RoboSoft

FP7 ICT-2013.9.1 Future and Emerging Technologies FET-Open Coordination Action

Soft Robotics Week

April 25-30, 2016

Livorno, Italy

Event Guide

Soft Robotics
Mary Ann Liebert, Inc. publishers

The BioRobotics Institute
Scuola Superiore Sant'Anna

frontiers in Robotics and AI

2016 Soft Robotics Week at a glance

April 25-30, 2016 - Livorno, Italy

Events

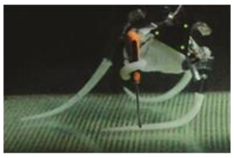
RoboSoft Spring School
April 25-29, 2016

Lectures and practical sessions, with invited speakers presenting technical and scientific issues related to the design and development of soft robots in different application fields and discussing with students to solve major challenges.

RoboSoft Plenary Meeting
April 27-28, 2016

A two-day workshop with plenary talks and panel discussions will involve the members of the RoboSoft Community, industrial stakeholders, external experts working in the field of soft robotics and related disciplines, and the students participating in the School.

RoboSoft Grand Challenge
April 29-30, 2016



The first outdoor challenge for soft robots organized with different scenarios and tasks where soft robots will compete using their resilience, their capability to pass through small apertures, their ability to move on uneven terrains and their capability of dextrous manipulation.

Themes

- Soft robots legged locomotion
- Soft robots manipulation
- Underwater soft robots
- Biomimetic soft robots
- Wearable soft robots
- Flying soft robots

- Plant-inspired soft robots
- Micro-soft robots
- Assistive soft robots
- Soft robots in rehabilitation
- Soft robots in endoscopy
- Soft robotics prostheses & organs
- Edutainment soft robots

Organizers

Cecilia Laschi, RoboSoft Coordinator
The BioRobotics Institute
Scuola Superiore Sant'Anna, Pisa
Fumiya Iida,
University of Cambridge, ETH Zurich
Jonathan Rossiter, University of Bristol
Helmut Hauser, University of Bristol
Matteo Cianchetti, The BioRobotics Institute
Scuola Superiore Sant'Anna, Pisa
Laura Margheri, The BioRobotics Institute
Scuola Superiore Sant'Anna, Pisa

Venue

Spring School and Plenary Meeting
Grand Hotel Palazzo
(Viale Italia, 195)

Grand Challenge
Bagni Pancaldi
(Viale Italia, 56)

www.robosoftca.eu/information/events/soft-robotics-week-2016

Program of the week

Monday 25, 2016

Spring School

Time	Lecture/activity		Location
9:00 – 9:30	***Registration***		Grand Hotel Palazzo Lobby
9:30 – 9:50	**Cecilia Laschi** *The BioRobotics Institute, RoboSoft Coordinator*	Welcome and introductory notes	Grand Hotel Palazzo Sala degli stucchi
9:50 – 10:30	**Mahmoud Tavakoli** *University of Coimbra*	Soft bionic hands	Grand Hotel Palazzo Sala degli stucchi
10:30 – 11:00	***Break***		
11:00 – 11:40	**Rob Scharff** *Delft Robotics Institute*	Additive manufacturing for soft robotic behaviour design	Grand Hotel Palazzo Sala degli stucchi
11:40 – 12:20	**Marcello Calisti** *The BioRobotics Institute*	Soft robotics in underwater legged locomotion: from octopus-inspired solutions to running robots	Grand Hotel Palazzo Sala degli stucchi
12:20 – 13:00	**Fumiya Iida** *University of Cambridge*	Design principles for self-organizing soft robots	Grand Hotel Palazzo Sala degli stucchi
13:00 – 14:30	***Break***		
14:30 – 15:10	**Francesco Dal Corso** *University of Trento*	Configurational forces in structures: elastica arm scale and torsional locomotion	Grand Hotel Palazzo Sala degli stucchi
15:10 – 18:30	***Students working groups***		Grand Hotel Palazzo Sala degli stucchi
19:00 – 20:30	***Welcome cocktail by RoboSoft***		Baracchina "Il Delfino"

Tuesday 26, 2016

Spring School

Time	Lecture/activity		Location
9:00 – 9:40	**Francesco Giorgio-Serchi** *Southampton Marine and Maritime Institute*	Underwater soft robotics, the benefit of body-shape variations in aquatic propulsion	Grand Hotel Palazzo Sala degli stucchi
9:40 – 10:20	**Jonathan Rossiter** *University of Bristol*	Eating, drinking, living, dying and decaying soft robots	Grand Hotel Palazzo Sala degli stucchi
10:20 – 11:00	**Alice Tonazzini** *EPFL, Laboratory of Intelligent Systems*	Variable stiffness materials	Grand Hotel Palazzo Sala degli stucchi
11:00 – 11:30	***Break***		
11:30 – 12:10	**Christian Duriez** *Institut National de Recherche en Informatique et Automatique – Lille*	Soft-robot modeling and simulation	Grand Hotel Palazzo Sala degli stucchi
12:10 – 12:50	**Thor Bietze** *Institut National de Recherche en Informatique et Automatique – Lille*	Constraint space kinematic model of deformable manipulators: application to close-loop position control	Grand Hotel Palazzo Sala degli stucchi
12:50 – 13:30	**Francesco Corucci** *The BioRobotics Institute*	Evolutionary soft robotics: towards adaptive and intelligent machines following nature's approach to design	Grand Hotel Palazzo Sala degli stucchi
13:30 – 14:30	***Break***		
14:30 – 15:10	**Helmut Hauser** *University of Bristol*	Morphosis – taking morphological computation to the next level	Grand Hotel Palazzo Sala degli stucchi
15:10 – 19:00	***Students working groups***		Grand Hotel Palazzo Sala degli stucchi

Wednesday 27, 2016

Plenary Meeting

Time	Lecture/activity		Location
9:00 – 9:20	Welcome addresses by the Mayor of the city of Livorno, by the Rector of the Scuola Superiore Sant'Anna and by the RoboSoft EC Project Officer		Grand Hotel Palazzo Sala Marconi
9:20 – 10:00	**Cecilia Laschi** *The BioRobotics Institute, RoboSoft Coordinator*	Opening of the RoboSoft Plenary Meeting	Grand Hotel Palazzo Sala Marconi
10:00 – 10:40	**Barbara Mazzolai** *Center for Micro-BioRobotics IIT@SSSA*	Plant-inspired soft robots	Grand Hotel Palazzo Sala Marconi
10:40 – 11:20	**Lucia Beccai** *Center for Micro-BioRobotics IIT@SSSA*	Soft robotics artificial touch	Grand Hotel Palazzo Sala Marconi
11:20 – 11:50	***Coffee break by RoboSoft***		Grand Hotel Palazzo Sala Marconi
11:50 – 12:30	**Kyu-Jin Cho** *Seoul National University*	Soft bio-inspired robots with physically Embodied Intelligence	Grand Hotel Palazzo Sala Marconi
12:30 – 13:00	***Plenary discussion on RoboSoft achievements and future legacy***		Grand Hotel Palazzo Sala Marconi
13:00 – 14:30	***Lunch break by RoboSoft***		Grand Hotel Palazzo Sala Marconi
14:30 – 15:10	**Mirko Kovac** *Imperial College of Science, Technology and Medicine*	Bio-inspired soft aerial robots: adaptive morphology for high-performance flight	Grand Hotel Palazzo Sala Marconi
15:10 – 16:10	***Robotics Challenges: experiences and perspectives*** *(Gabriele Ferri, Federico Renda, Cecilia Laschi)*		Grand Hotel Palazzo Sala Marconi
16:30	***Technical tour at the BioRobotics Institute (Pontedera) and Center for Micro-BioRobotics IIT@SSSA (Pontedera) OR visit to the Museo Fattori at Villa Mimbelli (walking distance)***		Bus to Pontedera leaves in front of the Grand Hotel Palazzo
20:30	***RoboSoft Social Dinner***		Ristorante Granduca, Livorno

