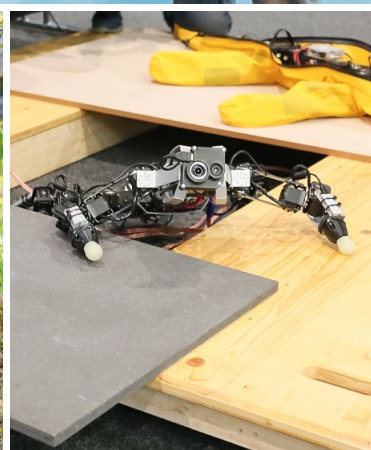
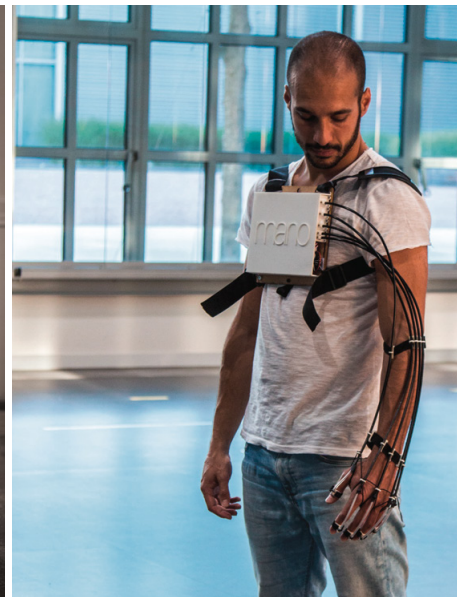


robotics⁺

Swiss National
Centre of Competence
in Research

INFORMATION PACK



CONTACT INFORMATION

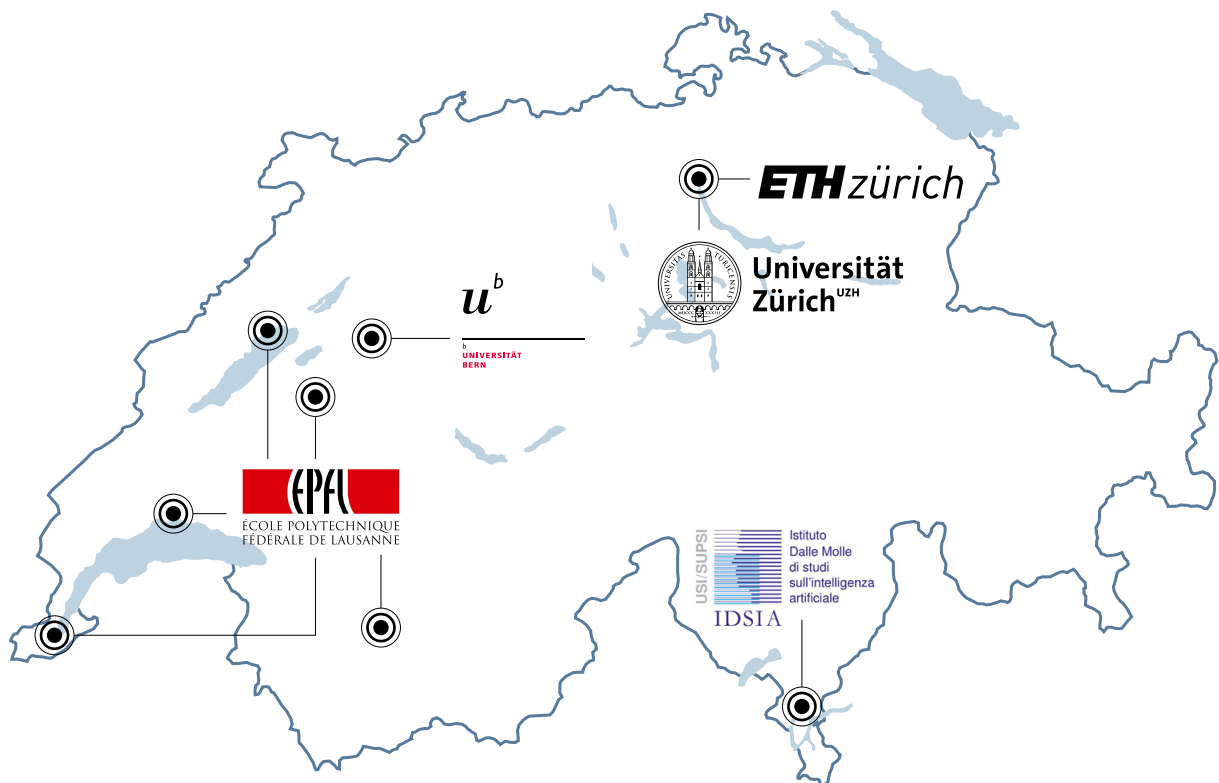


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The National Centre of Competence in Research (NCCR) Robotics is a federally funded programme bringing together robotics laboratories from EPFL, ETH Zurich, University of Zurich, University of Lugano and University of Bern to work on wearable, rescue and educational robots.

Please sign up for our news bulletins to receive cutting edge news from NCCR Robotics as it happens.



For any other queries or to arrange to speak to one of our research scientists please contact Jan Kerschgens (jan.kerschgens@epfl.ch), the NCCR Robotics Managing Director or Joëlle Mottier (joelle.mottier@epfl.ch), the NCCR Robotics Communication Officer.

