The Newsletter of RoboSoft
A Coordination Action for Soft Robotics

Editorial

It is a great time for soft robotics: the community is very dynamic and soft technologies are catching the attention of important stakeholders, representatives of the wider science and arts communities.

“Soft” is used more and more as a required characteristics for robotics systems, especially for those that have to negotiate natural environment and/or interact with humans. In fact there are several cases where soft technologies and integrated soft systems could revolutionize the use of robotic devices, especially in applications where adaptability and safe human-robot interaction are needed. Industrial robotics arms, agriculture robots, robotic endoscopes, wearable exoskeletons and rehabilitation devices can benefit from the use of soft and variable-stiffness components to increase their capacities to interact safely, dependably and effectively with humans and the physical environment, and ultimately to increase their acceptability.

Soft robotics is becoming *trendy*, too: a recent example is the fictional Baymax in the movie "Big Hero 6" that embodies new research on soft robotics.

With this in mind, RoboSoft’s activities are dedicated to enforcing collaborations and the involvement of industrial and scientific stakeholders to define target applications for industrial and societal needs.

Figure 1: The Big Hero 6 poster – source: http://en.wikipedia.org/wiki/Big_Hero_6_%28film%29#/media/File:Big_Hero_6_(film)_poster.jpg

In this third Newsletter of RoboSoft you will read about the latest events organized within RoboSoft Coordination Action and their outcomes; you will learn about novel control approaches for soft robots from our featured young researcher Kohei Nakajima; you will hear about the great potential of using soft robotics in agriculture; you will read about new research carried out at the Centre for Robotics at King’s College London; and you will receive an update on latest events relevant for the field.

Cecilia Laschi, Laura Margheri and Jonathan Rossiter

Issue 3, March 2015

Contents:

RoboSoft Pills

The first year of RoboSoft Coordination Action ended last November 2014 and our work has been evaluated as "Excellent" by the European Commission Project Officer and the external reviewers. We are happy with the work done and we want to thank all the Community Members for their participation and support.

The RoboSoft Community counts now 27 Members worldwide: http://www.robosoftca.eu/robosoft-community/community-members
and it is still growing. We also enforced our collaborations with some existing initiatives related to soft robotics, such as the IEEE Robotics and Automation Society Technical Committee on Soft Robotics, the Soft Material Robotics IGERT at Tufts, The Initial Training Network SMART-E, and the European Scientific Network for Artificial Muscles (ESNAM).

As part of RoboSoft activities, during this year, we have organized 11 events at international robotics conferences and other 4 events for cross-fertilization with other communities, particularly aimed at sharing research activity results, discussing theoretical and technological issues, and identifying challenges and milestones for soft robotics.

The Community met at the first Plenary Meeting in Pisa and after a period of consultation, the first RoboSoft Working Paper has been released. The document is available at: http://www.robosoftca.eu/results

Soft robotics technologies are starting to find their real-world applications and the forthcoming events and activities will include this challenge to address.

The first **Soft Robotics Week** has been announced and will be held in **Livorno** (**Italy**), **April 13-17, 2015**. The event will be entirely dedicated to soft robotics, featuring a unique concentration of several scientific, cultural and educational events.

International experts across multiple fields in the scientific community of soft robotics, industrial leaders, young researchers and students will meet together to discuss current research activities and applications and to face future frontiers for the field of soft robotics.

Three major events will take place: the **SMART-E Technical Skills Workshop -** April 13-17, 2015; the **RoboSoft Spring School -** April 13-17, 2015; and the **RoboSoft Plenary Meeting -** April 15-16, 2015

The **SMART-E Technical Skills Workshop** and the **RoboSoft Spring School** merge together in a unique **Joint School on "Applications and Frontiers of Soft Robotics"** co-organized by the **SMART-E Initial Training Network** and **the RoboSoft Coordination Action**.

The School programme will follow a combination of lectures and practical sessions (hands-on technical skills training) format. Invited speakers will present technical and scientific issues related to the design and development of soft robots, in particular on:

- soft materials, soft sensors and soft actuators;
- modelling, simulation and control of soft bodies;
- design and fabrication techniques;

- energy storage, harvesting soft devices and stretchable electronics;
- interdisciplinary interactions with biological/medical sciences, material science, chemistry, and others, as well as industrial applications.

Students will have the opportunity to present their research activity during short teasers presentations combined with poster sessions and exhibition of prototypes.
Working group sessions for the students will train them using on-line tools and hardware kit to design and build soft robots for target applications with relevance to "Dexterous, Soft and Compliant Robotics in Manufacturing".
On the occasion of the two-days **RoboSoft Plenary Meeting**, students will also have the opportunity to participate in the meeting and in the discussions among leaders in the field of soft robotics.
The SMART-E Technical Skills Workshop will continue for the SMART-E students in the following week at the Italian Institute of Technology (IIT) in Genova.