Thursday 28, 2016

Plenary Meeting

Time	Lecture/activity		Location
9:00 – 9:40	**Metin Sitti** *Max Planck Institute for Intelligent Systems*	Soft mobile milli/microrobotics	Grand Hotel Palazzo Sala Marconi
9:40 – 10:20	**Barry Trimmer** *Tufts University*	Non-pneumatic, biomimetic, soft robots	Grand Hotel Palazzo Sala Marconi
10:20 – 11:00	**Arianna Menciassi & Matteo Cianchetti** *The BioRobotics Institute*	Soft robots in surgery	Grand Hotel Palazzo Sala Marconi
11:00 – 11:30	***Coffee break by RoboSoft***		Grand Hotel Palazzo Sala Marconi
11:30 – 12:45	***Panel discussion on soft robotics*** ***Chair: Paolo Dario*** *(The BioRobotics Institute)*		Grand Hotel Palazzo Sala Marconi
12:45 – 13:00	***Closing of the RoboSoft Plenary Meeting***		Grand Hotel Palazzo Sala Marconi
13:00 – 14:30	***Lunch break***		
14:30 – 18:00	***Students working groups***		

Friday 29, 2016

Spring School/Grand Challenge

Time	Lecture/activity	Location
9:00 – 9:15	**Cecilia Laschi** *The BioRobotics Institute, RoboSoft Coordinator* Introduction	Bagni Pancaldi
9:15 – 11:00	**Students teasers on the working group projects**	Bagni Pancaldi
11:00 – 12:00	***Soft Robots Competition (working group projects evaluation)***	Bagni Pancaldi
12:00 – 13:00	***Award and closing of the RoboSoft School***	Bagni Pancaldi
13:00 – 14:30	***Lunch break by RoboSoft***	
14:30 – 15:00	***Briefing on the RoboSoft Grand Challenge for the Teams***	Bagni Pancaldi
15:00 – 18:00	***RoboSoft Grand Challenge: Test drive***	Bagni Pancaldi

Saturday 30, 2016

Grand Challenge

Time	Lecture/activity	Location
9:00 – 9:30	***Opening of the RoboSoft Grand Challenge***	Bagni Pancaldi
9:30 – 13:00	***Grand Challenge: Manipulation competition and Terrestrial race***	Bagni Pancaldi
13:00 – 14:00	***Lunch break by RoboSoft***	
14:00 – 16:00	***Grand Challenge: Manipulation competition and Terrestrial race***	Bagni Pancaldi
16:30 – 17:00	***Grand Challenge Awards Ceremony***	Bagni Pancaldi

Speakers and Abstracts

Monday 25, 2016

Cecilia Laschi
The BioRobotics Institute, Scuola Superiore Sant'Anna, Italy

Prof. Cecilia Laschi is Full Professor of Biorobotics at the BioRobotics Institute of the Scuola Superiore Sant'Anna in Pisa, Italy, where she serves as Rector's delegate to Research. She graduated in Computer Science at the University of Pisa in 1993 and received the Ph.D. in Robotics from the University of Genoa in 1998. In 2001-2002 she was JSPS visiting researcher at Waseda University in Tokyo. Her research interests are in the field of biorobotics and she is currently working on soft robotics, humanoid robotics, and neurodevelopmental engineering. Among the projects she has been involved in, it is worth mentioning that she was the coordinator of the European ICT-FET OCTOPUS Integrating Project, leading to one of the first soft robots, and she coordinates the European ICT-FET Open Coordination Action on Soft Robotics RoboSoft. She is Chief Editor of the Specialty Section on Soft Robotics of *Frontiers in Robotics and AI* and of *Frontiers in Bionics and Biomimetics* and she is in the Editorial Board of *Bioinspiration&Biomimetics*, *Robotics and Automation Letters*, *Frontiers in Bionics and Biomimetics*, *Applied Bionics and Biomechanics*, *Advanced Robotics*. She is member of the IEEE, of the Engineering in Medicine and Biology Society, and of the Robotics & Automation Society, where she served as elected AdCom member and currently is Co-Chair of the TC on Soft Robotics.

Mahmoud Tavakoli
University of Coimbra, Portugal

Dr. Mahmoud Tavakoli received a PhD in Robotics from University of Coimbra, Portugal (2010). He is the core member of Institute of Systems and Robotics and coordinator of the Romela-UC lab, and invited researcher in Scuola Superiore Sant'Anna, Italy. He is CEO of Soft Bionics(www.soft-bionics.com) and the core member of the PAMI network (Portuguese Additive Manufacturing Network-Research Infrastructure) in which his role is to promote additive manufacturing for Biomedical applications. He is the author of more than 50 articles in International Journals and top ranking conferences. Dr. Tavakoli is the PI of the International CMU-Portugal project of Soft MEMS skin, and the co-PI of the ERI CMU-Portugal project on additive manufacturing of soft electronics, where he is closely cooperating with the Soft Machines Laboratory of the Carnegie Mellon University on subjects related with the characterization and fabrication of soft electronics for wearable technology, including an electronic skin for soft bionic hands. His current research goals are fabrication and optimization of Soft MEMS (sensors, actuators), 3D printing of stretchable electronics, soft and adaptive grasping mechanisms and all integrated bionic hands.
ORCID Profile: http://orcid.org/0000-0002-2590-2196
Laboratory Website: https://sites.google.com/site/fsrlabisr/

"Soft bionic hands"

Integration of compliance into Robotics hands proved to be advantageous due to the better adaptability of the hand in grasping various shape and range of the objects. In this talk, an overview of soft bionic hands, such as the ISR-Softhand, and the UC-Softhand will be presented. It is well-known that the number of inputs that EMG signals can provide is usually not sufficient for controlling the complex prosthetic hands with many actuators. It will be described how integration of the compliance, contributes in grasping a wide range of objects with minimum number of control inputs.
The second part of this talk will focus on the current attempts on fabrication of electronic skin and its integration into soft bionics hands. This is a step toward adding a rich sense of touch in a way never experienced before. We discuss fabrication of a bionic soft finger with an "all-integrated" approach that resembles very much a human finger.

Rob Scharff

Delft Robotics Institute, The Netherlands

Rob Scharff is part of the Soft Robotics research group at the faculty of Industrial Design Engineering at Delft University of Technology in the Netherlands. This research group, a collaboration between the chairs of Advanced Manufacturing and Mechatronics, focuses on the additive manufacturing of Soft Robotics for improving Human-Robot Interaction. Meta- and multi-material printing enable the group to take inspiration from complex structures found in nature and translate them to functionalities in Soft Robotics. As a demonstrator of the group's vision, Rob developed a 3D-printed and bio-inspired soft robotic hand that can shake people's hands. His goal is to implement this technology in customized orthotics, customized grasping applications, and expressive robots.

"Additive manufacturing for soft robotic behaviour design"

Additive manufacturing provides designers unparalleled freedom in geometry and material distribution. Meta- and multi-material printing allows designers to create local variations in material behaviour within a single product. These variations in material behaviour can be combined with actuation methods to realize complex motions in soft robotics. This way, designing soft robotic behaviour is no longer limited to making use of existing components, but can be deeply embedded in the design of the robot's actuators, sensors and structure. This opens up a whole new world of possibilities for innovative soft robotic products with customized human-machine behaviour. Research projects include (1) a multi-material soft robotic gripper that uses an internal composite structure to create desired bending behaviour, (2) an active soft robotic hand with integrated actuators and sensors, and (3) a customized prosthetic socket that adapts to the daily volume changes of the human limb using meta-materials.

Marcello Calisti

The BioRobotics Institute, Scuola Superiore Sant'Anna, Italy

Dr. **Marcello Calisti** received the BSc in Mechanical Engineering from University of Perugia on 2005, the MSc in Biomedical Engineering from University of Firenze on 2008, and the PhD degree in Biorobotics from Scuola Superior Sant'Anna in 2012. He is a post-doctoral fellow at the BioRobotics Institute of SSSA. He collaborated in European Projects, such as OCTOPUS IP, and in National Projects, such as PoseiDRONE, while he is currently involved in the European Coordination Action RoboSoft and in the ECSEL project SWARMs. He is author or co-author of more than 20 peer-reviewed papers and his research interests are related to the locomotion of soft robots (with specific focus on underwater legged locomotion) and computer vision. He is a member of the IEEE since 2008.

