# The Newsletter of RoboSoft

## Coordination Action for Soft Robotics

**Issue 2** **www.robosoftca.eu** **September 2014**

# Editorial

The community of researchers in the field soft robotics is now extremely dynamic and well organized. This effort is involving both experts and visionary roboticists who were pioneers of soft robotics, and many young researchers who are experimenting with new soft robotic theories, design principles, and non-conventional approaches for creating new components and systems to address the future challenges and to apply soft robotics to meet pressing scientific and societal needs.

Beyond these research activities, there is also a concerted effort underway to establish new interactions and create opportunities for researchers to meet and exchange knowledge, to discuss the challenges and the applications of soft robots and to build links between laboratories and industries. The RoboSoft community is expanding its efforts in this direction and in the last months we have designed a series of international events, including workshops, special sessions and public meetings aimed at sharing research activity results, discussing theoretical and technological issues, and identifying challenges and milestones leading to high impact applications and innovation for soft robotics. In order to disseminate as widely as possible the results, discussions, and proposals for collaborations, RoboSoft members are preparing working papers and publishing articles in international journals in order to go beyond, and obtain a concrete implementation of, shared ideas and visions.

In this second issue of the RoboSoft Newsletter you will read about: the latest events organized within RoboSoft Coordination Action and their outcomes; industries at the forefront of soft materials development and exploitation; and the views of prominent researchers in this dynamic field.

The following months will be dedicated to enabling collaborations and facilitating events more focused on the translation of soft robotics research to real-world applications and innovation for societal needs.

**Laura Margheri**
**and Jonathan Rossiter**

---

## Issue 2, September 2014
## Contents:


Editorial ..... 0
RoboSoft Pills ..... 1
News and events ..... 4
Join RoboSoft ..... 4
Call for Newsletter Articles ..... 4
RoboSoft Bites ..... 5
Industries: ..... 5
BAE Systems ..... 5
ARTIS ..... 6
People: ..... 7
Jamie Paik ..... 7
Federico Carpi ..... 8
Contacts ..... 10

# RoboSoft Pills

### RoboSoft Community on the move

During the first months of the Coordination Action we invited laboratories working in the field of soft robotics to join the RoboSoft Community as Members and we currently have a network of 21 research centres and institutions worldwide whose researchers actively participate in the RoboSoft activities, consultations, and can benefit from the RoboSoft resources, channels and initiatives to promote their research and technological results.

The community members are organized in 4 Working Groups (WG) to focus on critical or emerging topics and technologies:

- ***Smart Materials, Soft Actuators and Soft Sensors*** (WG coordinated by Barbara Mazzolai, Center for Micro-BioRobotics - IIT@SSSA);
- ***Control Architectures and Paradigms for Soft Robots*** (WG coordinated by Helmut Hauser, UZH - AI Lab);
- ***Energy Storage, Harvesting Soft Devices and Stretchable Electronics*** (WG coordinated by Jamie Paik, EPFL - Reconfigurable robotics laboratory);
- ***Biological Insights*** (WG coordinated by Barry Trimmer, Tufts University).

RoboSoft community members are periodically involved in consultations to discuss the challenges and expected milestones of soft robotics, to provide research roadmaps for the field and to identify the supporting actions that should be provided by the European Commission. These are intended to generate the body of knowledge and scientific and technological standards needed to effectively materialize the potential impact of soft robots.

The participation and contribution of RoboSoft members to the consultations is reported through the RoboSoft working papers, joint publications, and through the book series on soft robotics that will be released at the end of the RoboSoft CA.

The first consultation took place during the first RoboSoft Plenary Meeting, organized on March 31-April 1, 2014 at the Scuola Superiore Sant'Anna in Pisa, Italy.

### RoboSoft First Plenary Meeting

The First Plenary meeting involved the members of the RoboSoft Community, external experts, representative scientists of different disciplines, and students with a total of 60 people from 20 international institutions.