The **RoboSoft Plenary Meeting** will involve the members of the RoboSoft Community, industrial stakeholders and external experts working in the field of soft robotics and related disciplines, to discuss roadmaps for soft robotics research and in particular with the focus of future applications in the robotics market. The programme includes scientific workshops with presentations by RoboSoft community members and industry stakeholders and with discussion and roadmapping activity of the RoboSoft working groups.

All the information and the registration details are available at:
http://www.robosoftca.eu/information/events/soft-robotics-week

RoboSoft is also co-organizing the workshop on "**Soft Robotics: Actuation, Integration, and Applications - Blending Research Perspectives for a Leap Forward in Soft Robotics Technology**" at the 2015 IEEE International Conference on Robotics and Automation (**ICRA 2015**), the IEEE Robotics and Automation Society (RAS) flagship conference and a premier international forum for robotics researchers.

The workshop will be held on May 30, 2015 in Seattle and will analyse how promises of soft robotics can be fulfilled, broadly benefiting society, with the ultimate goal of pointing the way forward for "real world" soft robots by answering: "Where and how can soft robots outperform rigid robots?" More information is available at:
http://robotics.oregonstate.edu/icra2015softrobotics

RoboSoft events

RoboSoft is planning a series of events and meeting opportunities for the next months:
- Soft Robotics Week, April 13-17 2015, Livorno, Italy
- Workshop at ICRA 2015, May 30, 2015, Seattle, Washington, USA

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

Follow RoboSoft

- Visit the RoboSoft web page and sign up: www.robosoftca.eu
- Facebook page
- Twitter

- For more information, contact Cecilia Laschi (cecilia.laschi@sssup.it) or Laura Margheri (laura.margheri@sssup.it)

Call for Fertilization Events

Soft robotics can be a source of inspiration, a useful tool, or a challenging application field for diverse disciplines: it can enable the realization of physical prototypes for the validation of theories and hypotheses in science; it can propose interesting case-studies for theoretical studies, mathematical analyses and techniques.

There are many potential interested scientists in other scientific communities who could fruitfully explore the field of soft robotics, which they may be not fully aware of, such as those working in the fields of neuroscience, biology, mathematics, material science, theory of modelling in fluido-dynamics or elasto-dynamics, medicine, and many others.

In consideration that scientists in these disciplines may not be easily attracted by soft robotics events, the strategy put in place in RoboSoft is to organize “fertilization” events at their main scientific meetings. These fertilization events can be special sessions or workshop or talks on soft robotics at, e.g. a biology or material science conference, mathematical modelling or medical symposia, or even exhibitions.

RoboSoft Community Members are invited to propose events for fertilization to promote soft robotics.

These events can be financially supported by RoboSoft. All RoboSoft community members are invited to contribute. If you are interested in this initiative, if you are planning a participation in a scientific event where soft robotics could be presented, and if you are available to give a presentation of RoboSoft, please write to Laura Margheri (laura.margheri@sssup.it).

Soft Bites

People: Kohei Nakajima on Physical Reservoir Computing for Soft Robots

Soft machines, which have flexible elements in their bodies, have attracted attention in a number of research fields in recent years. These machines provide significant advantages over traditional articulated ones in terms of interactional safety and resilience in applications [1]. They can adapt their body morphology to unstructured environments and manipulate fragile objects without causing damage, which make them especially applicable for rescues and interactions with humans [2].

In the OCTOPUS Integrating Project, we have also been pursuing the potential of soft bodies, but from a different angle. Our primary focus is the diverse and complex body dynamics that they exhibit when stimulated. In general, these dynamics exhibit a variety of properties, including nonlinearity, memory, and potentially infinite degrees of freedom, which leads to well-known difficulties in controlling these machines [3].
In nature, however, some animals have soft bodies and are able to control them in a sophisticated manner. The octopus serves as an extreme example. It has no rigid components in its body, which can execute virtually infinite degrees of freedom. Its motion control is far-reaching in terms of the conventional control framework. Recent biological findings suggest that the octopus masters its complex body in a highly sophisticated manner by capitalizing on its body dynamics [4].

Inspired by the octopus, we have pursued ways to exploit these dynamics positively and have found that the diverse properties of soft body dynamics are beneficial in that they allow us to use soft bodies as computational resources. The concept of embodiment manifested that the behavior of robots is generated from the dynamic coupling between the controller, the body, and the environment [5, 6]. In fact, many current bio-inspired robots are focused on a design of body morphology, aiming to make control efficient by partially outsourcing the robot's control to the body. Our approach also follows this line of thought, but more explicitly and radically, which provides higher and more efficient programmability and directly appeals to the information processing layer.

