



Ca' Foscari
University
of Venice



ECLT | Christmas Lecture 2021

Physical Intelligence of Small-scale Robots and Organisms



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Introduction

Prof. Achille Giacometti
Ca' Foscari University of Venice

Discussants:

Prof. Marcello Pelillo
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Prof. Luc Steels

ICREA Research Professor at the
Institute for Evolutionary Biology
(CSIC,UPF)

**20th
December
2021** h 2:30 PM

Hybrid, at Ca' Bottacin
Calle Crosera, Dorsoduro 3911,
Venice and online (zoom)



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Abstract

Intelligence of physical agents, such as human-made (e.g., robots, autonomous cars) and biological (e.g., animals, plants) ones, is not only enabled by their **computational intelligence (CI)** in their brain, but also by their **physical intelligence (PI)** encoded in their body. Therefore, it is essential to advance the PI of human-made agents as much as possible, in addition to their CI, to operate them in unstructured and complex real-world environments like the biological agents. This presentation gives a perspective on what PI paradigm is, when PI can be more significant and dominant in **physical and biological agents** at different length scales and how **bioinspired** and **abstract PI methods** can be created in agent bodies. PI paradigm aims to synergize and merge many research fields, such as **mechanics, materials science, robotics, mechanical design, micro/nanotechnology, fluidics, optics, active matter, biology, self-assembly and collective systems**, to enable advanced PI capabilities in human-made agent bodies, comparable to the ones observed in biological organisms. Such capabilities would progress the **future robots** and other **machines** beyond what can be realized using the current frameworks. In addition to general discussions about PI, this talk will include many case studies from various novel small-scale robots and biological organisms, where PI is dominant or the only solution. Especially, **bio-inspired soft-bodied miniature robots** are presented as new **multifunctional, adaptive and shape-programmable multilocomotion systems** to operate in **complex environments**, such as inside the human body towards future medical applications.

Short Bio

Prof. Metin Sitti is the director of **Physical Intelligence Department at Max Planck Institute for Intelligent Systems in Stuttgart, Germany**. He is also a professor at ETH Zurich, Switzerland and Koç University, Turkey. He was a professor at Carnegie Mellon University (2002-2014) and a research scientist at UC Berkeley (1999-2002) in USA. He received BSc and MSc degrees (1994) in electrical and electronics engineering from Boğaziçi University, Turkey, and PhD degree in electrical engineering from University of Tokyo, Japan (1999). His research interests include physical intelligence, small-scale mobile robotics, bio-inspiration, and wireless medical robots. He is an IEEE Fellow. As selected awards, he received the Breakthrough of the Year Award in the Falling Walls World Science Summit 2020, ERC Advanced Grant in 2019, Rahmi Koç Science Medal in 2018, SPIE Nanoengineering Pioneer Award in 2011, and NSF CAREER Award in 2005. He received over 15 best paper and video awards in major journals, conferences, including the Best Paper Award in the Robotics Science & Systems Conference in 2019 and the Cozzarelli Prize Finalist in the PNAS journal in 2020. He is the editor-in-chief of Progress in Biomedical Engineering and Journal of Micro-Bio Robotics and associate editor in Science Advances and Extreme Mechanics Letters journals.