During the two-day event, plenary talks by invited speakers and teaser presentations alternated with a series of parallel sessions encompassing working group consultations and brainstorming discussions. The four invited plenary speakers were Paolo Dario (The BioRobotics Institute, Scuola Superiore Sant'Anna), Rolf Pfeifer (UZH - AI Lab), George Jeronimidis (University of Reading) and Robert Shepherd (Cornell University).

*Plenary talk by Paolo Dario: "Soft robotics: new frontiers for BioRobotics and Robot Companions"*

They presented their own views on current strategies, new visions and grand challenges for soft robotics. Their very inspiring presentations encompassed themes related to embodied intelligence, new technologies and

design principles for robot companions, bioinspired solutions, material strategies and new manufacturing systems.

Young researchers were invited to present their works with shorter "teaser" presentations and during poster sessions.

*Participants during the meeting*

The event was in particular organized to allow members to meet and have the first working group discussions. This consultation exercise was targeted at the soft robotics community with the aim of identifying major challenges for research and technologies in soft robotics, as well as to identity new topics and instruments to be implemented for future FET initiatives. Experts were therefore invited to present an analysis of current technologies and their limitations, of the grand challenges and of what research topics should be included in the next work-programme. They were also asked to propose preferred means to implement the research (whether the projects should be big or small, or whether networking or coordination should be fostered) as well as what role should be played by high-tech companies, SMEs and large industries in this research.

The first RoboSoft working paper, to be released on 30 September 2014, represents the results of this first consultation.

Link to the first plenary meeting webpage:
www.robosoftca.eu/information/events/first-plenary-meeting

**RoboSoft around the world**

As part of RoboSoft activities, we organized a series of events and talks at major international conferences in the field of robotics.

Cecilia Laschi was invited to the EuroEAP Conference (Linköping, 10-11 June 2014) to present soft robotics to the 'European Scientific Network for Artificial Muscles' (ESNAM) community, and to the IEEE/RSJ IROS 2014 conference in Chicago; Laura Margheri was one of the finalist of the "Pecha Kucha Night" at IEEE ICRA 2014 conference in Hong Kong; and many other young members of the community participated in important international conferences, including ALIFE2014 and Living Machines 2014.

Among the most significant events was the one-day Workshop on "Advances on Soft Robotics" that was organized at the Robotics Science and Systems (RSS 2014) in Berkeley, CA, on July 13. The workshop was aimed at bringing together experts across multiple fields within the scientific community of soft robotics to discuss those aspects of soft robotics that are still in their exploration phase, or which have diverse roles in future robotic applications.

*Participants at the RSS 2014 Workshop on Advances on Soft Robotics*

Invited talks, contribution papers and roundtable sessions covered the development of general theories and new and unconventional approaches and techniques for most of the technologies involved in soft robotics. These included smart soft materials, soft (muscle-like) actuators, soft sensors,

modelling and control of soft robots, energy harvesting, design principles for soft robotics and morphological computation. The event gathered together researchers from different scientific backgrounds and potential stakeholders and was a great opportunity to establish new collaborations and invite new members to join the RoboSoft Community.

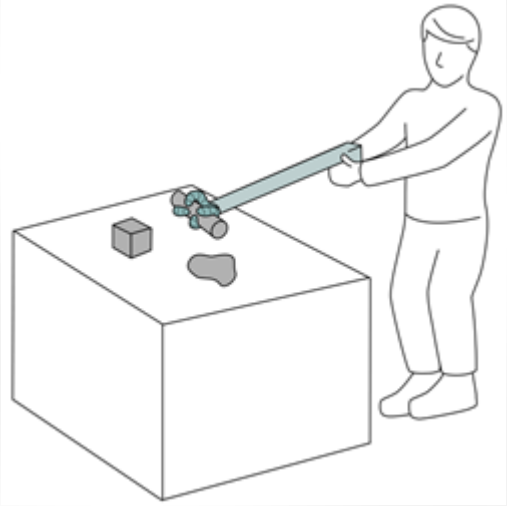
**Laura Margheri**

---

**RoboSoft Demonstrators**

An important component of the RoboSoft initiative is to communicate the potential and benefits of emerging soft robotic technologies to as wide an audience as possible. This will include outreach activities at European science fairs, visits to industrial stakeholders and visits to schools. To support these activities a set of soft robotic demonstrators is being designed. These will be safe and touchable by members of the public and will serve to demonstrate the core characteristics of soft robotics, including adaptability, scalability, safe human-machine interaction and low cost.