"Soft robotics in underwater legged locomotion:
from octopus-inspired solutions to running robots"

Seas and oceans are becoming the future target for companies searching for new resources or harvesting renewable energy, as well as its scientific and archaeological exploration is progressively expanding toward new, more extreme frontiers. Nowadays more than ever, underwater robots are required to perform highly challenging endeavors in forbidding scenarios. My personal research line proposes a new approach in underwater robot operations: by including compliance and legs on underwater robots, underwater legged robotics (ULR) wants to exploit the contact rather than maintaining all the time a safe distance from the environment (in order to avoid being damaged or causing damage). By merging legged robotics, soft robotics and underwater robotics, a whole new spectrum of applications will be at hand (like seabed observation, in situ sampling of benthos, inside-ship wreckage explorations, archaeological surveys and cleaning, etc...), while traditional underwater operations such as pipeline maintenance and inspection, structures surveillance, off-shore platform inspection, public safety diving and many more will be improved. This presentation will range from the very beginning of my experience on underwater legged robotics, to the last advancement recently published. To begin with, bio-inspired approaches were followed to extract fundamental principles from octopuses to copy the dexterity and softness of their arms. By taking as a reference those biological findings, a multi-arm soft robot with crawling and grasping capabilities was developed. Refined versions of the robot were designed by using evolutionary design tools: the simple actuation strategy used for crawling locomotion was kept unchanged, while we varied the robot morphology and we collected the different behaviors. Finally, with respect to previous works which focused on replicating biological solutions, my efforts are currently directed toward the investigation of a simple yet successful model to describe underwater legged locomotion. This research is related to the investigation of more abstract, fundamental principles of underwater legged locomotion (where biological solutions can be included into), and to the formalization of a fundamental model. My approach is based on the dynamical system analysis of a volumetric body with concentrated mass, attached to a compliant leg which pushes the ground. By numerical and analytical-approximate solutions, quantitative advantages of this locomotion can be demonstrated. The ambition of this research is to provides the starting point into the design and development of a new generation of underwater vehicles.

Fumiya Iida
University of Cambridge, UK

Fumiya Iida is a university lecturer at Department of Engineering, University of Cambridge. He received his bachelor and master degrees in mechanical engineering at Tokyo University of Science (Japan, 1999), and Dr. sc. nat. in Informatics at University of Zurich (Switzerland, 2006). In 2004 and 2005, he was also engaged in biomechanics research of human locomotion at Locomotion Laboratory, University of Jena (Germany). From 2006 to 2009, he worked as a postdoctoral associate at the Computer Science and Artificial Intelligence Laboratory, Massachusetts Institute of Technology in USA. In 2006, he awarded the Fellowship for Prospective Researchers from the Swiss National Science Foundation, and in 2009, the Swiss National Science Foundation Professorship hosted by ETH Zurich. In 2014 he moved to the University of Cambridge as the director of Bio-Inspired Robotics Laboratory. His research interest includes biologically inspired robotics, embodied artificial intelligence, and biomechanics, where he was involved in a number of research projects related to dynamic legged locomotion, navigation of autonomous robots, human-machine interactions, and self-reconfigurable soft robots. URL: http://divf.eng.cam.ac.uk/birl/

"Design principles for self-organizing soft robots"

Soft deformable robots have a large number (if not infinity) of degrees of freedom, thus motion control of them should always consider exploiting self-organization of mechanical bodies in one way or the other. In my talk, I would like to introduce design principles of soft robot motion control that we have been exploring in our laboratory, and discuss what are the challenges and perspectives.

Francesco Dal Corso
Department of Civil, Environmental and Mechanical Engineering,
University of Trento, Italy

Francesco Dal Corso is Assistant Professor of Solid and Structural Mechanics at University of Trento. After graduating in Civil Engineering at the University of Trento in 2005, he was awarded a Ph.D. in Solid Mechanics from the University of Trento in 2009. He spent one year as a Post-Doc at University of Cambridge in 2009. His research activity deals with problems in the field of the Mechanics of Solids and Structures related to configurational mechanics, stability, large deformations, stress concentrations and singularities, contact mechanics, homogenization.

"Configurational forces in structures: elastica arm scale and torsional locomotion"

Configurational mechanics is a theoretical framework introduced to explain motion of dislocations, phases, and, more in general, defects in solids [1]. This framework is extended to structural mechanics by

considering a (smooth and bilateral) movable constraint. Due to the energy change at varying the position of the movable constraint, a force driving the configuration of a structure is generated [2]. This configurational force, which can be derived both via variational calculus and, independently, through an asymptotic approach, is fully substantiated through experimental measures on a model structure.
This finding is exploited to develop two innovative devices: (i.) the 'elastica arm scale' [3], differing from the traditional rigid arm balance for the presence of flexible arms, and (ii.) the 'torsional gun' [4], a device providing torsional locomotion, namely, a propulsive force acting on a slender rod as the result of the application of a twisting moment.
Acknowledgement: Financial support from the ERC Advanced Grant 'Instabilities and nonlocal multiscale modelling of materials' FP7-PEOPLE-IDEAS-ERC-2013-AdG-340561-INSTABILITIES (2014-2019) is gratefully acknowledged.
References
[1] JD. Eshelby The continuum theory of lattice defects. In Progress in Solid State Physics 3 (eds. F. Seitz and D. Turnbull), Academic Press, New York, 1956.
[2] Bigoni, D., Dal Corso, F., Bosi, F. and Misseroni, D. (2015). Eshelby-like forces acting on elastic structures: theoretical and experimental proof. *Mechanics of Materials*, **80**, 368–374.
[3] Bosi, F., Misseroni, D., Dal Corso, F. and Bigoni, D. (2014). An elastica arm scale. *Proceedings of the Royal Society A*, **470**, 20140232.
[4] Bigoni, D., Dal Corso, F., Misseroni, D. and Bosi, F. (2014). Torsional locomotion. *Proceedings of the Royal Society A*, **470**, 20140599.

Tuesday 26, 2016

Francesco Giorgio-Serchi
Southampton Marine and Maritime Institute, UK

Dr. Francesco Giorgio-Serchi is currently appointed as a Lloyds Register Foundation Research Fellow at the Southampton Marine and Maritime Institute, within the Fluid-Structure-Interaction group. Previously he was a Postdoctoral Fellow at the Research Center on Sea Technologies and Marine Robotics in Livorno, Italy. He holds an MSc from the University of Pisa in Marine Sciences and a PhD in Computational Fluid Dynamics from the Centre for CFD of the University of Leeds, UK. From 2011 to 2014 he was awarded a European Marie Curie Reintegration Grant to study the propulsion of bioinspired soft-bodied aquatic vehicles. From 2013 to 2015 he was co-investigator in the PoseiDRONE project, a foundation grant sponsored research project the purpose of which was to develop a soft robotics platform for underwater operations. At present his work entails the coupled fluid-solid interaction of deformable bodies in dense water with the purpose of designing bioinspired aquatic vehicles with enhanced manoeuvrability and efficiency.

"Underwater soft robotics, the benefit of body-shape variations in aquatic propulsion"

Organisms travelling in water always exploit some degree of body-shape variations to propel themselves; this may occur in the form of flapping of fins, beating of tails or whole-body ondulatory motions. First systematic observation of the relationship between body kinematics and thrust production were reported for fish and jellyfish and more recently various contribution have addressed the role of body-shape changes in the unsteady propulsion within a rigorous mathematical frame.
Less studied, but of greater interest for the soft robotics community, is the case of those organisms which alter their body via volumetric pulsations or iso-volumetric cross sectional modifications. This is the case of squids and octopuses which, being for the most part devoid of prominent rigid parts, can perform extensive inflation and deflation of their bodies.
We will discuss how organisms which subject themselves to volume collapse during translation can benefit from burst of speeds. This is achieved by exploiting not only the expulsion of mass from their body, but also from the recovery of kinetic energy, otherwise dissipated by viscosity, via the variation of added mass. This

phenomenon has important implications in the design and control of soft-bodied underwater vehicles and marine energy harvesting devices.

Jonathan Rossiter
Bristol Robotics Laboratory, University of Bristol, UK

Jonathan Rossiter is Professor of Robotics at the University of Bristol, head of the Soft Robotics Lab at Bristol Robotics Laboratory and EPSRC research Fellow. His research includes soft robotic actuation, sensing and energy generation. Particular current focus is on wearable and implantable medical and assist devices and environmental autonomous robots, including biodegradable and edible soft robots.