ABOUT US

NCCR ROBOTICS

INTELLIGENT ROBOTS FOR IMPROVING THE QUALITY OF LIFE

The National Centre of Competence in Research (NCCR) Robotics is a Swiss nationwide organisation funded by the [Swiss National Science Foundation](#) pulling together top researchers from all over the country with the objective of developing new, human oriented robotic technology for improving our quality of life. The Centre opened on 1st December 2010, and binds together experts from five world-class research institutions: Ecole polytechnique fédérale de Lausanne ([EPFL](#), leading house), Eidgenössische Technische Hochschule Zürich ([ETH Zurich](#), co-leading house), Universität Zürich ([UZH](#)), Istituto Dalle Molle di Studi sull'Intelligenza Artificiale ([IDSIA](#)) Lugano and University of Bern ([UNIBE](#)) for a period of up to 12 years.

We are at the forefront of robotics research and develop robots that co-exist symbiotically with humans in order to enable them to help both individuals and society.

EPFL

EPFL is Europe's most cosmopolitan technical university with students, professors and staff from over 120 nations. A dynamic environment, open to Switzerland and the world, EPFL is centered on its three missions: teaching, research and technology transfer. EPFL works together with an extensive network of partners including other universities and institutes of technology, secondary schools and colleges, industry and economy, political circles and the general public, to bring about real impact for society.

ETH ZURICH

Founded in 1855, ETH Zurich has more than 20,600 students from over 120 countries, including 4,100 doctoral students. It offers an inspiring working environment to researchers and a comprehensive education to students. Twenty-one Nobel Laureates have studied, taught or conducted research at ETH Zurich, underlining the excellent reputation of the university.

UNIBE

With roots in the 1500s, the institution is based in the heart of the Swiss capital, Bern, and counts Albert Einstein as a former lecturer. 17,500 students benefit from a full range of courses in most disciplines. With notable strengths in space science, dentistry, climate science and biomedical engineering, the University of Bern is also a leading house for five national competence centres.

UZH

The University of Zurich (UZH) is a member of the League of European Research Universities and numbers among Europe's most prestigious research institutions. UZH's international standing is reflected in the many renowned academic distinctions conferred upon its members, including twelve Nobel Prizes. As Switzerland's largest university, UZH has a current enrollment of over 25,000 students and offers the most comprehensive academic program in the country. Nearly 5,000 excellent members of staff teach and perform research at one of the University's 130 departments, including 675 professors. UZH also looks back on a rich history, having been founded in 1833 as Europe's first university to be established by a democratic political system.

IDSIA

The Swiss AI Lab IDSIA is a not-for-profit research institute for artificial intelligence, affiliated with both the Faculty of Informatics of the Università della Svizzera Italiana and the Department of Innovative Technologies of SUPSI, the University of Applied Sciences of Southern Switzerland. IDSIA focuses on machine learning (deep neural networks, reinforcement learning), operations research, data mining, and robotics.

KEY MEMBERS



DIRECTOR

PROF. DARIO FLOREANO

LABORATORY OF INTELLIGENT SYSTEMS (LIS), EPFL

Dario Floreano is the director of the Laboratory of Intelligent Systems and director of the NCCR Robotics. His research activities focus on aerial robotics, soft robotics, wearable robotics and evolutionary robotics. He published almost 400 peer-reviewed articles and four books on Artificial Neural Networks, Evolutionary Robotics, Bio-inspired Artificial Intelligence, and Bio-inspired Flying Robots. His research and communication activities resulted in two companies, senseFly.com and Flyability.com, and in the online robotics news platform RoboHub.org. Dario Floreano has supervised almost 40 PhD students and 20 postdocs, many of whom hold professorships and started companies. He is or has been on several boards, such as the Future and Emergent Technologies of the European Commission, the International Society of Artificial Life, Inc., the General Agenda Council on robotics and smart devices of the World Economic Forum, the International Society for Neural Networks, and several research centers and programs.



CO-DIRECTOR

PROF. ROBERT RIENER

SENSORY MOTOR SYSTEMS LAB (SMS), ETH ZURICH

Robert Riener is Full Professor for Sensory-Motor Systems at the Department of Health Sciences and Technology, ETH Zurich. As he holds a Double-Professorship with the University of Zurich, he is also active in the Spinal Cord Injury Center of the Balgrist University Hospital (Medical Faculty of the University of Zurich). Robert obtained his doctoral degree from the TU München in 1997. Since he began working in Zurich, Riener has developed robots and interaction methods for motor learning in rehabilitation and sports.

His current research interests involve human motion synthesis, biomechanics, virtual reality, man-machine interaction, and rehabilitation robotics, along with being the founder and head of Cybathlon 2016.



PROF. DAVID ATIENZA

EMBEDDED SYSTEMS LABORATORY (ESL), EPFL

David Atienza Alonso is Associate Professor of electrical engineering and director of the Embedded Systems Laboratory (ESL) at EPFL. He received his PhD degree in Computer Science from the Inter-University Micro-Electronics Center (IMEC), Leuven, Belgium. His research interests focus on system-level design methodologies for high-performance multi-processor systems-on-chip (MPSoC) and low-power embedded systems, including new thermal-aware design for 2D and 3D MPSoCs, design methods and architectures for wireless body sensor networks, dynamic memory management and interconnection hierarchy optimisations.