For example a pair of grippers will be fabricated, one made from compliant soft materials and one made from rigid articulating components. These can then be handled by members of the public and the limitations of the rigid gripper, i.e. its inability to adapt to different shaped objects and objects of differing compliance, will be communicated. We envisage that these demonstrators will be very low cost and can be distributed to RoboSoft members, industry partners and the wider community. Below is an example showing a design for an engagement activity where a user is able to remotely handle different shapes and sizes of object with one soft robotic gripper.



Soft robotic outreach and public engagement activity

**Jonathan Rossiter**

---

# News and events

RoboSoft is planning a series of events and meeting opportunities for the next months:

- RoboSoft Review Meeting , November 18, 2014, Pontedera, Pisa, Italy
- RoboSoft engagement event for stakeholders in February 2015
- RoboSoft second plenary meeting and "Spring School" in March 2015

More on:
http://www.robosoftca.eu/news/events

# Join RoboSoft

- Visit the RoboSoft web page and sign up: www.robosoftca.eu
- Facebook page https://www.facebook.com/pages/Robosoft-Coordination-Action/579415472150017
- Contact Laura Margheri at: laura.margheri@sssup.it

# Call for Newsletter Articles

Articles for the RoboSoft newsletter are welcome. These can be in any of newsletter sections:

- **News**: latest news and announcements
- **RoboSoft Pills**: short snips of information
- **RoboSoft Bites**: longer articles, typically under one of the following headings:
  - *People*
  - *Places*
  - *Partners*
  - *Industries*
  - *Technologies*
- **Calls**: funding call and scientific calls (e.g. edited volumes, workshops)
- **Vacancies**: research, industrial and academic vacancies in Soft Robotics and closely related fields.

Please send articles and any questions about the newsletter to the editor: Jonathan.Rossiter@bris.ac.uk

# RoboSoft Bites

## *Industries:*

### *BAE Systems*

BAE Systems is one of the World's leading global defence, security and aerospace companies. We work at the cutting edge of technology, creating more than 100 new inventions every year for customers around the World.

The Advanced Technology Centre of BAE Systems is at the forefront of technology development; be it solving current engineering challenges closely aligned to existing BAE products, or working on novel, innovative research that could provide game changing capability to the company in the future.

Soft materials are, in this context, classified as a subfield of condensed matter comprising a variety of physical states that are easily deformed by thermal stresses or thermal fluctuations. They offer a new generation of soft material related applications, directly relevant to BAE Systems interests.

Of particular appeal are applications in robotics, camouflage, sensors and stretchable power sources.

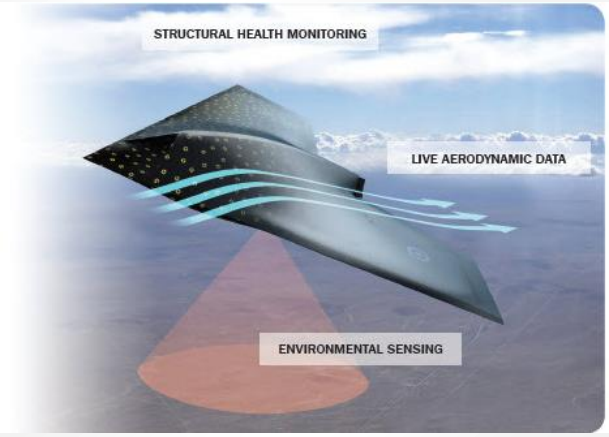
Robots that resist damage to pressure or impact would be useful in operations that expose them to damaging mechanical forces, for example, in exploration of human-unfriendly, dangerous unstable sites.