"Eating, drinking, living, dying and decaying soft robots"

Soft robotics opens up a whole range of possibilities that go far beyond conventional rigid and electromagnetic robotics. New smart materials and new design and modelling methodologies mean we can start to replicate the operations and functionalities of biological organisms, most of which exploit softness as a critical component. These range from mechanical responses, actuation principles and sensing capabilities. Additionally the homeostatic operations of organisms can be exploited in their robotic counterparts. We can, in effect, start to make robotic organisms, rather than just robots. Important new capabilities include the fabrication of robots from soft bio-polymers, the ability to drive the robot from bio-energy scavenged from the environment, and the degradation of the robot at the end of its life. The robot organism therefore becomes an entity that lives, dies, and decays in the environment, just like biological organisms. In this talk we will examine how soft robotics will change in light of these new developments and explore the versatility and potential applications of bio-like robotic organisms. We will examine how robots eat, drink, live and die, and how these characteristics helps us make new biodegradable, wearable, implantable and environmental autonomous robots.

Alice Tonazzini
Laboratory of Intelligent Systems, EPFL, Switzerland

Alice Tonazzini received the M.Sc. degree in Biomedical Engineering from University of Pisa (Pisa, Italy) in 2011 and the Ph.D. degree in Biorobotics from The Biorobotics Institute (Scuola Superiore Sant'Anna, Pontedera, Italy) in 2015. She was with Center of Micro BioRobotics (Istituto Italiano di Technologia, Pontedera, Italy) working on plant inspired technologies. She currently holds a post-doctoral position at Laboratory of intelligent systems (École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland). Her research interests include soft robotics, bioinspired robotics, medical devices.

"Variable stiffness materials"

Soft structures show robustness and adaptability in unstructured environments and during delicate interactions with fragile objects and humans. However, deformable bodies suffer from limited ability in exerting or withstanding high forces, and they are difficult to control due to their high number of degrees of freedom. In recent years, the integration of materials with controllable stiffness into soft devices has been explored as a possible solution to these limitations. In fact, under certain stimuli those materials can selectively tune the load bearing capabilities of the bodies where they are embedded; also they can enhance the hosting structures' controllability by selectively stiffening or locking degrees of freedom and therefore achieving complex configurations and motions with a reduced number of actuators.
In this talk two case studies will be presented, where different variable stiffness materials (i.e. electro rheological fluids, low melting point alloys) are exploited to address specific limitations of purely soft technologies.

Christian Duriez

Institut National de Recherche en Informatique et Automatique – Lille, France

Christian Duriez received the engineering degree from the Institut Catholique d'Arts et Métiers of Lille, France and a PhD degree in robotics from University of Evry, France. His thesis work was realized at CEA/Robotics and Interactive Systems Technologies followed by a postdoctoral position at the CIMIT SimGroup in Boston. He arrived at INRIA in 2006 and worked on interactive simulation of deformable objects and haptic rendering for surgical simulation. He co-created the open source framework SOFA (www.sofa-framework.org) and he is one of the founder of inSimo (www.insimo.fr) a start-up company working on surgical simulation.
He is now research director (equivalent to full professor) and head of the DEFROST team at INRIA. His research topics are soft robot modeling and control, new algorithms for haptics, fast finite element methods, simulation of contact response and other complex mechanical interactions.

"Soft-robot modeling and simulation"

Due to their theoretical infinite number of degrees of freedom, modeling of soft-robot robots is a challenge. Their physical behavior is classified in the domain of deformable solids that belongs to continuum mechanics. Numerical methods in computational mechanics (Finite Elements Methods and others…) can provide solutions to the differential equations but generally at a price of a high computation time.
However, during the last 10 years, some progresses have been done on reducing the computation time for modeling deformable & soft bodies using these methods. Now, real-time computation is not unattainable !
During this talk, existing work in this domain will be presented and analyzed. The presentation will include a short introduction to SOFA (www.framework.org), a framework dedicated to the simulation of soft-bodies. We will see how we have adapted these existing tools to model and simulate soft-robots and their interaction with their environment. Some examples of robot simulations will be presented and analyzed. In particular we will show how these tools can help the design of soft-robots.

Thor Bietze

Institut National de Recherche en Informatique et Automatique – Lille, France

After obtaining a master degree in control systems from the University of San Nicolas de Hidalgo in Mexico, in 2013, **Thor Bieze** started his PhD studies at the French Institute for Research in Computer Science and Automation – Inria Lille. The main focus of his research is the simulation – assisted design and control of deformable manipulators with antagonistic actuation towards the partial rigidification of these type of robots.
At the beginning of 2016, he was invited to participate in the international master in robotics and transport at Polytech Lille as a speaker for the bio-inspired robotics lectures.

"Constraint space kinematic model of deformable manipulators: application to close-loop position control"

In this talk, the first generic modeling and motion control methodology for deformable manipulators at low speed is presented. It offers a way to obtain the kinematic characteristics of this type of deformable robots. Contrary to articulated rigid robots, the kinematic model of a deformable robot motion does not only depend on its geometry but also on the deformation properties of the involved materials. Consequently, this modeling methodology relies on continuum mechanics which does not provide analytic solutions in the general case. Instead, this approach proposes a real-time numerical integration strategy based on Finite Element Method (FEM) with a numerical optimization based on Lagrangian Multipliers to obtain direct and inverse (forward and backward) models. To reduce the dimension of the problem, at each step, a projection of the model to the constraint space (gathering actuators, sensors and end-effector) is performed to obtain the smallest number possible of mathematical equations to be solved. The usefulness of the modeling method to control the motion of a deformable manipulator in close-loop is illustrated.

Francesco Corucci

The BioRobotics Institute, Scuola Superiore Sant'Anna, Italy

Francesco Corucci is a PhD Fellow in BioRobotics at The BioRobotics Institute of Scuola Superiore Sant'Anna (SSSA), where he is advised by Prof. Cecilia Laschi. He develops part of his activities at the Research Centre on Marine Robotics and Sea Technologies (Livorno). Since November 2015 he is a Visiting PhD Fellow at the Vermont Complex Systems Center, University of Vermont (USA), where he works with Prof. Josh Bongard as a member of the Morphology, Evolution & Cognition Laboratory. He previously worked in the Intelligent Automation Systems group of the Perceptual Robotics Laboratory (SSSA). He achieved a MEng and BEng in Computer Engineering (with honors, within the "Excellence Program") from University of Pisa (IT). He has been involved in a number of research projects (PoseiDRONE, RoboSoft), and served as external consultant for others (COMAS). He is Student Member of the ACM (Special Interest Group on Genetic and Evolutionary Computation). His research interests include evolutionary robotics, artificial life, embodied cognition, morphological computation, and soft robotics. His recent work is concerned with the evolution and development of morphologically-plastic soft robots. His ultimate goal is to understand the general nature of cognition, evolving adaptive and intelligence artificial creatures approaching the complexity of biological ones.

"Evolutionary soft robotics: towards adaptive and intelligent machines following nature's approach to design"

In this talk we will discuss how soft robotics can benefit from the adoption of simulations and computational processes inspired by the natural evolution. From an engineering perspective, evolutionary algorithms can assist and replace humans in solving complex optimization problems associated with the design and control of soft robots. These algorithms demonstrated to be able to outperform human-devised solutions in several domains, producing unconventional yet surprisingly effective designs, reminiscent of the astonishing creativity of natural evolution. In the evolutionary robotics field, these algorithms are used to evolve complete robots from scratch, optimized for specific tasks and environments. The possibility to co-evolve all aspects of a robot (morphology, material properties, sensory and control systems) is unique to this approach, and particularly appealing for soft robotics, especially in light of the recent developments in fields such as embodied intelligence and morphological computation. Replicating nature's approach to design, evolutionary robotics represents the ultimate form of bio-inspired robotics, in which the processes that led to successful solutions observed in nature are replicated, instead of the final solutions themselves. This approach is very promising for what concerns the possibility to build truly adaptive and intelligent machines, the lack of these characteristics being one of the main limiting factors to the widespread of robots outside controlled environments. More in general, simulations based on evolutionary algorithms can be used in fields such as artificial life and computational biology in order to shed light on general properties of soft-bodied creatures, providing novel insights that could help unleashing the full potential of soft robotic technologies.

Helmut Hauser

Bristol Robotics Laboratory, University of Bristol, UK

Helmut Hauser is a Lecturer in Robotics at the University of Bristol and the Bristol Robotics Laboratory. He is also part of the core team of the Coordination Action RoboSoft.

His research is focused on morphological computation and embodiment, especially in the context of soft robotics. He is interested in understanding the underlaying principles of how complex physical properties of biological systems are exploited to facilitate learning and controlling tasks, and how these principles can be employed to design better robots. He has published in international conferences and high-impact journals including Scientific Reports and Royal Society Interface. Helmut won two best paper awards at international conferences and his work is highly cited including publications in Nature, Trends in Cognitive Sciences and PNAS.