PROF. AUDE BILLARD

LEARNING ALGORITHMS AND SYSTEMS LABORATORY (LASA), EPFL

Aude Billard is a Full Professor at EPFL and head of the Learning Algorithms and Systems Laboratory (LASA). She has a PhD in artificial intelligence from the University of Edinburgh and moved to EPFL in 2006 where she was first an associate professor, becoming a full professor in 2014. Aude Billard's research interests include control, automation, neural modelling and computation.

**PROF. OLAF BLANKE**

LABORATORY OF COGNITIVE NEUROSCIENCE (LNCO), EPFL

Olaf Blanke is the director of the Laboratory of Cognitive Neuroscience at EPFL and is Professor of Neurology at the Department of Neurology at the University Hospital of Geneva. His research is dedicated to the neuroscientific study of multisensory body perception and its relevance for self-consciousness by using a broad range of methods such as neuropsychology, invasive and non-invasive electrophysiology and brain imaging in healthy subjects, neurological and psychiatric patients. Most recently he has pioneered the joint use of engineering techniques such as robotics and virtual reality with techniques from cognitive neuroscience and their application to systems and cognitive neuroprosthetics and neuro-rehabilitation.

**PROF. HANNES BLEULER**

ROBOTIC SYSTEMS LABORATORY (LSRO), EPFL

Hannes Bleuler became “Toshiba Professor for Intelligent Mechatronics” in 1991 at the Institute of Industrial Science of The University of Tokyo, after a position as lecturer at ETHZ (main course “Technische Dynamik” for mechanical engineers). In 1994 he became associate professor at the Precision Engineering Department of The University of Tokyo. Since 1995 he is full professor of Microengineering at EPFL, with biomedical robotics as main activity. He is responsible for relations of EPFL and Japan (academic and industrial).

Several spin-off companies have been created by PhDs from his lab. His interests are in medical robotics (surgery telemanipulators and rehabilitation devices), human-machine interface, haptics and mechatronics in general.

Hannes Bleuler is member of the Swiss Academy of Technical Sciences (SATW), IEEE, and is a Fellow of the School of Engineering of The University of Tokyo..

**PROF. MARGARITA CHLI**

VISION FOR ROBOTICS (V4RL), ETH ZURICH

Margarita Chli, is an Assistant Professor at ETH Zurich leading the Vision for Robotics Lab (V4RL). Moreover, she is the vice-director of the Institute of Robotics and Intelligent Systems of ETH Zurich and an Honorary Fellow of the University of Edinburgh in the UK. She holds Bachelor and Master degrees in Information and Computing Engineering from the University of Cambridge (Trinity College), UK, and a PhD in Information Theory for efficient robot navigation from Imperial College London. Previous posts include the prestigious Chancellor’s Fellowship of the University of Edinburgh, while she currently holds the highly competitive Swiss National Science Foundation Professorship. Her research interests lie in developing vision-based perception for robots, while her work contributed to the first vision-based autonomous flight of a small helicopter. Margarita received numerous academic scholarships from both Cyprus and Cambridge as well as international recognition for her work earning her a place in Robohub’s 2016 list of 25 women in Robotics you need to know about, while she received the biannual Zonta Prize 2017 on the basis of her high impact contributions on the development of robotic vision. Margarita’s work was featured in Reuters and she was a speaker at the World Economic Forum in Davos in 2017.

**PROF. GRÉGOIRE COURTINE**

CHAIR IN SPINAL CORD REPAIR (IRP), EPFL

Grégoire Courtine was trained in Mathematics, Physics, and Neurosciences. He received his PhD degree from the French institute of health (INSERM) and University of Pavia in Italy in 2003. After obtaining the Chancellor Award during his post-doctoral training at the University of California Los Angeles (UCLA), he established his own laboratory at the University of Zurich in 2008. He became Associate Professor in the Center for Neuroprosthetics at EPFL in 2012. The results of his research in spinal cord repair have been published in various high profile journals such as Nature and Science, and have been discussed extensively in national and international media. In 2014, he launched a startup, GTX Medical, that aims to translate the medical and technological advances gained over the past 15 years into a treatment to accelerate and augment functional recovery after spinal cord injury.

**PROF. TOBI DELBRUCK**

INSTITUTE FOR NEUROINFORMATICS (INI), ETH ZURICH AND UZH

Tobi Delbruck studied Physics and Applied Mathematics as an undergraduate in San Diego and then Computation in Neural Systems as a graduate student at Caltech. He joined the Institute for Neuroinformatics (INI) in 1998 and has been working on developing neuromorphic vision sensors for real-world applications in machine vision. Together with doctoral student Patrick Lichtsteiner, he achieved a breakthrough with the first highly functional Dynamic Vision Sensor event-based silicon retina in 2006. Since then, the Sensors group has been evolving this technology and exploring its manifold applications in event-driven vision.

**PROF. PIERRE DILLENBOURG**

COMPUTER-HUMAN INTERACTION FOR LEARNING
& INSTRUCTION (CHILI), EPFL

Pierre Dillenbourg is a former teacher in elementary school. He graduated in educational science (University of Mons, Belgium) and started his research on learning technologies in 1984. He obtained a PhD in computer science from the University of Lancaster (UK), in the domain of artificial intelligence applications for education.