The UK Ministry of Defence recently highlighted the need to integrate novel camouflage and stealth technologies (including optical/infra-red signature modification and reduction as well as optical camouflage) directly into or onto structures in order to achieve a greater level of protection as well as potentially reducing the weight of such systems.

There is also an increasing need for smart monitors and embedded sensors in order to mimic the multiple functions found in biological systems. Compliant sensors that permit monitoring of surface strain, deformation and impacts are being considered for Structural Health Monitoring (SHM) which will assist in the efficacy of maintenance schedules, thereby reducing the through-life costs of platforms.

Deformable surfaces and structures may also find applications in exoskeletons and flat packed components.

BAE Systems is keeping a watching brief on the field in order to monitor this rapidly evolving area.




*The flying machines of the future are expected to be smart, adaptable and multifunctional.*

For enquiries, please contact Dr Emma Forsey of the Advanced Technology Centre: emma.forsey@baesystems.com

# *ARTIS*

ARTIS is a materials development consultancy formed in 2007 from the R & D group of Avon Rubber Plc. With over 125 years of developing soft materials for industry Avon is well known and respected in the industry and has created everything from Formula 1 Tyres to signature management for military applications. That history is now available through ARTIS to solve materials issues.

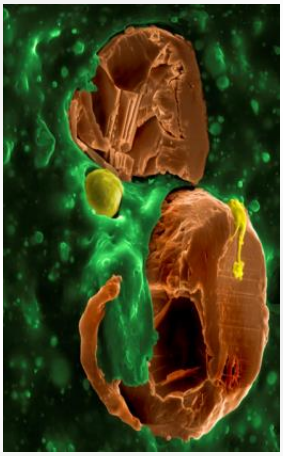
ARTIS has grown since inception and covers issues such as materials development, production, testing, failure analysis, application design, life prediction and compatibility.

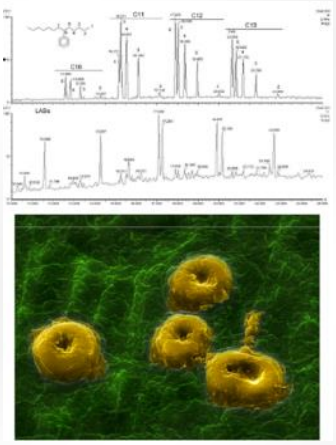
ARTIS has the capability to evaluate your application, design the material, produce the first off samples, evaluate and iterate to give you the solution you require. ARTIS also has the capability for small scale production of materials ideal for prototyping and development work. After the initial development work ARTIS can evaluate the performance and look to full scale manufacture if required or undertake the long term ageing tests needed for regulatory compliance. ARTIS has a selection of ageing capabilities in house and good range of dynamic test capability ranging from loads of a few Newtons to 29kN servo-hydraulic rigs in tension and torsion and static load deflection capability up to 20 tonnes.

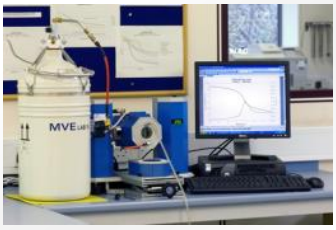
As well as a fully equipped analytical suite for compositional analysis, ARTIS works with a number of academics sponsoring research and is currently active in dielectric elastomer research at QMUL and has excellent links to a range of academic and military institutions. In the past ARTIS has developed strain sensitive materials with linear properties and ARTIS also has experience of collaborative R & D funded at UK and International levels from both civilian and military sources.

