Fabian Meder · Alexander Hunt ·
Laura Margheri · Anna Mura ·
Barbara Mazzolai (Eds.)

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Biomimetic and Biohybrid Systems

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Genoa, Italy, July 10–13, 2023
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Fabian Meder · Alexander Hunt ·
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Editors

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Preface

These proceedings contain the papers presented at the 12th International Conference on Biomimetic and Biohybrid Systems (Living Machines 2023) in Genoa, Italy, July 10–13, 2023. The international conferences in the Living Machines series focus on the intersection of research on novel life-like technologies inspired by the scientific investigation of biological systems, biomimetics, and research that seeks to interface biological and artificial systems to create biohybrid systems. The conference aims to highlight the most exciting research in both fields united by the theme of "Living Machines."

Gaining a deep understanding of the essence of life is an essential prerequisite for advancing artificial technology. There are two fundamental principles to consider. Firstly, technology should serve life and living beings. Its development should aim to improve the well-being and quality of life of all living organisms. Secondly, as researchers, our primary objective should be the development of sustainable technologies that harmoniously integrate with Earth's ecosystems and the inherent life within them. The escalating environmental pollution and resulting climate changes pose significant challenges that must be addressed. This situation presents humanity with an unprecedented and monumental challenge, arguably the greatest we have ever encountered. As researchers, it is imperative for us to look deeper into how living systems solve issues and explore ways to translate these solutions into technology.

By studying and emulating the strategies and mechanisms found in living systems, we can strive to develop innovative technologies that are not only efficient and functional but also environmentally friendly and sustainable. This approach requires a multidisciplinary effort, combining knowledge from biology, ecology, engineering, and other relevant fields. The Living Machines conference embodies and promotes this vision by bringing together researchers from various disciplines such as engineering, biology, computational science, and materials science. These researchers propose technical solutions that draw inspiration from a wide range of biological mechanisms found in nature. These mechanisms span from the nervous system to motion, sensing, and materials in plants and animals. The conference also encompasses biohybrid systems, where artificial technology directly interacts with biological systems.

The Living Machines conference series was first organized by the Convergent Science Network (CSN) of biomimetic and biohybrid systems to provide a mechanism for ensuring this communication. It is a focal point for gathering world-leading researchers and the presentation and discussion of cutting-edge research at the boundary of biology and engineering. This year's Living Machines conference upheld this esteemed legacy by showcasing biologists and engineers who have dedicated their careers to advancing biomimetic and biohybrid systems. Furthermore, the event provides an opportunity to introduce and support numerous young researchers in this rapidly expanding field. This emphasis on nurturing emerging talent ensures continued growth and innovation within the realm of biomimetics and biohybrid systems.

The papers in these proceedings encompass the research submissions to the conference, and from these submissions, a careful selection was made for oral and poster presentations. The articles underwent rigorous evaluation, with an average of 2.7 reviewers per paper, conducted in a single-blind review process. A total of 66 papers were received, and the acceptance rate for publication in the proceedings was 87%. This indicates that a significant portion of the submitted research met the standards set by the conference organizers and reviewers. Moreover, the 180 reviewers who contributed to the evaluation provided authors with detailed comments, typically offering comprehensive suggestions rather than brief, superficial responses. To illustrate the depth of the review process, one article received over 100 comments from a reviewer. This level of engagement demonstrates the commitment of the reviewers to support the authors by offering valuable suggestions for improving their work. Following revisions, most papers underwent a second round of review. The meticulous evaluation and revision process ensures that the papers included in these proceedings represent a high standard of research in the field of biomimetic and biohybrid systems.

The main conference was a three-day in-person meeting with single-track oral presentations and six plenary talks taking place in Genoa, Italy, preceded by a one-day event with four workshops and four tutorials. The conference venue, the Aquarium of Genoa, was selected to further underline the importance of life for the conference where the participants were surrounded by over 800 animal and vegetal species and over 15000 living specimens in one of Europe's biggest aquariums. This setting added an immersive and enriching dimension to the conference, aligning with its focus on biomimetic and biohybrid systems. The plenary speakers were Peter Fratzl (Max Planck Institute of Colloids and Interfaces, Germany), Eleni Stavrinidou (Linköping University, Sweden), Marco Dorigo (Université Libre de Bruxelles, Belgium), Oussama Khatib (Stanford University, USA), Kyu-Jin Cho (Seoul National University, South Korea), and Olga Speck (University of Freiburg, Germany). Session themes included: Bioinspired materials, actuators, sensors I+II; Human-robot interaction, rehabilitation and learning; Joints and muscles; Biohybrid systems and interactions; Invertebrate locomotion and perception mechanisms; Computational tools and modelling; Bioinspiration under water; and Biomimetics analyzed. Additionally, a Science Café was organized on "Living Machines: the Origin and the Future" that was open to the public and moderated by Nicola Nosengo, Chief Editor, Nature Italy.

We wish to thank the many people that were involved in making Living Machines 2023 possible. The conference would not have been possible without the dedication, efforts, and support of numerous individuals. Additional guidance and support were provided by the Living Machines International Advisory Board. We would also like to thank the authors and speakers who contributed their valuable work to the conference. A significant acknowledgment goes to the reviewers who dedicated their time and expertise. Lastly, we would like to express our gratitude to the volunteers, sponsors, and all other

individuals who contributed their time, resources, and support to ensure the smooth running of Living Machines 2023.

June 2023

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