Helmut was the project manager of the EU project LOCOMORPH and he participated in a number of other projects like OCTOPUS, SMART-E, NCCR Robotics and others. He organised international conferences, workshops, special issues on the topics of soft robotics and morphological computation and he is the editor of the e-book "Opinions and Outlooks on Morphological Computation". He has been part of the Pogramm committee of various international conference including this years ALIFE2016 and Living Machines 2016. Helmut has published various articles on RoboHub and he is Associate Editor of the Soft Robotics section of Frontiers in Robotics and AI.

"Morphosis – taking morphological computation to the next level"

From the view point of morphological computation the physical properties of a robot play a crucial role in its intelligent behaviour. Loosely speaking computation can be outsourced to the physical body. This implies the encoded computation will be determined by physical parameters. As a result, a fixed set of properties is only able to provide a predefined behaviour. However, looking at biological systems we can see that they are highly versatile, adaptive and resilient. Their solution is a set of mechanisms that allow them to adapt their morphologies (morphosis). A remarkable property of these mechanisms is that their transitions are of a discrete quality as opposed to smooth dynamics on the physical level. They represent a switch between clearly distinguishable, observable behaviours like a change in gaits, or a transition from walking to grasping. Naturally, the control of morphosis is very low-dimensional and therefore simplifies the underlying control and learning problems. Moreover, the control of these changes can be rather imprecise as the corresponding physical morphological computations are forming a supportive attraction space towards the desired behaviour. All of these features are highly beneficial. We will argue that morphosis can be seen as another level of morphological computation that sits on top of pure physical interaction and we will demonstrate the great potential of this approach by showing recent results with a model of an octopus robot.

Wednesday 27, 2016

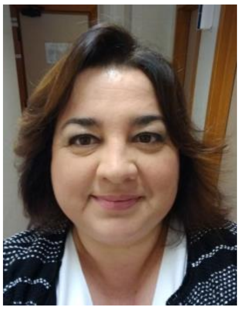
Barbara Mazzolai

Center for Micro-BioRobotics IIT@SSSA, Italy

Barbara Mazzolai is the Director of the Center for Micro-BioRobotics (CMBR) of the Istituto Italiano di Tecnologia (IIT) of Genoa, Italy, since 2011, and Deputy Director for Supervision and Organization of IIT Centers Network, since 2012. From 2009 to 2011 she was Team Leader at CMBR and from 2004 to 2009 Assistant Professor in Biomedical Engineering at Scuola Superiore Sant'Anna in Pisa (Italy). She graduated (MSc) in Biology (with Honours) at the University of Pisa, Italy, in 1995, and received the Ph.D. in Microsystems Engineering from the University of Rome Tor Vergata. Her current scientific research is in the fields of biorobotics and biomimetic robotics, focused on studying and understanding mechanisms, sensors, actuation solutions, and locomotion strategies inspired by nature, especially by plants and soft animals. In 2010 she was awarded the "Marisa Bellisario Award" for her advanced research in the field of service robotics, and in 2013 the "Medal of the Senate of the Italian Republic" for her scientific activities performed in biomimetics and biorobotics. She has a long experience as Coordinator and Project Manager of European Projects in these fields. She recently was the Coordinator of the PLANTOID FET-Open European Project, aimed at developing a new generation of ICT hardware and software technologies inspired from plant roots. She is Member of the Editorial Board of the Journal of Soft Robotics and of the Bioinspiration & Biomimetics Journal, and Associate Editor for the Journal of Micro-Bio Robotics, and for the Journal of Frontiers in Bionics and Biomimetics. She is member of the IEEE, and of the Engineering in Medicine and Biology Society and of the Robotics and Automation Society.

"Plant-inspired soft robots"

Bioinspired robotics is a worldwide known paradigm to develop new solutions for science and technology, giving way to a series of innovative robotic solutions assisting and supporting today's society. Such biological principles traditionally originate from animal models for robots that can walk, swim, crawl, or fly. In this talk I will present some scientific and technological challenges and solutions coming from plants, which represent a completely new paradigm in robotics. In the animal kingdom, in fact, a function is often related to an organ or compartment. Instead plants are networked, decentralized, modular, redundant, and resilient. Plants are able to move, control, sense, but they do and act differently with respect to animals or other living beings. I will present ideas, biological features, and technological translations coming from the Plantae Kingdom and related to areas of interest in robotics: movement, sensing and control.



Lucia Beccai
Center for Micro-BioRobotics IIT@SSSA, Italy

Dr. Lucia Beccai is Tenure Track Researcher at the Center for Micro-BioRobotics of the Istituto Italiano di Tecnologia (iit.it) of Genoa, Italy, where she leads the research line of "Artificial Touch in Soft Biorobotics". Previously, she had a position as Assistant Professor in Biomedical Engineering Institute of Biorobotics of Scuola Superiore Sant'Anna (SSSA). She is expert in biomechatronics and microsystem engineering and collaborated in many international projects (also as project manager) like in CYBERHAND (EU-IST-FET-2001-35094), NANOBIOTACT (FP6-NMP-033287) and NANOBIOTOUCH (FP7-NMP-228844),and PLANTOID (ICT-2011.9.1 FET Open "Innovative Robotic Artefacts Inspired by Plant Roots for Soil Monitoring"). She focuses mainly on biomimetic touch. Her interests relate to smart tactile systems inspired from living organisms-especially plants and soft animals, and soft energy harvesting methods for self-powered devices, for applications in soft robotics, including wearable devices/human-computer interfaces. She is author of about 100 articles on refereed international journals, books, and international conference proceedings, has 3 patents. She's Member of IEEE Robotics&Automation Society and Material Research Society.

"Soft robotics artificial touch"

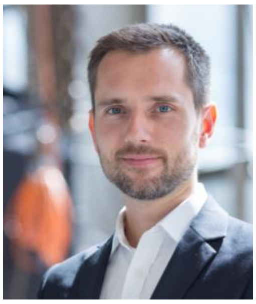
In soft robotics one of the main challenges is to build robots that are immersed in the real world because they can sense the externally provoked mechanical perturbations while they are dealing with locomotion and exploratory movements in undetermined surroundings, or grasping and manipulation of unknown objects. Such mechanosensing solutions, from their material to the architecture, need to fulfill the requirement of compliance with the environment - similar to that found in the natural mechanoreceptive structures of animals and plants - in addition to being robust. In parallel, artificial strategies must be identified for revealing different types of mechanical stimuli without complicating the overall robotic solution in terms of structure or computation. In this talk I will show some results of our group as regards highly sensitive soft tactile systems able to reveal different mechanical stimuli - like pressure, strain, and multi-directional force – although they incorporate biomimetic mechanical features (e.g. compliance, flexibility and extensibility). I will describe how studying the exceptional tactile capabilities of plant roots can inspire the development of new strategies for soft sensing bodies revealing bending and external force. Finally, I will conclude showing a very recent development at the international level regarding a bioinspired skin for tactile sensing used to provide a soft robot with exteroception and proprioception capability, setting a new milestone in the soft robotics field.

Kyu-Jin Cho
Bioinspired engineering and Soft Technology Robotics Lab,
Seoul National University, Korea

Kyu-Jin Cho received B.S and M.S. degrees from Seoul National University, Seoul, Korea in 1998 and 2000, respectively, and a Ph.D. degree in mechanical engineering from Massachusetts Institute of Technology in 2007. He was a post-doctoral fellow at Harvard Microrobotics Laboratory until 2008. At present, he is an associate professor of Mechanical and Aerospace Engineering and the director of BeSTerLa (Bio-inspired engineering and Soft Technology Robotics Lab) at Seoul National University. His research interests include biologically inspired robotics, soft robotics, soft wearable devices, novel mechanisms using smart structures, and rehabilitation and assistive robotics. He has received the 2014 IEEE RAS Early Academic Career Award, 2014 ASME Compliant Mechanism Award, 2013 IROS Best Video Award, 2015 KROS Hakbo ART Award and 2013 KSPE Paik Am Award.