ARTIS is approved to ISO 9001

For more information please visit us at www.artis.uk.com







*ARTIS expertise in materials, fabrication and testing*

## *People:*

## *Jamie Paik*

Jamie Paik received her B.A.Sc. from UBC in 2002, majoring in both Mechanical and Electro-Mechanical Design Engineering. She obtained her Ph.D. from Seoul National University in South Korea before completing a post-doc at the Université Pierre et Marie Curie in Paris, where she designed and built a surgical instrument (the JAiMY) which is used for suturing in laparoscopic surgery, and subsequently at Harvard University. In the Microrobotics Laboratory in Harvard she collaborated with Erik Demaine, Daniela Rus and Robert Wood on the design of Programmable Matter, highly reconfigurable compliant and active materials and structures. She currently lives in Lausanne, Switzerland, where she is a tenure-track Assistant Professor at École Polytechnique Fédérale de Lausanne (EPFL) and founding director of the Reconfigurable Robotics Lab (RRL) lab. She is also a member of the Swiss National Centre of Competence in Research (NCCR) robotics group.

In 2013, robohub.org named Jamie one of "25 women in robotics you need to know about."

## *Jamie on soft robotics:*

**Q. What does soft robotics mean to you**?
"To me, soft robotics is a culmination of the need for novel robotic solutions toward more intuitive and intelligent systems."

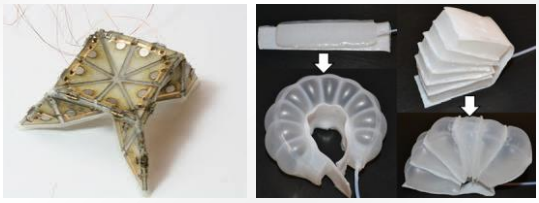
**Q. What can soft robotics deliver now and in the future?**
"The community has presented various efforts and results in soft electronics, soft power source, soft/multi-DoF mechanism, multi-material fabrication methods, impedance/ modular/multi-body control. Most of current solutions are not ready for a straightforward integration with conventional systems nor with other soft components. In the future not too far, I foresee advanced soft components not only superior in their functional performance, but also characterized with a unified standard."

**Q. What needs to be done to advance soft robotics?**
"I believe we already are on a good track. It is already exciting that not only classically trained mechanical, electrical engineers and roboticists associate their research with soft robotics, but also material, chemical engineers, and physicists also find their research interests coinciding with soft robotics' booming community. Therefore, while keeping this an open community (and stressing that it is), it is crucial to keep the research focus also on its applicability to address criticism that soft robotics = "mooshy" robotics. One way of addressing application oriented research would be standardization of materials, connections or fabrication processes. It may be too early to discuss this but as mentioned above, this would allow faster, and effective collaboration with different fields within soft robotics and adaptation to conventional robotic systems: proving that in fact, soft robotics is a solid research field."

Professor Jamie Paik
Reconfigurable
Robotics Laboratory
(RRL),
STI / IGM
EPFL

jamie.paik@epfl.ch

http://rrl.epfl.ch/



*Jamie's Reconfigurable matter (left) and origami soft robots*

## *Federico Carpi*

Federico Carpi is Associate Professor (Reader) in Biomedical Engineering and Biomaterials at Queen Mary University of London, School of Engineering and Materials Science, UK. He was born in Pisa, Italy, in 1975 and received from the University of Pisa the Laurea degree in Electronic Engineering, the Ph.D. degree in Bioengineering and a second Laurea degree in Biomedical Engineering. From 2000 to 2012, he has been with the University of Pisa, School of Engineering - Research Centre "E. Piaggio". Since 2012, he is with Queen Mary University of London.

From 2011 to 2014 he has been the coordinator of the 'European Scientific Network for Artificial Muscles (ESNAM)', focused on transducers and artificial muscles based on electroactive polymers. He organizes the annual 'EuroEAP: International Conference on Electromechanically Active Polymer Artificial Muscles & Transducers' and is the President of 'EuroEAP – European Society for Electromechanically Active Polymer Transducers & Artificial Muscles'.

