



## FULL-DAY WORKSHOP

### ***Soft-bodied structures in nature and robotics: towards new trends and opportunities***

#### ORGANIZERS

<p>Barbara Mazzolai <i>Director</i> <i>Center of Micro-BioRobotics (CMBR)</i> <i>Istituto Italiano di Tecnologia (IIT)</i> <i>Viale Rinaldo Piaggio 34</i> <i>56025 Pontedera (Pisa), Italy</i></p>	<p>Robert Shepherd <i>Professor</i> <i>Mechanical &amp; Aerospace Engineering</i> <i>The Organic Robotics Lab (ORL)</i> <i>Cornell University</i> <i>553 Upson Hall</i> <i>Ithaca, NY</i></p>
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#### ABSTRACT

The study and the extraction of biological key principles, and their translation in design guidelines for a new generation of robots and technological solutions, have been widely adopted in the biomimetics and bionics fields.

Biologically inspired approaches have traditionally been widely adopted in robotics, as well. Robots that implement solutions inspired by nature show capabilities that permit adaptive, flexible interactions with unpredictable environments. Consequently, in the goal to mimic living beings, the different components of an artificial system have to be designed from models of the reference biological systems, in an integrated way, making explicit the general design principles underlying the embodiment. The next generation of robots will be “soft”, because this better allows the interaction with environment, mediated by body, as in natural systems. Advances in “soft technology” will lead to a quantum leap in intelligent robotics.

With this workshop, we wish to contribute to the discussion on the development of bioinspired soft robots, not just as robotic systems implementing solutions inspired by nature, but as platforms for biological studies: building a bioinspired robot allows thoroughly understanding the biomechanics, control, perception, and behavior of the reference living system. Mimicking animals, or plants and even microorganisms, requires deep investigation of new materials, bio-mechanisms, sensors, actuators, and control schemes and can lead to breakthrough advances of robotics technologies.

## **DESCRIPTION**

The proposed workshop aims at gathering robotics, biology, biophysics, and biomechanics researchers among the key actors of bioinspired soft robotics worldwide, with the objectives of:

- stimulating a fruitful and attractive discussion on this emerging scientific area, not only restricted to the robotics community, but expanded to include interaction with the biology, materials science, biophysics communities;
- providing an authoritative overview of recent advancements in studying features (e.g., materials, behaviors, mechanisms, etc.) of selected living systems belonging to Animalia, Plantae, Bacteria Kingdoms and their related counterparts in soft robotics;
- creating an occasion in which scientists and roboticists can offer different perspectives and viewpoints in developing a new class of soft robots, which exhibit different performance compared with today's robots, in terms of materials, fabrication technologies, machine and natural intelligence, sensors and actuators;
- discussing the role of dimensional scale, interaction with environment, morphology, materials hierarchical organization, and other features relevant to define new emerging abilities of soft robots;
- outlining the current opportunities and challenges of bioinspired robotics.

## **PLAN TO SOLICIT PARTICIPATION**

Several activities will be undertaken to solicit participation in the workshop. First of all, the goal will be to attract biologists, roboticists, material scientists, and other scientists that work in the field of biomimetics, soft and bioinspired robotics, but also industrial players and potential users, interested in different perspectives and viewpoints in developing a new class of biomimetic robots, which exhibit different performance compared with the today's robots, in terms of materials, fabrication technologies, sensors and actuators. This will be made by disseminating the workshop and its goals using mailing lists of different scientific sectors, as well as a dedicated web site, social accounts (Twitter, Youtube, etc), and leaflets.

## **PLAN TO ENCOURAGE INTERACTION AMONG PARTICIPANTS**

The workshop will include a panel discussion open to all the attendees. The workshop speakers and additional experts will animate the discussion, by briefly presenting key issues that deserve further analysis and interdisciplinary debate.

The proposed workshop is intended for the robotics researchers and the scientists who share this vision of bioinspired soft robotics, including the young students and researches who are encouraged to enter this emerging and challenging field of research.

The novelty of the area and the multidisciplinary approach will stimulate creativity and interactions among participants, with the potentiality of a strong impact for different topics in engineering, ICT solutions, and basic science.

## EQUIPMENT

Invited speakers will be asked to take their own laptop. No special equipment will be required.

## INVITED SPEAKERS

#	Name	Affiliation	Country	Status
<i>in alphabetical order</i>				
1	Antonio De Simone	SISSA	Italy	Confirmed
2	Peer Fischer	Max Planck	Germany	Confirmed
3	Peter Fratzl	Max Planck	Germany	Confirmed
4	Daniel Goldman	Georgia Institute of Technology	USA	Confirmed
5	José Halloy	Université Denis Diderot	France	Confirmed
6	Roger Hanlon	Marine Biological Laboratory	USA	Confirmed
7	Mirko Kovac	Imperial College	England	Confirmed
8	Rebecca Kramer	Yale University	USA	Confirmed
9	Barbara Mazzolai	Istituto Italiano di Tecnologia	Italy	Confirmed
10	Paolo Milani	University of Milan	Italy	Confirmed
11	Bradley Nelson	ETH	CH	Confirmed
12	Kirstin Petersen	Cornell University	USA	Confirmed
13	Nicola Pugno	University of Trento	Italy	Confirmed
14	Yasmine Meroz	Tel Aviv University	Israel	To be confirmed
15	Robert Shepherd	Cornell University	USA	Confirmed
16	Metin Sitti	Max Planck	Germany	Confirmed

## TENTATIVE PROGRAM

**FROM LIVING BEINGS TO ARTEFACTS: SOFT ROBOTS, MATERIALS, ADAPTIVE BEHAVIOR,  
MOVEMENT, AND CONTROL IN ANIMALIA, PLANTAE, AND BACTERIA**

TIME	SPEAKER	TOPICS
09:00 - 09:10	Barbara Mazzolai & Robert Shepherd	<i>Welcome and introduction</i>
<b><i>Animalia</i></b>		
09:10 – 09:35	Robert Shepherd	<i>Animal models in soft robotics</i>
09:35 – 10:00	Daniel Goldman	
10:00 – 10:25	Nicola Pugno	
10:25 – 10:50	Kirstin Petersen	
10:50 - 11:15	<i>coffee break</i>	
11:15– 11:40	Roger Hanlon	<i>Animal models in soft robotics</i>
11:40 – 12:05	Mirko Kovac	
12:05 – 12:30	Rebecca Kramer	
12:30 – 13:45	<i>Lunch &amp; Discussion</i>	
<b><i>Plantae</i></b>		
13:45 – 14:10	Barbara Mazzolai	<i>Plant models in soft robotics</i>

14:10 – 14:35	Peter Fratzl	
14:35 – 15:00	Yasmine Meroz	
15:00 – 15:25	José Halloy	
15:25 – 15:55	<i>Coffee break &amp; Discussion</i>	
<b>Bacteria</b>		
15:55 – 16:20	Metin Sitti	<i>Microorganism models in soft robotics</i>
16:20 – 16:45	Antonio De Simone	
16:45 – 17:10	Bradley Nelson	
17:10 – 17:35	Peer Fisher	
17:35 – 18:00	Paolo Milani	
18:00 – 18:15	Concluding remarks and end of the workshop	