"Soft bio-inspired robots with physically Embodied Intelligence"

Soft robotics deals with interaction with environments that are uncertain and vulnerable to change, by easily adapting to the environment with soft materials. However, softness requires controlling large degrees of freedom. Many soft robots use pneumatics which can easily distribute the actuation. If tendons are used for actuating a soft body, the large degrees of freedom of the material either requires large number of tendons or limits the controllability. Tendon drive soft robots can benefit from using the concept of physically embodied intelligence, first proposed by Prof. Rolf Pfeifer. By embodying intelligence into the design, better performance can be achieved with a simpler actuation. In nature, there are few example that exhibit this property. Flytrap, for example, can close its leaves quickly by using bistability of the leaves instead of just relying on the actuation. Inchworm achieves adaptive gripping with its prolegs by using the buckling effect. In this talk, I will give an overview of various soft bio-inspired robotic technologies, and some of the soft robots with physically embodied intelligence that are being developed at the Bioinspired engineering and Soft Technology Robotics Lab (BeSTeRLa). These examples will show that the concept of physically embodied intelligence simplifies the design and enables better performance by exploiting the characteristics of the material.



Mirko Kovac

Imperial College of Science, Technology and Medicine, UK

Dr. Mirko Kovac is director of the Aerial Robotics Laboratory at the Aeronautics Department at Imperial College London. His research interest is the conception and design of novel morphologies and locomotion methods for mobile robots and their analogy in biological systems. Before his appointment in London, he was post-doctoral researcher at the Wyss Institute for Biologically Inspired Engineering at Harvard University in Cambridge, USA. He obtained his PhD with the Laboratory of Intelligent Systems at the Swiss Federal Institute of Technology in Lausanne (EPFL). He received his M.S. degree in Mechanical Engineering from the Swiss Federal Institute of Technology in Zurich (ETHZ) in 2005. During his studies he was research associate with the University of California in Berkeley USA, RIETER Automotive Switzerland, the WARTSILA Diesel Technology Division in Switzerland, and CISERV in Singapore. Since 2006, he has presented his work at numerous international conferences and in journals and has won several best paper and best presentation awards. Also, he is advisor to the UK government on aerial robotics opportunities and he is founding member of the London Robotics Network that acts as the community building hub in the larger London area for robotics in academia and industry. He has also been invited lecturer at more than 30 research institutions world wide and has been representative speaker on education and innovation at the World Knowledge Dialogue Symposium 2008, the EPFL Didactic Days Conference 2008 and the London Innovation Summit 2014.

"Bio-inspired soft aerial robots: adaptive morphology for high-performance flight"

The field of soft robotics offers the potential to reduce control complexity while increasing versatility, performance and robustness of robot operation. Most of current aerial robots however, have rigid body structures and rely predominantly on abundant sensing and dynamic closed loop control to fly. In contrast, flying animals combine sensing and control with adaptive body designs and exploit the fluid dynamic and bio-mechanic effects taking place to achieve very high levels of operational robustness and multi-functionality. In this talk, I will give an overview of existing examples where softness is used for aerial robots and I will outline where and how we can take inspiration from biology to develop the next generation of aerial robots that selectively use soft materials and adaptive morphologies to achieve high-performance flight.

Gabriele Ferri

NATO Centre for Maritime Research and Experimentation, Italy

Gabriele Ferri (S'06–M'08) received the Laurea degree (M.S.) in computer engineering (with honors) from the University of Pisa, Pisa, Italy, in 2003and the Ph.D. degree in biorobotic science and engineering jointly from Scuola Superiore Sant'Anna, Pisa, Italy and IMT Advanced Studies, Lucca, Italy, in 2008.From 2003 to 2005, he was a Software/SystemConsultant Engineer for WASS (a Finmeccanica group company), Livorno, Italy, developing a new system of control and guidance for a light-weightedtorpedo. In 2007, he was a Visiting Researcher at the Woods Hole Oceanographic Institution, Woods Hole, MA, USA. After a period as a Postdoctoral Investigator at Scuola Superiore Sant' Anna in which he worked as Project Leader of the HydroNet project, in 2012, he won a position as Research Scientist at the NATO Centre for Maritime Research and Experimentation (CMRE), La Spezia, Italy. His research interests include multi-robot systems forlittoral surveillance, autonomous decision-making, data-driven behaviours and robot navigation topics.
He is the Technical Director of the Student Autonomous Underwater Vehicle Challenge—Europe (SAUC-E) (http://sauc-europe.org/) and he was the Technical Director of the euRathlon 2015 Grand Challenge (www.eurathlon.eu), the world's first multi-domain outdoor search and rescue robotic competition.

"euRathlon 2015 Grand Challenge"

euRathlon was an outdoor robotics competition that invited teams to test the intelligence and autonomy of their robots in realistic mock emergency-response scenarios inspired by the 2011 Fukushima accident. The project, funded by the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement no 601205, has culminated in the euRathlon 2015 Grand Challenge held in **Piombino, Italy, from the 17th- 25th September 2015.**
The event was held in the area surrounding the Enel-owned thermal power plant of Tor del Sale.The euRathlon Grand Challenge **was the world's first competition** to require a team of ground, marine and aerial robots to work together to survey the scene, collect environmental data, and identify critical hazards. Competitors and their robots faced real life conditions (i.e., a ruined building, sandy terrain, etc) in a realistic mock disaster scenario.
The talk will describe the euRathlon project with a focus on the euRathlon 2015 Grand Challenge. The great success of the competition in terms of participation of specialized and general public made euRathlon 2015 Grand Challenge more than a robotic competition: an international robotics event for the general public.

Federico Renda

Khalifa University of Science, Technology and Research, UAE

Dr. Federico Renda received his BEng and MEng degrees in Biomedical Engineering in 2007 and 2009 respectively from the University of Pisa. He completed his PhD in Bio Robotics in 2014 from the Bio Robotics Institute of the Scuola Superiore SantAnna, Pisa. In 2013, as visiting PhD student, he joined the IRCCyN Lab, at the Ecole des Mines de Nantes, Nantes. He is currently a Post Doctoral Fellow with the Khalifa University Robotics Institute of Khalifa University of Science, Technology and Research, Abu Dhabi. Dr. Federico Renda develops geometrically exact models and simulations of mobile continuous systems based on the theory of differential geometry and geometrical mechanics. He acquired these skills in the context of soft robotics and applied his models to the passive elastic structures of soft robots driven by cables.

"The Mohammed Bin Zayed International Robotics Challenge (MBZIRC)"

The Mohamed Bin Zayed International Robotics Challenge (MBZIRC) is a prestigious international robotics competition, held every two years. MBZIRC provides an ambitious and technologically demanding set of challenges, and is open to a large number of international teams. MBZIRC aims to inspire the future of robotics through innovative solutions and technological excellence. The inaugural MBZIRC will take place in

November 2016. The competition is motivated by the technological challenges facing the next generation of robotics which is poised to have a transformative impact in a variety of new applications and markets. The enabling technologies required to make this happen include robots working more autonomously in dynamic, unstructured environments, while collaborating with other robots and humans. MBZIRC will focus on some of these enabling technologies, by providing a demanding set of benchmark robotics challenges to attract the best international teams, and to inspire innovation in robotics technology.

Thursday 28, 2016

Metin Sitti

Max Planck Institute for Intelligent Systems, Germany

Metin Sitti received the BSc and MSc degrees in electrical and electronics engineering from Bogazici University, Istanbul, Turkey, in 1992 and 1994, respectively, and the PhD degree in electrical engineering from the University of Tokyo, Tokyo, Japan, in 1999. He was a research scientist at UC Berkeley during 1999-2002. He is currently a director in Max-Planck Institute for Intelligent Systems and a professor in Department of Mechanical Engineering and Robotics Institute at Carnegie Mellon University. His research interests include small-scale physical intelligence, mobile microrobots, bio-hybrid microsystems, bio-inspired micro/nanomaterials and millirobots, soft robots, and micro/nanomanipulation. He is an IEEE Fellow. He received the the SPIE Nanoengineering Pioneer Award in 2011 and NSF CAREER Award in 2005. He received the IEEE/ASME Best Mechatronics Paper Award in 2014, the Best Poster Award in the Adhesion Conference in 2014, the Best Paper Award in the IEEE/RSJ International Conference on Intelligent Robots and Systems in 2009 and 1998, the first prize in the World RoboCup Micro-Robotics Competition in 2012 and 2013, the Best Biomimetics Paper Award in the IEEE Robotics and Biomimetics Conference in 2004, and the Best Video Award in the IEEE Robotics and Automation Conference in 2002. He is the editor-in-chief of Journal of Micro-Bio Robotics.