Our approach is based on a machine learning technique called *reservoir computing*, which has a particular focus on real-time computing with time-varying inputs and is suited to emulate complex temporal computations [7, 8]. Its framework places emphasis on the transient dynamics of high-dimensional dynamical systems, which are typically referred to as the *reservoir*. To have computational capabilities, a reservoir should have the properties of input separability and fading memory. Input separability is usually achieved by nonlinear mapping of low-dimensional input to a high-dimensional state space. Fading memory is a property of a system that retains the influence of a recent input sequence within the system, which permits the integration of stimulus information over time. This enables reproducible computation for which the recent history of the signal is significant. If the dynamics of the reservoir involve enough nonlinearity and memory, emulating complex, nonlinear dynamical systems requires only adding a linear, static readout from the high-dimensional state space of the reservoir. In particular, the approach using a physical entity rather than abstract computational units as a reservoir is called *physical reservoir computing* (a simple summary of physical reservoir computing can be found in [9]).

Using body dynamics generated from soft robotic platforms and models, we have shown in a number of cases that these diverse properties of soft body dynamics can be sufficient to be a successful reservoir and can be employed to emulate desired nonlinear dynamical systems. For example, it is well known that the octopus has a characteristic muscle organization called muscular-hydrostat, which keeps its volume constant during muscle contractions. Using a dynamic model of the muscular-hydrostat system, we have shown that it has a certain information processing capability [10]. Moreover, using a dynamic model of a soft robotic arm equipped with the muscular-hydrostat system, we have quantified its information processing capability and shown that it can embed nonlinear limit cycles into the body in a closed-loop manner [11]. This implies that without any support of nonlinearity and memory from external controllers, using only its own complex body dynamics, we can embed a motor program, such as a CPG, directly into the body itself. Recently, these results have been also demonstrated using real-world physical soft robotic platforms made of silicone materials [12, 13]. Researchers interested in locomotion are starting to follow this approach, which directly exploits body dynamics to embed robust oscillatory motor patterns [14]. We expect that the scheme of physical reservoir computing will open up various engineering applications and research opportunities in soft robotics.

References

1. Pfeifer R, Lungarella M, Iida F. 2012 **The challenges ahead for bio-inspired 'soft' robotics**. Commun. ACM 55, 76–87. (doi:10.1145/2366316.2366335)
2. Kim S, Laschi C, Trimmer B. 2013 **Soft robotics: a new perspective in robot evolution**. Trends Biotechnol. 31, 287–294. (doi:10.1016/j.tibtech.2013.03.002)
3. Tedrake R. 2009 **Underactuated robotics: learning, planning, and control for efficient and agile machines**. Course Notes for MIT 6.832: Working draft edition.
4. Hochner B. 2012 **An embodied view of octopus neurobiology.** Curr. Biol. 22, R887–R892. (doi:10.1016/j.cub.2012.09.001)
5. Pfeifer R, Lungarella M, Iida F. 2007 **Self-organization, embodiment, and biologically inspired robotics**. Science 318, 1088–1093. (doi:10.1126/science.1145803)
6. Pfeifer R, Bongard J. 2006 **How the body shapes the way we think: a new view of intelligence**. Cambridge, MA: MIT Press.
7. Jaeger H, Haas H. 2004 **Harnessing nonlinearity: predicting chaotic systems and saving energy in wireless communication**. Science 304, 78–80. (doi:10.1126/science.1091277)
8. Maass W, Natschlager T, Markram H. 2002 **Real-time computing without stable states: a new framework for neural computation based on perturbations**. Neural Comput. 14, 2531–2560. (doi:10.1162/089976602760407955)
9. Hauser H, Füchslin RM, Nakajima K. 2014 **Morphological Computation - The Body as a Computational Resource**, in E-book on *Opinions and Outlooks on Morphological Computation* (edited by

