Dallmann, Roger Quinn

12:30 - 13:30  POSTER SESSION

13:30 - 15:00  Lunch Break
Thursday July 30th                        Program

15:00 - 15:50  TALKS

15:00 - 15:25
Spatio-temporal Memory for Navigation in a Mushroom Body Model.
Le Zhu, Michael Mangan, Barbara Webb

15:25 - 15:50
Snapshot Navigation In The Wavelet Domain.
Stefan Meyer, Thomas Nowotny, Paul Graham, Alex Dewar, Andrew Philippides

16:00 - 17:00  PLENARY TALK
From Walking to Cognition, a Decentralized, Insect-Inspired Hexapod Controller.
Holk Cruse

17:00 - 17:30  AWARDS
BEST PAPER
BEST POSTER

17:30  Conference Ends
In human vision, looking orients head and gaze to put attended objects into the central visual field for seeing or scrutiny. It enables attention to select a tiny fraction of sensory input information into the attentional bottleneck. This bottleneck, more severe in lower animals, should also apply to most robots. I will present recent findings in a new framework for understanding vision. This framework views vision as containing encoding, selection, and decoding stages, putting attentional selection (looking) at the center stage. In primates, selection starts in the primary visual cortex (V1), suggesting a massive loss of non-selected information from V1 downstream along the visual pathway. Hence, feedback from downstream visual cortical areas to V1 to aid seeing (decoding), through analysis-by-synthesis, should query for additional information and be mainly directed at the foveal region. Hence, looking and seeing are mainly by the peripheral and central vision, respectively. Non-foveal vision is not only poorer in spatial resolution, but also more susceptible to many illusions (in seeing). In some animals (like rodents), some senses like vision and audition serve the “peripheral” role for “looking” to orient the central "seeing" senses, by (e.g.,) whiskers, tentacles, snouts, nose, lips, and tongues, towards the attending object for better scrutiny.

LI ZHAOPING – Max Planck Institute for Biological Cybernetics Tübingen, Germany. Zhaoping's research experience throughout the years ranges from areas in high energy physics to neurophysiology and marine biology, with most experience in understanding the brain functions in vision, olfaction, and in nonlinear neural dynamics.
Simulation studies provide an important tool to understand how behavior of animals may be controlled. Generally, such studies focus on a comparatively narrow behavioral segment, an approach that necessarily circumvents the question as to how an architecture may be designed that is able to control a broad range of behaviors as observed in animals. To cope with this question, we apply an ANN-based decentralized and semi-hierarchical architecture. This architecture consists of separate, partially-autonomous sensori-motor memories arranged at various levels. These memories pursue local goals, while receiving memory-specific sensory signals and may operate at different time scales. To describe the properties of this network, we start with “lower-level” behavior, in this case hexapod walking. The network shows both adaptivity and stability against disturbances, describing quite a number of behavioral data as well as neurophysiological ones. It will then be shown how such a network may be expanded to deal with higher level control tasks as for example navigation and, after a minor further expansion, with cognitive behavior in a strict sense. The latter means that, in critical situations, the network is able to invent new behaviors by exploiting the decentralized memory architecture, and is able to plan ahead by using an internal body model for simulation and can thereby search for a solution of the current problem.

HOLK CRUSE - Bielefeld University, Germany. Cruse’s research focuses on insect locomotion including behavioural studies as well as software and hardware simulation on both the reactive and the cognitive level.
Wednesday, July 29th and Thursday, July 30th

POSTER SESSIONS 12:30 - 13:30

1. Improving recall in an associative neural network model of the hippocampus.  
Nikolaos Andreakos, Shigang Yue, Vassilis Cutsuridis

2. Biohybrid wind energy generators based on living plants.  
Fabian Meder, Marc Thielen, Giovanna Adele Naselli, Silvia Taccola, Thomas Speck, Barbara Mazzolai

Isabella Fiorello, Alessio Mondini, Barbara Mazzolai

Rémi Dromnelle, Erwan Renaudo, Guillaume Pourcel, Raja Chatila, Benoit Girard, Mehdi Khamassi

5. Can small scale search behaviours enhance large-scale navigation?  
Fabian Steinbeck, Paul Graham, Thomas Nowotny, Andrew Philippides

Franco Angelini, Matteo Bianchi, Manolo Garabini, Antonio Bicchi, Cosimo Della Santina

Simon Levy
8. Using the neural circuit of the insect central complex for path integration on an MAV.
Jan Stankiewicz, Barbara Webb

Lea Musiolek, Verena V. Hafner, Jens Krause, Tim Landgraf, David Bierbach

10. Split-belt Adaptation Model of a Decerebrate Cat Using a Quadruped Robot with Learning.
Kodai Kodono, Hiroshi Kimura

11. Evaluation of possible flight strategies for close object evasion from bumblebee experiments.
Andreas Thoma, Alex Fisher, Olivier Bertrand, Carsten Braun

Jie Fan, Francesco Visentin, Emanuela Del Dottore, Barbara Mazzolai

Vasiliki Vouloutsi, Anna Chesson, Maria Blancas, Oscar Guerrero, Paul Verschure

Ismael Tito Freire González, Dina Urikh, Xerxes Arsiwalla, Paul Verschure

15. Response of a neurodynamical insect joint model to inhibition of fCO sensory afferents.
Clarissa Goldsmith, Nicholas Szczecinski, Roger Quinn

Fletcher Young, Alexander Hunt, Hillel Chiel, Roger Quinn
17. Integrated Topological Planning and Scheduling for Orchestrating Large Human-Robot Collaborative Teams.
Ioannis Chatzikonstantinou, Ioannis Kostavelis, Dimitris Giakoumis, Dimitrios Tzovaras

18. Efficient fine-grained object detection for robot-assisted WEEE disassembly.
Ioannis Athanasiadis, Athanasios Psaltis, Apostolos Axenopoulos, Petros Daras

Connor Morrow, Ben Bolen, Alexander Hunt

20. Bioinspired Navigation Based on Distributed Sensing in the Leech.
Sebastian Nichols, Catherine Kehl, Brian Taylor, Cynthia Harley

Marshaun Fitzpatrick, Yangyang Wang, Peter Thomas, Roger Quinn, Nicholas Szczecinski

22. Insect inspired view based navigation exploiting temporal information.
Efstathios Kagioulis, Andrew Philippides, Paul Graham, James C. Knight, Thomas Nowotny

23. A plausible mechanism for Drosophila Larva intermittent behavior.
Panagiotis Sakagiannis, Miguel Aguilera, Martin Paul Nawrot

Alejandro Jimenez Rodriguez, Robert Schmidt, Tony Prescott, Stuart Wilson
Oscar Guerrero Rosado, Paul Verschure

Adrián Fernández Amil, Jordi-Ysard Puigbò Llobet, Paul Verschure

27. Kinematic and Kinetic Analysis of a Biomechanical Model of Rat Hind Limb with Biarticular Muscles.
Kaiyu Deng, Nicholas Szczecinski, Alexander Hunt, Hillel Chiel, Roger Quinn

Anna Sedlackova, Nicholas Szczecinski, Roger Quinn

29. Robophysical modeling of bilaterally activated and soft limbless locomotors.
Perrin Schiebel, Marine Maisonneuve, Kelimar Diaz, Jennifer Rieser, Daniel Goldman
Conference Chair
Thomas Speck (University of Freiburg, Germany)
Paul Verschure, (IBEC; ICREA, Spain)

Program chair
Vicky Vouloutsi (IBEC, BIST, Spain)

Workshops chair
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We hope to see you next year at

Living Machines

The 10th International Conference on Biomimetic and Biohybrid Systems