"Soft mobile milli/microrobotics"

Using soft materials, actuation, and sensing in small-scale mobile robots could enable physical intelligence by enabling them capabilities such as shape changing and programming, adaptation, multi-functional and diverse behavior, and mechanical computation. In this talk, our recent activities on how to design, manufacture and control new untethered soft actuators, sensors, swimmers, and shape-programmable materials at the milli/microscale. First, inflated soft actuators with reversible stable deformations are proposed combining hyperelastic membranes and dielectric elastomer actuators to switch between stable deformations of sealed chambers. This method is capable of large repeatable deformations, and has a number of stable states proportional to the number of actuatable membranes in the chamber. Next, parallel microcracks-based ultrasensitive and highly stretchable strain sensors are proposed and demonstrated for wearable device and soft robot gripper sensing applications. Moreover, new milli/microscale swimming robots inspired by spermatozoids, flagellated bacteria, and jelly fish are proposed using elastomeric magnetic composite materials. Finally, shape-programmable magnetic soft materials are developed using a rigorous computational methodology and new design and fabrication technique.

Barry Trimmer

Tufts University, USA

Barry Trimmer (Professor, Department of Biology) – Barry Trimmer is the Henry Bromfield Pearson Professor of Natural Science and holds secondary appointments in Biomedical Engineering and in Neuroscience at the Tufts Medical School. He received both his undergraduate and PhD degrees from the University of Cambridge in England and carried out post-doctoral training in Neuroscience at Harvard Medical School and at the University of California, Berkeley and the University of

Oregon, Eugene. His research focus is on the Neuromechanics of Locomotion, the science of how animals control their movements. In addition to his work on living systems, Professor Trimmer is Director of the Tufts Neuromechanics and Biomimetic Devices Laboratory which specializes in the application of found biological principles to design and fabricate Soft Robots. Dr. Trimmer is also Director of the NSF-funded Integrative Graduate Education and Research Training (IGERT) program in Soft Material Robotics and Editor in Chief of the journal Soft Robotics. His interests in living systems and robots converge in his recent research that seeks to "grow" robotic devices using a combination of biosynthetic materials, cellular modulation, and tissue engineering. These Biosynthetic Robots will be versatile, safe, biocompatible, and biodegradable.

"Non-pneumatic, biomimetic, soft robots"

Human-built machines are usually efficient, fast and powerful, and are largely constructed from stiff materials. In order to cope with complex environments, the most recent robotic devices have begun to incorporate compliant joints and control systems based on impedance rather than force and position monitoring. However, even these advanced machines cannot perform with the robustness and adaptability found in living animals. A major challenge is that the design, fabrication and control of highly deformable structures are still poorly understood. In our research on soft animal and robots our guiding framework is that morphological computation (embodied intelligence) is essential for moving and manipulating things in the natural world, and that soft machines need to incorporate the same strategies. In this presentation I will describe a novel soft robotic platform (Softworms) as a modular device for research, education and public outreach. These robots are inspired by recent neuromechanical studies of crawling and climbing by larval moths and butterflies (Lepidoptera, caterpillars). Unlike most soft robots currently under development, the Softworms do not rely on pneumatic or fluidic actuators but are electrically powered and actuated using either shapememory alloy micro coils or motor-tendons and they can be modified to accept other muscle-like actuators such as electroactive polymers. The technology is extremely versatile and different designs can be quickly and cheaply fabricated by casting elastomeric polymers or by direct 3D printing. Softworms can crawl, inch or roll, they are steerable and even climb steep inclines. Softworms can be made in any shape but here we describe modular and monolithic designs requiring little assembly. These modules can be combined to make multi-limbed devices. I will also describe some possible methods for controlling such highly deformable structures using either model-free state transition-reward matrices or distributed, mechanically coupled oscillators. In addition to their value as a research platform, these robots can be developed for use in environmental, medical and space applications where cheap, lightweight and shape changing deformable robots will provide new performance capabilities.

Arianna Menciassi & Matteo Cianchetti

The BioRobotics Institute, Scuola Superiore Sant'Anna, Italy

Prof. Arianna Menciassi obtained the M.Sc. in Physics from the University of Pisa in 1995 (magna cum Laude) and the Ph.D. in Bioengineering from the Scuola Superiore Sant'Anna (SSSA) in 1999. She becamo Full Professor in May 2014, in the same institution. Currently, she is with The BioRobotics Institute of the SSSA where she is Area Leader of "Surgical Robotics and Allied Technologies".

Between 2013 and 2014, she was Visiting Professor at the Ecole Nationale Superiorieure de Mecaniques et des Microtechniques (ENSMM) of Besancon (France), in the FEMTO Institute, and at the Universitè Pierre Marie Curie in Paris.Her main research interests involve biomedical robotics, surgical robotics, microsystem technology, nanotechnology, with a special attention to the synergy between robot-assisted therapy and micro/nanotechnology-related solutions. She carries on an important activity of scientific management of several projects, European and extra-European. She is co-author of more than 330 scientific publications (more than 200 on ISI journals) and 6 book chapters on biomedical robots/devices and microtechnology. She is also inventor of 32 patents, national and international.

She served in the Editorial Board of the IEEE-ASME Trans. on Mechatronics and she is now Topic Editor in Medical Robotics of the International Journal of Advanced Robotic Systems; she is Co-Chair of the IEEE-RAS Technical Committee on Surgical Robotics. She is involved in the BioRobotics Technical Committee of IEEE-EMBC. She is NTC (Nanotechnology Technical Committee) representative in the steering committee of the IEEE Transactions on Nanobioscience. She is IEEE Senior Member.

Matteo Cianchetti received the Master's degree in Biomedical Engineering (with Hons.) from the University of Pisa, Pisa, Italy, in July 2007 and the Ph.D. degree in Biorobotics (with Hons.) from the BioRobotics Institute (Scuola Superiore Sant'Anna, Pisa). He is currently Assistant Professor with the BioRobotics Institute leading the Soft Mechatronics for Biorobotics Lab and he is author or co-author of more than 50 international peer reviewed papers and he regularly serves as a reviewer for more than 10 international ISI journals. He has been and currently is involved in EU-funded projects with the main focus on the development of Soft Robotics technologies. His main research interests include bioinspired robotics and the study and development of new systems and technologies based on soft/flexible materials for soft actuators, smart compliant sensors and flexible mechanisms.

"Soft robots in surgery"

Minimally Invasive Surgery (MIS) has become the gold standard in the majority of abdominal operations, although some fundamental limitations are still present and are far to be really approached despite emerging robotic solutions. The reason why traditional laparoscopic operations need up to 4 or 5 trocar accesses depends on the limited dexterity, flexibility, maneuverability of the available tools. In addition especially in the case of laparo-endoscopic single site surgery (LESS) and natural orifice transluminal endoscopic surgery (NOTES), rigid or semi-rigid tools may lead to significant clashing of instrumentation and increase the complexity of the procedures. Flexible endoscopes can be used for NOTES or LESS; indeed thanks to their high flexibility, they may allow to reach the surgical target while being inserted remotely or by a natural orifice. However endoscopes may lack stability that rigid tools normally provide.
Novel surgical instrumentation is being developed in order to provide higher dexterity and flexibility to the surgeon, but unlike traditional surgical manipulators based on metallic steerable needles, tendon driven mechanisms, or articulated motorized links, we are presenting a combination of flexible fluidic actuators to obtain multidirectional bending and elongation with a variable stiffness mechanism based on granular jamming. The idea is to develop a manipulator based on a series of modules, each consisting of a silicone matrix with pneumatic chambers for 3-D motion, and one central channel for the integration of granular-jamming-based stiffening mechanism.

Soft Robotics Week Venue

The **2016 Soft Robotics Week** will be held in **Livorno** (Italy) a fascinating city of the Tyrrhenian coast, where Tuscan traditions merge into Mediterranean culture creating lively, colourful and cosmopolitan atmospheres. The city was founded at the end of the 16th century by the Medici family (Grandukes of Florence) who made this little village of fishermen the first Tuscan harbour of the Mediterranean Basin.
Livorno has a peculiar history rich of culture which nowadays remains in its ancient palaces, churches, fortresses and along the medieval canals which remind the old pentagonal shape of the town. The old fortress, built during the 1500s, the suggestive Venice Quarter and the magnificent Central Market are a must of a journey to discover Livorno’s history, culture and tradition.