Helmut H, Füchslin RM, Pfeifer R), Chapter 20, 226-244.
10. Nakajima K, Hauser H, Kang R, Guglielmino E, Caldwell DG, Pfeifer R. 2013 **Computing with a muscular-hydrostat system**. In Proc. IEEE Int. Conf. on Robotics and Automation, Karlsruhe, Germany, 6–10 May 2013, 1504–1511. (doi:10.1109/ICRA.2013.6630770)
11. Nakajima K, Hauser H, Kang R, Guglielmino E, Caldwell DG, Pfeifer R. 2013 **A soft body as a reservoir: case studies in a dynamic model of octopus-inspired soft robotic arm**. Front. Comput. Neurosci. 7, 91. (doi:10.3389/fncom.2013.00091)
12. Nakajima K, Li T, Hauser H, Pfeifer R. **2014 Exploiting short-term memory in soft body dynamics as a computational resource**. J. R. Soc. Interface 11, 20140437. (doi:10.1098/rsif.2014.0437)
13. Nakajima K, Hauser H, Li T, Pfeifer R. 2015 **Information processing via physical soft body**. (submitted)
14. Zhao Q, Nakajima K, Sumioka H, Hauser H, Pfeifer R. 2013 **Spine dynamics as a computational resource in spine-driven quadruped locomotion**. In Proc. IEEE/RSJ Int. Conf. on Intelligent Robots and Systems, Tokyo, Japan, 3-7 Nov. 2013, 1445-1451. (doi: 10.1109/IROS.2013.6696539)

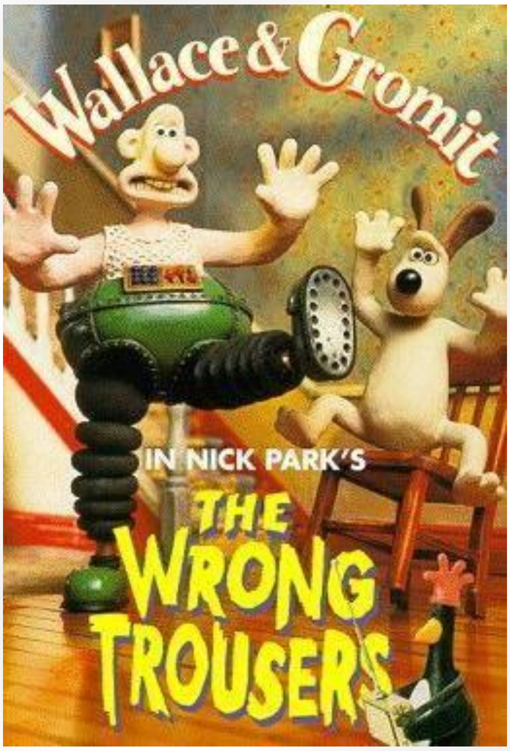
Kohei Nakajima

Kohei Nakajima is an Assistant Professor at the Hakubi Center for Advanced Research in Kyoto University. He received the B.S., M.S., and Ph.D degrees from the University of Tokyo in 2004, 2006, and 2009, respectively. From 2009 to 2013, he was involved in the OCTOPUS Integrating Project (FP7, ICT-FET, contract number 231608) as a postdoc researcher at University of Zurich. He was one of the organizers of *the 2nd International Conference on Morphological Computation (ICMC2011)* and *the 2013 International Workshop on Soft Robotics and Morphological Computation (SoftRobot2013)*. From 2013 to 2014, he was a JSPS Postdoctoral Fellow for Research Abroad at ETH Zurich - Swiss Federal Institute of Technology Zurich. In 2013, he was awarded the title of the Hakubi researcher from Kyoto University (20 awardees out of 644 applicants). His research interests include nonlinear dynamical systems, embodied cognition, physical reservoir computing, and information theory.

Projects: Move over Wallace and Gromit – it's the right trousers!

A new Soft Robotics project led by the University of Bristol aims to address the growing healthcare needs of people to live independently with dignity. There are 10.8 million disabled people living in the UK today (Office for Disability Issues 2010). Nearly 6.5 million have mobility impairments; 6 million have an impairment of lifting and carrying; 2.4 million have impaired co-ordination. Many of these people are supplied with assistive and rehabilitative technologies (ART), but much ART has low user acceptability and concordance, and may have a negative impact on people's perceived dignity. Many people do not use ART correctly, or at all, and many people find ART devices undignified. In extreme cases ill-fitting or ill-prescribed ART may even cause injury or increase disability. The consequence of this lack of effective and acceptable ART is that people living with mobility impairments are more prone to conditions such as poor circulation, skin pressure damage and falls. Each of these conditions has an enormous public health implication and together they constitute a substantial drain on health and social care resources. The cost of falls to the UK NHS alone is £2Bn, skin pressure damage £2.1Bn, and the overall cost of stroke to health and social care services and the loss of income is £9.8Bn.

This project will be the first time that emerging soft robotics technologies are employed to address multiple rehabilitation and health care needs in one single class of wearable device, enabling effective and comfortable rehabilitation, functional restoration and long term assisted living. In contrast to conventional rigid robotics, the inherent physical compatibility of soft robotics with biological tissue and human motion means that truly adaptive assistive and rehabilitative technologies (or aART) can be realised. Soft robotic aART has the potential to be the ubiquitous, low cost and highly adaptable technology that transforms independent living for the disabled and infirm.