He has been Assistant Professor at the University of Geneva. He joined EPFL in 2002. He is currently Full Professor in learning technologies in the School of Computer & Communication Sciences, where he is the head of the CHILI Lab (Computer-Human Interaction for Learning & Instruction). His lab is conducting several projects on educational robotics. With EPFL colleagues, he recently launched the Swiss EdTech Collider, an incubator with 60 start-ups in learning technologies.

**PROF. LUCA GAMBARDELLA**

IDSIA, UNIVERSITY OF LUGANO

Luca Maria Gambardella is director at IDSIA, a research institute affiliated to SUPSI (University of Applied Science of Southern Switzerland, DTI Department of Technology and Innovation) and to USI (University of Lugano). His major research interests and publications are in the area of optimisation, simulation, swarm robotics, multi-agent learning, applied to academic and real-world problems. He has invented and developed several Ant Colony Optimisation algorithms able to compute best-known solutions for many benchmark instances: Sequential ordering problems (SOP), Vehicle routing problems (VRP), Travelling salesman problems (TSP), Quadratic assignment problems (QAP).

Current research projects include online Fleet Management, Resource Allocation and Scheduling in Flexible Manufacturing Systems, Simulation and Optimization for intermodal transport, Theory and practice of Metaheuristics, Ad-Hoc Networks, Swarm Intelligence and Cooperative Robotics.



PROF. ROGER GASSERT

REHABILITATION ENGINEERING LAB (RELAB), ETH ZURICH

Roger Gassert received an MSc degree in microengineering and a PhD in neuroscience robotics from EPFL in 2002 and 2006, respectively. In 2008 he joined ETH Zurich as Assistant Professor of rehabilitation engineering where he is now Associate Professor and applies robotics, wearable sensor technologies and non-invasive neuroimaging to the exploration, assessment and restoration of sensorimotor function.



PROF. MARCO HUTTER

ROBOTIC SYSTEMS LAB (RSL), ETH ZURICH

Marco Hutter is Assistant Professor for Robotic Systems at ETH Zurich and Branco Weiss Fellow. After studying mechanical engineering, he conducted his doctoral degree in robotics at ETH Zurich with a focus on design, actuation and control of dynamic legged robotic systems. He coordinates several research projects, industrial collaborations and international competitions (e.g. ARGOS challenge) that target the application of high-mobile autonomous vehicles in challenging environments such as for search and rescue, industrial inspection or construction operation. His research interests are in the development of novel machines and actuation concepts together with the underlying control, planning and optimisation algorithms for locomotion and manipulation.



PROF. AUKE IJSPEERT

BIOROB, EPFL

Auke Ijspeert is a professor at EPFL and head of the Biorobotics Laboratory (BioRob). He has a PhD in artificial intelligence from the University of Edinburgh and has been at EPFL since 2002, where he was first an SNF assistant professor, then an associate professor (2009), and since 2016 a full professor. His research interests are at the intersection between robotics, computational neuroscience, nonlinear dynamical systems and applied machine learning. He is interested in using numerical simulations and robots to gain a better understanding of animal locomotion and movement control, and in using inspiration from biology to design novel types of robots and locomotion controllers. He is also interested in the control of exoskeletons for lower limbs.



PROF. WALTER KARLEN

MOBILE HEALTH SYSTEMS LAB (MHEALTH), ETH ZURICH

Walter Karlen is an Assistant Professor in the Department for Health Sciences and Technology of ETH Zurich since 2014. He received his Master degree in micro-engineering and his PhD from the doctoral program in Computer, Communication and Information Sciences both from EPFL. His expertise includes biomedical signal processing, mobile health (mHealth) design, adaptive algorithms, and decision support systems. His main interest is to apply automation to wearable and implantable medical device development for solving major challenges in global health.



PROF. STÉPHANIE LACOUR

LABORATORY FOR SOFT BIOELECTRONICS INTERFACES (LSBI), EPFL

Stéphanie P. Lacour holds the Bertarelli Foundation Chair in Neuroprosthetic Technology at the School of Engineering at EPFL. She received her PhD in Electrical Engineering from INSA de Lyon, France. Her research focuses on the materials, technology and integration of soft bioelectronic interfaces including artificial skin, ultra-compliant neural electrodes for in vitro platforms as well as in vivo implants.



PROF. LAURA MARCHAL-CRESPO

ARTORG CENTER FOR BIOMEDICAL ENGINEERING RESEARCH, UNIBE

Laura Marchal-Crespo is an Assistant Professor at the ARTORG Center for Biomedical Engineering Research, University of Bern. She is also affiliated with the Sensory-Motor Systems at the Department of Health Sciences and Technology, ETH Zurich.

Laura Marchal-Crespo obtained her MSc and PhD degrees from the University of California at Irvine, USA, in 2006 and 2009, respectively. In 2010 she joined the Sensory-Motor Systems, ETH Zurich, as a postdoc researcher. In 2017 she obtained a Swiss National Science Foundation (SNSF) Professorship and joined the ARTORG Center for Biomedical Engineering Research as medical faculty. She carries out research in the general areas of human-machine interfaces and biological learning, and, specifically, in the use of robotic assistance and virtual reality to aid people in learning motor tasks and rehabilitate after neurologic injuries.