Arriving by train at Livorno Central Station
Livorno Central Station is located on the railway connecting Pisa and Roma.
From **Pisa Central Station** the trip takes about 15 min; from **Florence S.M.N.** there are trains that go directly to Livorno that take about 1h 25 min. Trains run frequently from Pisa and about every hour from Florence during all the day. See www.trenitalia.com for a complete timetable.

Florence Airport – Florence S.M.N.
The Florence airport (FLR) is called Amerigo Vespucci and is situated on the north-west outskirts of Florence, just 4 km from the city center. From the Florence airport, you can get to the central Santa Maria Novella train station (SMN) either with a taxi or with the special "Vola in Bus" bus shuttle (run by BusItalia Sita Nord). It takes about 20 minutes, sometimes a little more if there is heavy traffic. The service runs daily, including Sundays and holidays. Departures from the airport are every 30 min between 5.30 am to 8.30 pm, then every hour until 11.45 pm. The last shuttle is at 1.00 am, but at this time, it will be more convenient to take a taxi. Departures from the SMN train station are every 30 min between 5.00 am to 8.00 pm, then every hour up until 11.00 pm.
Another option is to reach Firenze Rifredi train station by taxi (10-15 minutes, around 10 €) and take the train to Livorno from Firenze Rifredi (same train line).
Taxi Firenze +39 055 4242

Pisa Airport – Pisa Central Station
Connections between Pisa Airport and Pisa Central Station are provided by the PisaMover Bus Service. The PisaMover Bus service starts at 6 a.m. and stops at 12 p.m., every day, including Sunday and Bank holidays, for each route (Pisa Airport – Pisa Central Station and Pisa Central Station- Pisa Airport), with a timetable departure of every 10 minutes and a journey time of just 8 minutes. Ticket price is 1,30€* one way. You can buy your ticket at the **Pisa Airport Information Office** (Arrivals Hall) and at Pisa Central Railway Station newsstands (open every day 7.00 a.m.-23.00 p.m.). During Information Office and newsstands closing time, you can buy your ticket on the bus.
Another option is to reach Pisa Central Station by taxi (5-10 minutes, around 10 €).
Pisa Radio Taxi +39 050 541600

The events of the Soft Robotics Week are organized in two different locations, the **Grand Hotel Palazzo** and the **Bagni Pancaldi**, one in front of the other on the seafront of Livorno in **Viale Italia** (have a look also at the map in the following page).

The seafront is about 5 km from the Livorno Central Station and it is connected with the **Bus No.1** or by taxi (**Livorno Radio Taxi** +39 0586 210000; **Consorzio Taxi Livorno** +39 0586 883377).

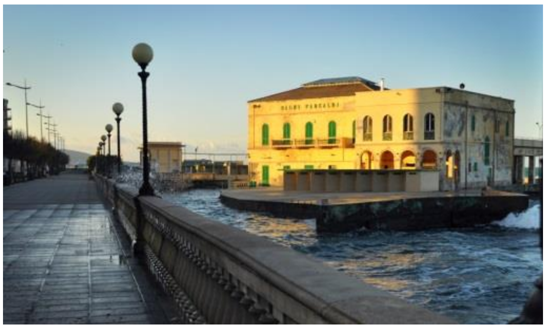
RoboSoft Spring School and RoboSoft Plenary Meeting

The lectures of the **RoboSoft Spring School** and the **RoboSoft Plenary Meeting** will be held at the **Grand Hotel Palazzo**.
By bus from the Livorno Central Station, take the **No.1 bus** from the station forecourt (Piazza Dante) towards Miramare and get off at "**Viale Italia-Pancaldi"** stop.

Grand Hotel Palazzo
Viale Italia, 195 - 57127 Livorno - Tel +39 0586 260836 - Fax +39 0586 806182 –
Website: http://www.grandhotelpalazzo.com/
Email: info@grandhotelpalazzo.it
Find here directions on: Google Maps

RoboSoft Grand Challenge

The **RoboSoft Grand Challenge** (April 29-30) will be held at the Meeting and Convention Centre "**Bagni Pancaldi**", just in front to the Grand Hotel Palazzo.



Bagni Pancaldi
Viale Italia, 56 - 57127 Livorno
Website:
http://www.eventiitaliasrl.it/meeting-conference-centre-pancaldi/
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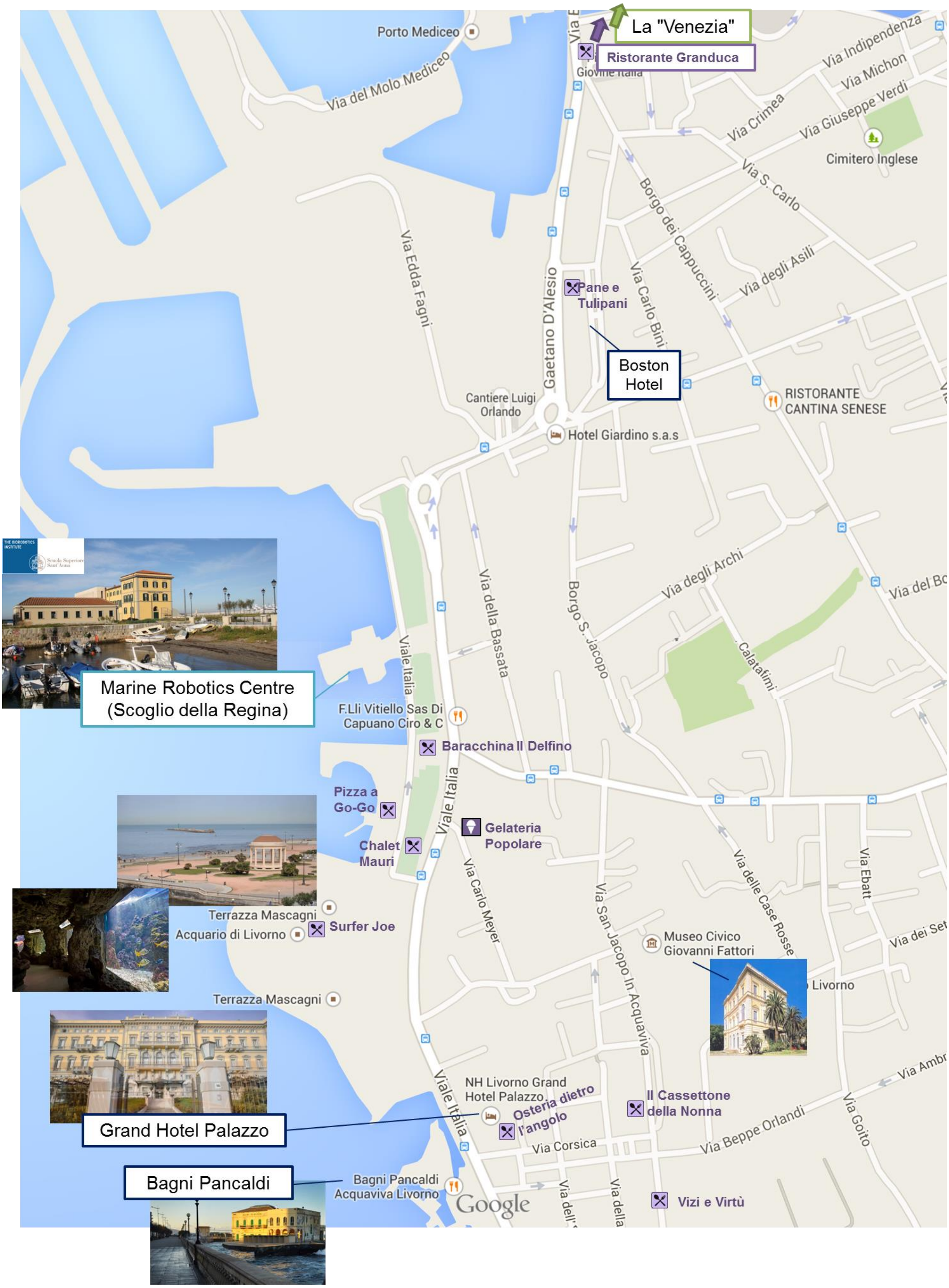
Map of the main venues



Organizers

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Frontiers in Robotics and AI Journal (http://journal.frontiersin.org/journal/robotics-and-ai)

Soft Robotics Week 2016 website

http://www.robosoftca.eu/information/events/soft-robotics-week-2016

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