The exciting challenge of this project is to develop fundamental soft robot technologies needed to deliver wearable soft robotic assistive clothing and devices that are: 1. Effective in respect to a patient and their clinical need; 2. Easy to use; and, 3. Highly adaptable. The outcome of this project will be two fully tested soft robotic wearable demonstrator devices, including smart trousers.

The project is part of a £5.3 million funding programme announced by the UK Engineering and Physical Sciences Research Council (EPSRC) to transform the design of assistive and rehabilitative devices

Project Details
Title: *Wearable Soft Robotics for Independent Living*
Project Lead: *Dr Jonathan Rossiter, University of Bristol*
Funder: *Engineering and Physical Sciences Research Council*
Total Budget: *£2.5M (€3.4M)*
Timeline: *July 2015-July 2018*
Project Partners: Universities of Bristol, Leeds, Loughborough, Nottingham, Southampton, Strathclyde, and the West of England

Places: Centre for Robotics Research at the Department of Informatics, King's College London

Scientists at the Centre for Robotics Research at the Department of Informatics, King's College London, are researching a new type of soft robotic manipulator making use of a novel hybrid actuation principle combining pneumatic and tendon-driven actuators. The interaction of these two actuation principles leads to an overall antagonistic drive mechanism whereby pneumatic actuation opposes tendon actuation. We have taken inspiration from biology where quite commonly muscle groups oppose each other and can be actuated at the same time to achieve stiffness. The octopus is a particularly interesting example, since it has no skeletal structure and is relying solely on this stiffening mechanism to move stones, catch prey or even walk - the octopus uses its longitudinal and transversal muscles in its arms to achieve varied motion patterns - activating both sets of muscles, the octopus can control the arm stiffness over a wide range.

The new approach proposed by the King's roboticists mimics this antagonistic muscle behaviour and achieves comparable motion patterns, including bending, elongation and stiffening. It combines the advantages of tendon-driven and pneumatic actuated systems and goes beyond what current soft, flexible robots can achieve: because the new robot structure is effectively an inflatable sleeve, it can be pumped up to its fully inflated volume but, also, completely deflated and shrunk, when required. Since, in the deflated state, it comprises just its outer "skin" and tendons, the robot can be compressed to a very small size, many times smaller when compared to its fully-inflated state. The described work is summarised in the proceedings of IROS 2014 and ICRA 2015.

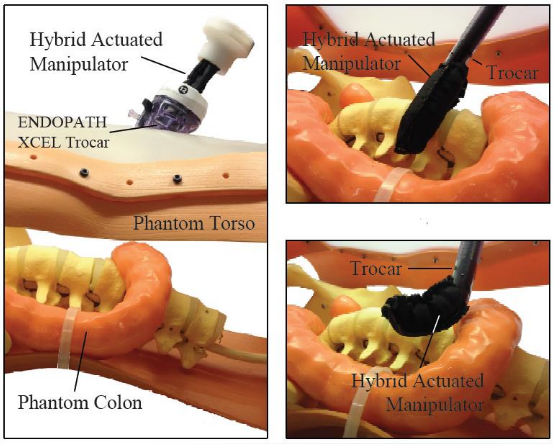


Figure 2: The inflatable manipulator is squeezed through an ENDOPATH XCEL Trocar of 18mm diameter

Contact Details:

Web: http://nms.kcl.ac.uk/core/

Kaspar Althoefer: kaspar.althoefer@kcl.ac.uk
Helge Würdemann: helge.wurdemann@kcl.ac.uk

Industries: Soft Robotics in Agriculture

Farmers are operating in a natural environment. Animals, fruits, vegetables, plants in general, as well as soil interaction in various processes set the stage. It seems obvious that bio-inspired and soft robotics approaches go along well with these surroundings. And in fact, some of the tedious manual tasks could not be automated so far due to mainly two reasons: too complex control algorithms and lack of suitable manipulators. At least the second issue can be addressed through new soft robotics ideas. But there is even more potential…

It is the intent of this article to raise awareness of soft robotics potential for agriculture tasks and tickle the brains of researchers to combine their robotics experience with a focus on a more sustainable farming in terms of machinery usage as well as production and logistics processes. Besides inspiration for practical use in the industry the two following examples about machinery usage and about harvest processes will address questions to the research community. One thing is for sure: We will need more food in the years to come and we will need to produce it with less input, be it work force, energy or seeds and agrochemicals.