PROF. SILVESTRO MICERA

TRANSLATIONAL NEURAL ENGINEERING LABORATORY (TNE), EPFL

Silvestro Micera holds the Bertarelli Foundation Chair in Translational Neuroengineering at the School of Engineering at EPFL. He received a Laurea degree in Electrical Engineering from the University of Pisa and a PhD in Biomedical Engineering from the Scuola Superiore Sant'Anna. Prof. Micera's research interests include the development of hybrid neuroprosthetic systems (interfacing the nervous system with artificial systems) and of mechatronic and robotic systems for function and assessment restoration in disabled and elderly persons.



PROF. JOSÉ MILLÁN

CHAIR IN NON-INVASIVE BRAIN-MACHINE INTERFACE (CNBI), EPFL

Dr. José del R. Millán holds the Defitech Foundation Chair in Brain-Machine Interface Laboratory at EPFL. He received a PhD in computer science from the Technical University of Catalonia, Barcelona, in 1992. He has made several seminal contributions to the field of BMI, especially based on electroencephalogram (EEG) signals. Most of his achievements revolve around the design of brain-controlled robots. He has received several recognitions for these seminal and pioneering achievements, most recently the IEEE-SMC Norbert Wiener Award in 2011 and elevation to IEEE Fellow in 2017. During the last years he has been engaged on the translation of BMI to end-users suffering from motor disabilities. As an example of this endeavour, his team won the first Cybathlon BMI race in October 2016. In parallel, he is designing BMI technology to offer new interaction modalities for able-bodied people.



PROF. FRANCESCO MONDADA

ROBOTIC SYSTEMS LABORATORY (LSRO), EPFL

Francesco Mondada received his MSc in micro-engineering in 1991 and his Doctoral degree in 1997 at EPFL. His interests include the development of innovative mechatronic solutions for mobile and modular robots, the creation of know-how for future embedded applications, and making robot platforms more accessible for education, research and industrial development.



PROF. JAMIE PAIK

RECONFIGURABLE ROBOTICS LAB (RRL), EPFL

Jamie Paik is Director of Reconfigurable Robotics Laboratory (RRL) of EPFL. The RRL leverages expertise in multi-material fabrication and smart material actuation for novel robot designs. She received her PhD in Seoul National University on designing humanoid arm and a hand. At Institut des Systems Intelligents et de Robotique (ISIR) in Universitat Pierre Marie Curie, Paris VI, she developed laparoscopic tools that are internationally patented. At Harvard University's Microrobotics Laboratory, she started developing unconventional robots that push the physical limits of material and mechanisms. Her latest research effort is in soft robotics including self-morphing Robogami (robotic origami) that transforms its planar shape to 2D or 3D by folding in predefined patterns and sequences, just like the paper art, origami.



PROF. DAVIDE SCARAMUZZA

ROBOTICS AND PERCEPTION GROUP (RPG), UZH AND ETH ZURICH

Davide Scaramuzza is Professor of Robotics and Perception at both departments of Informatics (UZH) and Neuroinformatics (UZH and ETH Zurich), where he does research at the intersection of robotics, computer vision, and neuroscience. Specifically he investigates the use of standard and neuromorphic cameras to enable autonomous, agile, navigation of micro drones in search-and-rescue scenarios. He did his PhD in robotics and computer vision at ETH Zurich and a post-doc at the University of Pennsylvania. From 2009 to 2012, he led the European project sFly, which introduced the PX4 autopilot and pioneered visual-SLAM-based autonomous navigation of micro drones. For his research contributions, he was awarded the IEEE Robotics and Automation Society Early Career Award, the SNSF-ERC Starting Grant, a Google Research Award, KUKA, Qualcomm, and Intel awards, the European Young Research Award, the Misha Mahowald Neuromorphic Engineering Award, and several conference paper awards. He coauthored the book "Introduction to Autonomous Mobile Robots" (published by MIT Press, 10,000 copies sold) and more than 100 papers on robotics and perception published in top-ranked journals (TRO, PAMI, IJCV, IJRR) and conferences (RSS, ICRA, CVPR, ICCV). In 2015, he cofounded a venture, called Zurich-Eye, dedicated to the commercialization of visual-inertial navigation solutions for mobile robots, which later became Facebook-Oculus Switzerland and Oculus' European research hub. He was also the strategic advisor of Dacuda, an ETH spinoff dedicated to inside-out VR solutions, which later became Magic Leap Zurich.



PROF. ROLAND SIEGWART

AUTONOMOUS SYSTEMS LAB (ASL), ETH ZURICH

Roland Siegwart has been a Full Professor in autonomous systems at ETH Zurich since July 2006. He received both his Diploma in Mechanical Engineering and his Doctoral Degree from ETH Zurich. Roland Siegwart's research interests are in the design and control of systems operating in complex and highly dynamical environments. His major goal is to find new ways to deal with uncertainties and enable the design of highly interactive and adaptive systems. Prominent application examples are personal and service robots, planetary exploration robots, autonomous micro-aircrafts and driver assistant systems.

PROJECTS

NCCR Robotics focuses on three main research strands: the Wearable Robotics Grand Challenge, the Rescue Robotics Grand Challenge and the Educational Robotics Grand Challenge. Although the strands each have a distinct aim, certain aspects such as soft robotics, control and sensors do overlap, thus strengthening the collaborative objectives of the NCCR and enhancing Switzerland's position as a global leader in these areas.