Federico is the head of the 'SMART – Soft Matter ARtificial muscles & Transducers' Research Group. The main research focus of the group is on biomedical & bioinspired mechatronic devices made of smart materials. The activities of the group are oriented to the development of innovative devices based on electromechanically active polymer transducers (EAPs) and, in particular, dielectric elastomer (DE) transducers. DE actuators exhibit a mechanical response to an electrical stimulus, while offering, at the same time, light weight, mechanical compliance, compact size, simple structure, low power consumption, acoustically silent operation, and low cost. Because of their ability to exhibit significant actuation upon electrical stimulation and emulate the main functional properties of natural muscles, DEs are referred to as 'smart materials' as well as 'artificial muscle materials'. The group studies DE transducers as a highly-promising solution to the need for new electromechanical transduction technologies to enable a huge variety of applications not feasible or even imaginable with conventional technologies. In particular, activities of the group cover design, prototyping and testing of new devices and applications. Two examples are represented by bioinspired electrically tuneable lenses (Fig. 1) and electrically refreshable Braille cells (Fig. 2).

## *Federico on soft robotics:*

**Q. What does Soft Robotics mean to you?**

"I regard Soft Robotics as a new frontier of Robotics dealing with mechatronic systems made of compliant mechanisms and/or soft matter. Especially the second aspect is particularly interesting to me, as I think that the development of devices made of soft and smart materials might truly enable a diversity of applications hard to imagine today. My main field of research – EAP transducers – clearly shows the great potential of using soft matter that is able to respond to an electrical stimulation with a significant change of strain and stress, so as to serve for actuation or compliance control. This implies a revolutionary paradigm shift in mechatronics, from assemblies of hard components to fusions between structure and motor function.**"**

**Q. What can Soft Robotics deliver now and in the future?**

"I think that it is quite evident that what has been demonstrated so far is nothing as compared to what we can reasonably expect from the future. Indeed, the huge potential for Soft Robotics of technologies like EAP transducers is still mostly unexplored. It is not difficult to envisage significant benefits in a number of different fields of possible application, including new biomedical systems,

safe and/or comfortable man-machine mechanical interfaces, versatile autonomous robotic systems for exploration and rescue, etc."

**Q. What needs to be done to advance Soft Robotics?**

"I think that current Soft Robotic systems are made of brains much more evolved than the primitive bodies that they have to control. Indeed, the advanced state of the art of artificial intelligence is not paralleled by comparable advances for artificial bodies, including artificial muscles. So, research on smart materials needs to gain momentum in order to boost performance and enable real applications."

Dr Federico Carpi

Queen Mary University of London, School of Engineering & Materials Science, London, UK

f.carpi@qmul.ac.uk

**http://www.smart.sems.qmul.ac.uk**


Fig. 1. Bioinspired tuneable lens

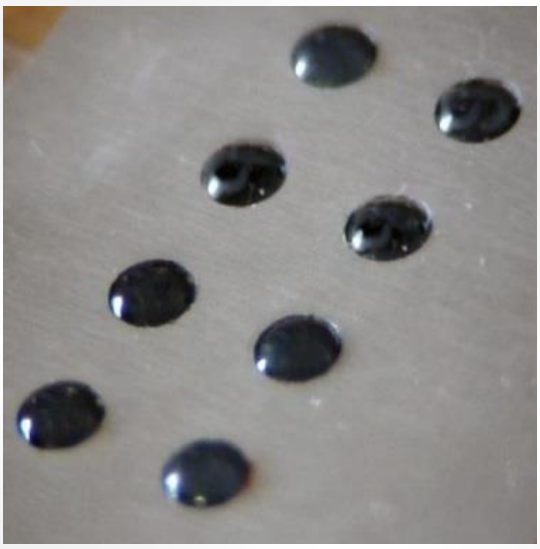


Fig. 2. Braille cell

# Contacts

**RoboSoft Project Coordinator**
Prof. Cecilia Laschi
Email: cecilia.laschi@sssup.it

**RoboSoft Scientific Secretariat and Management**
Dr. Laura Margheri
Email:laura.margheri@sssup.it

**RoboSoft Newsletter Editor**
Dr. Jonathan Rossiter
Email: Jonathan.rossiter@bris.ac.uk

**The BioRobotics Institute**
Scuola Superiore Sant'Anna
Piazza Martiri della Libertà, 33
Pisa (Italy)
Tel: +39-050883395
Fax: +39-050883497