Tractor Tires

The tire and the tire-soil interaction are often underestimated in its importance for agricultural machinery and processes. For agricultural tractors the largest share (about 40 %) of overall power loss from tank to pulled implement arises from slip and rolling resistance within the tire-soil contact [1]. Besides that, soil compaction from machinery has substantial impacts on the yield potential of arable land. The tire pressure is currently the main parameter to address optimum adaption to the operating environment. E.g. a high pressure on the road allows for lower rolling resistance and wear, low pressure in the field creates a larger footprint to achieve low track depth and rolling resistance and at the same time a high contact area to provide maximum tractive capabilities. On top of that, tractor tires need to provide comfort functions by dampening and deflection behaviour as possibilities to provide separate chassis suspension are limited.

Figure 3: Fendt 939 Vario Tractor

Changing the tire pressure in a big tractor is not a piece of cake. The overall atmospheric air volume of the four tires for a typical tractor like a Fendt 939 Vario, **Fig. 2** is more than 2800 litres. Required operating pressure changes are often more than 1 bar. A rough calculation of the energy demand for such a pressure change indicates that an equivalent of more than 0,2 l Diesel are required for only one change – and the tremendous demand of air to fulfil this pressure change results in filling times of more than 10 minutes. This limits practical usability. The following topics have been identified as potential benefits of a "RoboTire", that would work with smart materials, integrated changeable structures and a direct electronic control:

Now how would a technical solution of a RoboTire look like? One example that could give a hint is the Michelin Tweel [2], shown in **Fig. 3**. How about designing soft actuators into the wheel to realize spokes with variable stiffness? Could this allow for large footprints in the soil? A more comfortable ride on the road? Stiffness changes in an instance, electronically controlled? With less energy required and less additional system components? Could we use the tire as a sensor to provide feedback about the ground the tractor works on and even determine soil types? Could we determine wheel loads in real time and provide date to an intelligent ballasting and torque control algorithm? Could smart materials change the profile from field (high traction) to road (low rolling resistance)? Could we instantly react on bumps and other impacts to deliver more ride comfort? What about tires that can change their geometry from round to square to allow for climbing stairs? Can we overcome phenomenons like power-hop [3]? Could we harvest energy from the damping function instead of dissipating it? Could the tire react on the wheel load and guarantee optimum driving conditions in a wide range of loads and surfaces? Could we even realize propulsion and steering by clever, dynamic shaping of individual wheel segments? What else could we think of? And how would a technical proof of concept look like? Good Year has recently shown prototypes for the automotive sector [4].

Figure 4: Michelin Tweel, Source: Construction Business Owner [5]

Cucumber Harvesting

Cucumber harvesting in Germany is a well-paid job - for those that are not part of a prospering high GDP country with favourable office jobs and thus need to accept the strains of a long working day, lying face down to pick cucumbers, **Fig. 4**. The retail market of industrialized nations is driven by a low cost consumer attitude that hardly values food appropriately and forces agriculture into a low cost struggle. New laws for a minimum wage in Germany are expected to result in a minor earthquake. Many labour intensive vegetable production systems need to rely on cheap and willing workforce from low income countries. Besides economic arguments (and of course someone somewhere in the world will continue to deliver low cost cucumbers), is it a valid long term vision to waste human intelligence by locking labour force into monotonous potentially harmful manual tasks?

The market potential of an actuator and a control system, that can identify cucumbers by their size, that can grab them carefully cut them off the plant to place them on a conveyor belt is huge. In Germany only we are talking about some 10.000 employees and seasonal workforce, Germanys annual cucumber production in 2013 was 223.000 tons [6]. If the weather is too hot, the harvesting capacities are not even big enough to keep the pace and food is rotting on the field.

There are first concepts of automated versions, but they dig out the whole plant [7]. This is economically critical, as only a specific size of cucumbers can be sold by the farmer and thus the “human harvesters” are passing every plant up to 30 times during the season to check whether new cucumbers have reached the target size. There are also robot research approaches for green house production [8], but no commercial products. A similar situation applies to e.g. strawberry and asparagus.

Figure 5: Cucumber Harvester, Source: Lausitzer Rundschau [9]

It feels like soft robotics has the potential to provide solutions to some of these challenges as well as many other applications in the broad field of agriculture. Academia research needs to address it and offer practical proof of concept demonstrators. Clever ideas will provide reputation to the research community and lead to joined actions of academia and industry creating strong and economical successful networks.