WEARABLE ROBOTICS GRAND CHALLENGE

The goal of the NCCR Robotics Grand Challenge on Wearable Robotics (WR-GC) is to develop a novel generation of wearable robotic systems, which will be more acceptable for patients and more extensively usable in the clinical environment. These new technological solutions will facilitate the sensorimotor recovery of locomotion and grasping after cerebrovascular accident (CVA) and Spinal Cord Injury (SCI) and will provide long-term assistance.

This goal will be reached through a combination of robotic systems and neuro-prosthetic technologies, which will enable rehabilitative solutions defined by the following unique characteristics:

- **Personalisation** – advanced computational models and neuroimaging techniques will allow definition of the optimal (hardware, software, rehabilitation protocols) characteristics of the WR-GC device that are personalised for different neurological deficits, and to patient-specific impairments and their evolution.
- **Symbiosis** – the use of natural and bidirectional “neuro- to-machine” interfaces will allow the user to seamlessly interact with the WR-GC devices and increase the level of cortical plasticity.
- **Softness** – the use of novel soft materials (and more compliant control algorithms) will increase the usability, effectiveness and comfort of the technological solutions developed by the WR-GC.

Within the various projects of the WR-GC our researchers work on exoskeletons, soft robotics, prosthetics, implants and Brain Computer Interfaces (BCI).

Key projects within the WR-GC include **SOFT3**, which focuses on soft robotics, **ReGait**, a research that develops a conceptual framework to identify the mechanisms underlying the recovery of leg motor control during EES (epidural electrical stimulation), and **ReHand**, which seeks to exploit natural control signals for the operation of a soft hand/arm exoskeleton.

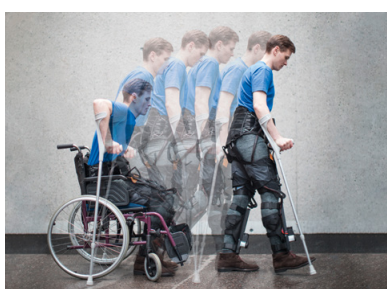
WEARABLE ROBOTICS GRAND CHALLENGE HIGHLIGHTS



SOFT3

SOFT 3 regroups three research projects focusing on “soft” components:

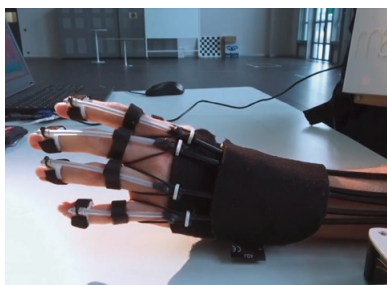
- Soft sensors, which were developed for monitoring the position of the fingers.
- Soft Pneumatic Actuator (SPA) skin with integrated soft sensors and design customisation for specific wearable applications.
- Multi-contact strategy using variable impedance control and stabilisation of conditions for grasping in robotic hands.



REGAIT

ReGait developed a conceptual framework to identify the mechanisms underlying the recovery of leg motor control during EES (Epidural electrical spinal-cord stimulation). It then extended it with an evidence-based framework to understand the interactions between epidural electrical stimulation and spinal circuits to optimise stimulation protocols for clinical applications.

It also focused on designing and fabricating a second-generation prototype of the lower-limb exosuit, referred to as MAXX – Mobility Assisting teXtile eXoskeleton. One of its key design features is the emphasis on gravity assistance, which enables a continuous assistance against gravity forces.



REHAND

The ReHand project seeks to exploit natural control signals for the operation of a soft hand/arm exoskeleton in order to restore the cortico-peripheral structure naturally used to control the hand during grasping. This encompassed three phases:

- Develop new approaches to decode grasping commands using cortical and muscular signals.
- Develop two new robotics solutions to achieve usable and effective hand exoskeletons.
- Develop wearable control and feedback prosthetic systems to reactivate muscles by using neuromuscular electrical stimulation.



CYBATHLON

Conceived and headed by Prof. Robert Riener, NCCR Robotics co-director, the Cybathlon is a global initiative which first took place in Zurich in 2016, under the NCCR Robotics umbrella. The Cybathlon was launched as a platform for exchange between people with disabilities, technology providers and the public in order to raise awareness of the challenges faced by those with disabilities and to promote the development of assistive technologies.

70 pilots with 56 teams from 25 nations competed in six races: Brain-Computer Interface (BCI) Race, Functional Electrical Stimulation (FES) Bike Race, Powered Arm Prosthesis Race, Powered Leg Prosthesis Race, Exoskeleton Race and Powered Wheelchair Race. The next Cybathlon will be organised by ETH Zurich in 2020.

PROJECTS

RESCUE ROBOTICS GRAND CHALLENGE

The goal of the Rescue Robotics Grand Challenge (RR-GC) is to investigate and develop robotic technologies for search and rescue operations and to address the key scientific questions on perception, navigation, locomotion, embodied intelligence and bio-mimetic engineering necessary to approximate the agility and versatility of animals moving in unstructured terrains. The aim is to create a heterogeneous robot team that 1) is composed of legged and flying robots, 2) is capable of multimodal locomotion, 3) is compliant and enables rich interaction with the environment, 4) is able to adapt and learn, and 5) allows symbiotic co-operation between robots and human operators.