AGCO

AGCO is a global leader focused on the design, manufacture and distribution of a full line of agricultural machinery. Products are sold through five strong core brands, Challenger®, Fendt®, Massey Ferguson®, Valtra® and GSI®, and are distributed globally through 3,150 independent dealers and distributors in more than 140 countries worldwide. Founded in 1990, AGCO is headquartered in Duluth, Georgia, USA. More than 20.000 people around the globe are currently working for AGCO. In 2014 AGCO reported net sales of 9.7 Billion USD. About 300 Million Euros annually R&D budget fuel technology and innovation leadership, another 300 Million are spent for invest. Being 100 percent focused on agriculture means that 100 percent of the R&D budget goes towards moving agricultural industry and technology forward.

Fendt

Fendt is the leading high-tech brand of AGCO for the most demanding, professional customers. In multiple areas of agricultural technology, Fendt is recognized as the pioneer par excellence when it comes to trendsetting innovations. Fendt customers benefit earlier from the latest technology for enhancing performance, efficiency and profitability in their farming businesses. AGCO Fendt employs some 3,700 people in the areas of research and development, sales and marketing, production, service and administration at its Marktoberdorf, Asbach-Bäumenheim and Hohenmölsen sites in Germany.

Fendt Research & Advanced Engineering

A core team of eight people, embedded in a local expert network and a global R&AE organisation is the spearhead of Fendt future technologies. The group's duties range from preparing short and mid-term innovations for new product introductions to long term strategic research and guidance. Patents and IP services are anchored in this department as the management of effective relations to universities and research institutes. The team has mainly an engineering background but a broad understanding of natural sciences and profound knowledge about agricultural processes and agronomy is a must. In this context the Fendt R&AE department is currently involved in two robotic initiatives, funded by the European Union: SMART-E, a Marie Curie Actions Network (http://www.smart-e-mariecurie.eu) and Echord++ (http://www.echord.eu).

References

1. Pichlmaier, B.: **Traction Management for Large Tractors**. ATZoffhighway, November 2011.
2. Product Website: http://www.michelintweel.com/ (Internet: March 11th 2015)
3. Wiley, J. C., R. J. Turner: **Power Hop Instability of Tractors**. In: ASABE Distinguished Lecture Series 32 (2008)
4. Edelstein, S.: Goodyear Unv**eils Electricity-Generating And Shape-Shifting Concept Tires At Geneva**. http://www.motorauthority.com (Internet: March 11th 2015)
5. Image Source: http://www.constructionbusinessowner.com (Internet: March 11th 2015)
6. **Cucumber and Gherkins.** FAO Statistics. http://faostat3.fao.org (Internet: March 11th 2015)
7. N.N.: Gurkenernte mit High Tech. (engl.: High Tech cucumber harvest). www.handelsblatt.com, September 7th 2013. (Internet, March 11th 2015)
8. Henten, E.J. van et Al.: **Optimal manipulator design for a cucumber harvesting robot**. Computers and Electronics in Agriculture 65 (2), 2009. - p. 247 – 257
9. Image Source: Lausitzer Rundschau. www.lr-online.de, June 21st 2008. (Internet: March 11th 2015)

AGCO

Contact Details:

Benno Pichlmair:
benno.pichlmaier@agcocorp.com

Web: http://www.agcocorp.com

Event: Electroactive Polymer Actuators and Devices (EAPAD) XVII Conference

The 17th Electroactive Polymer Actuators and Devices conference took place in San Diego, CA, from 8-12 March, as part of the SPIE Smart Structures/NDE symposium. This is one of the main venues for presentations of advances in soft smart materials.

The four-day long conference was packed with many exciting talks, ranging from material science through fabrication processes to applications and soft machines. Electroactive Polymers (EAPs) are being used as sensors, actuators and generators, as well as combinations of the above. The keynote presentation was given by Brett Kennedy (NASA JPL) on the development of the RoboSIMIAN (simian=monkey), JPLs entry to the DARPA Robotics Challenge.

One highlight was the annual EAP-in-action demonstration session, where the latest applications of EAP technologies were showed off. Demos included a crawling robot fabricated entirely from soft materials, grippers, applications of nylon-based sensors and actuators, and compact driving electronics.

I also enjoyed the talks and demos from the LMTS lab at EPFL, Switzerland, where they produce very nice silicone Dielectric Elastomer Actuators (DEAs) with long lifetimes, thin layers and finely-patterned electrodes that they were using for grippers, soft proximity sensors and for measuring the contraction of muscle cells.

Electroactive Polymers still exist primarily in research labs, but in the last few years they have started making their way into commercial applications. Many of the long-standing issues of fabrication and reliability, as well as driving electronics, are being overcome and there were presentations at the conference from companies using EAP technologies. StretchSense, an up-and-coming spinout from the Auckland Biomimetics Lab, New Zealand, are making soft and flexible stretch sensors. Here, they demonstrated a very cool motion-capture glove controlling the video game *Doom*! Optotune, from Switzerland, are using EAP actuators for tuneable optics.