The Rescue Robotic Grand Challenge (RR-GC) is split into three main projects: legged robots, flying robots and collaboration and coordination. Each project has interaction and field test evaluations at model disaster sites with stakeholders on a regular basis, to ensure that the robots are being developed with the end users in mind. This work has led to state-of-the-art perception, control, and navigation controllers for robots that can move in complex unstructured terrains. It has also led to the design of new robots such as:

- **PackDrone** – a drone surrounded by an origami-inspired foldable protective cage, which allows deliveries of items up to 500 grams.
- **K-Rock** – a bio-inspired amphibious quadrupedal robot, able to move both on solid ground and in water.
- **ANYmal** – a quadrupedal robot that features a compact main body filled with powerful computers, networking devices, power electronics and batteries for about three hours of autonomous operations.

RESCUE ROBOTICS GRAND CHALLENGE HIGHLIGHTS



PACKDRONE

Packdrone is a four-rotor drone surrounded by a protective, foldable cage. Inspired by the behavior of an insect's wings in a situation of collision, the cage, also called frame, is strong enough to maintain its shape when flying, but can soften and fold during a collision to avoid permanent damage. The research team based its design on the origami folding shelters that have been developed for space exploration and adapted them to create a Chinese lantern shaped frame, using carbon fibre tubes and 3D printed flexible joints. This foldable frame sits around the multicopter and around the package to be carried, shielding spinning propellers and ensuring safety of all people around it.



ANYMAL & K-ROCK

Two quadrupedal robots have been developed in order to be deployed on the field and work in harsh conditions:

- ANYmal is designed for autonomous operation in challenging environments. Thanks to incorporated laser sensors and cameras, the robot can perceive its environment, accurately localize, and autonomously plan its navigation path and carefully select footholds while walking. With a weight of less than 30 kg, ANYmal can be easily transported and deployed by a single operator.
- K-Rock is one of the few legged robots able to work in water along with employing various amphibious gaits, e.g. swimming and crawling. It has a modular architecture which allows several leg designs to be installed as well as head/camera modules and tail removal. It includes an easily deployable and robust water suit. In January 2017, it was featured in a BBC wildlife documentary shot in Uganda, where it helped capture close images of crocodiles in the Nile.



SYMBIOTIC DRONE ACTIVITY

Piloting drones with current interfaces, such as joysticks and remote controllers, requires extensive training and constant cognitive effort during flight. The Symbiotic Drone Activity consists of exploring novel interactions, mainly the bidirectional link between the physical bodies and control systems of the robot and the human, in order not only to enable a more intuitive control of drones, even for novices, but also to provide users with immersive sensations of flight, in a way which is not rendered in current interfaces. We are developing a smart jacket, which is a soft exosuit equipped with inertial measurement units for gesture control. It can be operated as a remote controller for drones in both open and cluttered environments.



DRONE DAYS

This event was initiated by NCCR Robotics in 2017, and now runs as an independent franchise by EPFL. Over this 2-day event, more than 5000 people were treated to drone races, a robotics showcase, a conference and demonstrations on EPFL's campus.

PROJECTS

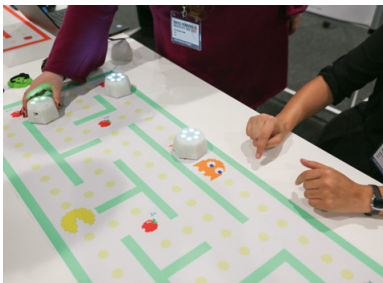
EDUCATIONAL ROBOTICS GRAND CHALLENGE

Our economy is missing engineers and our society needs a better education in technology in general and in robotics in particular. This Education Robotics Grand Challenge (ER-GC) aims at making people more conscious and better understand how to deal with these technologies, thus improving the acceptance of robotics.

While natural science, mathematics and partially computer science are topics addressed in schools, many technologies including robotics are rarely part of the educational programme.

The ER-GC investigates how robots could trigger rich learning activities. New palm-sized robots have been developed to hold key properties: they interact with paper (localisation), they can be manipulated by users, they provide haptic feedback, they can behave as a swarm and they are cheap. The combination of these four features has created an unprecedented experience.

EDUCATIONAL ROBOTICS GRAND CHALLENGE HIGHLIGHTS



CELLULO

Cellulo has been designed to address classroom integration in three ways:

- Its behaviour depends upon its position on paper and each paper sheet can be tailored to a specific learning activity. Regular structured (printed dot patterns) paper is used.
- It constitutes a tangible interface: it moves by itself, as any robot, but can also be moved by kids, like a game token. It relies on magnetic-ball drives for holonomic motions, allowing the robot to be used for haptic feedback which paves the road for very creative learning activities.
- Since each Cellulo can be located, the behaviour of multiple robots was coordinated and hence developed into swarm behaviour. The learner's action can be propagated to the whole swarm through programming, such that the degree is decided by the designer. The combination of swarm and tangible is unique in education.



THYMIO

Thymio was developed through NCCR Robotics and is an affordable teaching robot which uses open-source hardware and software.

It allows young users to discover the universe of robotics and learn a robot's language with the aim of programming it and carrying out numerous experiments. With Thymio, the basics of robotics and programming become notions everyone can discover, whatever their age.