For me, the conference highlighted that EAPs are approaching the stage where they are ready for commercialisation on a large scale. The field is moving fast, and much will happen in the next few years in the field of soft and compliant actuators!

Proceedings from the conference will be available from the SPIE digital library.

Related upcoming conferences:

EuroEAP 2015. Tallinn, Estonia, 9-10 June 2015. http://www.euroeap.eu/conference

8th World Congress on Biomimetics, Artificial Muscle and Nano-Bio. Vancouver, Canada, 24-26 August 2015. www.BAMN2015.org

Contact Details:

Espen Knoop:
Espen.Knoop@bristol.ac.uk

Event: Soft Robotic workshop in the EU project SMART-E

SMART-E (http://smart-e-mariecurie.eu/) is a Marie Curie ITN project coordinated by Samia Nefti-Meziani (University of Salford). As an ITN (International Training Network) the project has received funding to prepare a group of PhDs to form leaders for the next generation of roboticists to secure sustainable manufacturing. All of the 13 PhDs as well the 2 involved postdocs work in different areas at various universities and with industrial partners. Besides the supervision and the opportunity to research at top universities in Europe, the students will get valuable insights from secondments at partners like FESTO, AGCO GmbH, R.U.Robotics Ltd., ABB, the Shadow Robot Company Ltd., and others. On top of that they receive education in management techniques and entrepreneurial skills.

The project has three main research topics, which have been identified as areas of great potential for future industrial applications. One of these is **soft robotics** in manufacturing, which involves a postdoc from the Artificial Intelligence Laboratory from the University of Zurich, two PhDs and another postdoc from the BioRobotics Institute from Scuola Superiore Sant'Anna.

In the context of SMART-E Martin Eder, Rolf Pfeifer and Helmut Hauser organized a virtual workshop via a teleconferencing system to introduce all PhDs of the project to the ideas of soft robotics, morphological computation, and embodiment. Over the range of two weeks a total of 23 speakers talked about various facets of soft robotics. The list of speaker was impressive. They came from renowned universities all around the world. For example, from the US the workshop included Barry Trimmer (Tufts University), Rob Wood (Harvard), Rob Shepherd (Cornell) and Josh Bongard (University of Vermont). From Europe the workshop featured talks by Fumiya Iida (Cambridge/ETH), Cecilia Laschi (SSSA), Jonathan Rossiter (University of Bristol), Auke Ijspeert (EPFL), Benno Pichlmaier (AGCO GmbH), and many others. Of course soft robotics is also a big topic in Japan and China. Hence, we had great speakers from Asian universities like Rolf Pfeifer (Osaka University and Shanghai Jiaotong University), Masayuki Inaba (University of Tokyo), and Koh Hosoda (Osaka University). For a full list of speakers and more details, please refer to the SMART-E homepage.

The talks covered a whole range of topics reflecting the interdisciplinarity of soft robotics.

For example, the involved speakers are working in classical robotics, in material science, and biology. Others carry out their research in the field of computer science, neuroscience, or they are developing new technologies in agriculture. This points also to the great potential of soft robotics to bring a lot of different technologies together to provide novel approaches.

Figure 6: The commando centre of the teleconferencing workshop

All talks were recorded and they are made available for everybody on the SMART-E homepage. The idea is to reach as many people as possible, to inspire and to disseminate the idea of soft robotics.

In addition and in parallel to the talks, the students worked in teams of two to three on hand-on tasks. They received basic robotic toolkits designed by Dorit Assaf [1] (Tufts University and expert in educational technologies). The groups worked on two predefined tasks that involved designing robots based on soft morphologies to meet defined performance goals. A third task was carried out in simulations in Ludobots, a freely available software package that allows you to develop easily different morphologies and combines them with Genetic Algorithms to find optimal controllers for them. Despite the intense program all groups provided impressive design and very creative and clever solutions (see pictures for a couple of examples).

[1] http://www.droidfactory.ch

The feedback of the students was great. We hope to be able to repeat the workshop in one or another form. In the mean time, please feel free to share the videos and let as many people as possible enjoy learning about soft robotics.

Figure 7: Students of the TU Munich

<u>Workshop Details:</u>

Contact: Helmut Hauser
helmut.hauser@bristol.ac.uk
Title: *SMART-E Teleconference Workshop on Soft Robotics*
Organizers: *Martin Eder, Rolf Pfeifer and Helmut Hauser*
Speaker: 23 speakers from USA, Europe, China and Japan.
Participants: *14 Students from ITN Marie Curie project SMART-E project*
Link: *http://smart-e-mariecurie.eu/training_main*

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