Since 2013, over 1000 teachers in Switzerland have been trained to use Thymio in the classroom, more than half of them were trained in 2017 alone, showing the rapid growth in interest.

INDUSTRY AND SOCIETY ACTIVITIES

NCCR Robotics has four main industry and society activities: knowledge and technology transfer, education, advancement of women and communication.

KNOWLEDGE AND TECHNOLOGY TRANSFER

THE SWISS ROBOTICS INDUSTRY DAY

This one-day annual event is exclusively designed for industry to showcase the activities of NCCR Robotics and selected Swiss start-ups active in the field of robotics through a series of robot and technology demonstrations, posters and panel discussions. In synergy with this unique programme, we offer you the opportunity to exchange views on current and future needs and challenges facing the industry through talks by research and industry leaders. This is a unique opportunity for the industry to gain an insight into technology research performed within the NCCR Robotics Consortium and to get privileged access to new and emerging technologies.

As part of our KTT activities we also present the “Swiss Robotics” initiative. Swiss Robotics provides Swiss start-ups with unique opportunities:

- to exhibit at the [Swiss Robotics Industry Day](#).
- to network with other robotics companies and researchers.

For further inquiries related to our KTT activities and start-ups please contact our Managing Director and KTT Officer, Jan Kerschgens and/or visit the industry section of [our website](#) for details.

SPIN-OFFS

NCCR Robotics is committed to knowledge and technology transfer between the laboratory and industry. To fulfill this aim we exhibit at international conferences and trade fairs and host visiting academics. We also support the creation of start-ups from NCCR Robotics research projects through the [NCCR Robotics spin fund](#). We currently have 10 spin-offs:

- **ANYBotics**. The next major step in robot evolution will see robots leave the structured factory floor. This requires versatile and highly mobile mechanical devices to move and act autonomously in unstructured environments, collaborating where needed with humans. For this to become reality, robot capabilities need to be massively improved in three areas: mobility, interaction and autonomy. [anybotics.com](#)
- The **Feeltronix** breakthrough technology platform stretches the mechanical limits of electronics and provides solutions for robust and ultra-compliant rubber-based systems. Applications include smart bands for the next generation of wearables in sports, healthcare, AR/VR and fashion. [feeltronix.com](#)
- **Flyability** is a Swiss company building safe drones for operating indoors, in complex and confined spaces, and in contact with people. The company's main market is in industrial inspection where it avoids sending people in dangerous and confined spaces for the inspection of power generation, oil & gas, maritime and chemical infrastructures. It is also active in search & rescue and public security to assess emergency situations without putting humans at risk. [flyability.com](#)

- **Foldaway** is developing ultra-portable and low cost haptic interfaces that interact with human fingers by tracking their motion and providing force, stiffness and texture perception. foldaway-haptics.ch
- **Fotokite** is a spin-off from ETH Zurich's Flying Machine Arena with patented technology that fundamentally solves key problems with traditional drone systems, including safety, flight time and accountability. fotokite.com
- **Intento** has developed an easy-to-use, effective solution to help severely paralyzed stroke patients recover motor function in upper limbs. Even several years after the stroke. intento.ch
- **MyoSwiss** develops the Myosuit, a garment-like set of active and passive layers designed to assist people with muscle weakness when performing movements. myoswiss.com
- **Noonee** is a Swiss based exoskeleton company, spin-off of ETH Zürich, founded in 2014 by Keith Gunura and Olga Motovilova. The company is focusing on exoskeletons for industrial application to improve the working environment and assist industrial workers in their daily tasks. noonee.com
- **SensArs** mission is to restore complete functionality of upper and lower limb amputees, as well as those that had nerve-damage. The solution SensArs proposes, a neuroprosthetic device, is called SENSY: a unique device, which allows amputees, unlike currently available prostheses, to feel again from missing limbs. sensars.com
- **Twiiice** is a modular exoskeleton for walking assistance that allows spinal cord injury paraplegics to regain independence in their daily activities. twiiice.ch

EDUCATION

In the field of education, NCCR Robotics excels at promoting robotics to the next generation. We have regular outreach events which we run in collaboration with the equal opportunities office at EPFL, we also promote educational activities and encourage people on how to get into robotics through our video series “so you want to be a roboticist”. As part of our drive to encourage educational activities we offer internships and exchanges at Master’s, PhD and Postdoc levels, both to external candidates wishing to work at NCCR Robotics and internal candidates who wish to partake in a short-term project elsewhere.

MASTER IN ROBOTICS:

- ETHZ offers a Master in Robotics, Systems and Control.
- A new Master in Robotics has been launched in 2018, with the first intake in the Fall Semester (master.epfl.ch/robotics).

MASTER INTERNSHIP FOR WOMEN

Every year, NCCR Robotics opens a call for proposals for projects for female Master’s students who wish to spend a period of 3–6 months in an NCCR Robotics lab.

PhD/POSTDOC EXCHANGE PROGRAMMES

Every year, NCCR Robotics opens a call for proposals for projects for PhD and Postdoc candidates who wish to spend a period of 3–6 months in an NCCR Robotics lab. This also applies to NCCR Robotics PhD and Postdoc students who wish to visit another lab.

DOCTORAL SCHOOL

The five partner Universities of NCCR Robotics are committed to further education and as a result all of them offer different Doctoral Programmes and PhD opportunities. Please note that any questions should be directed directly to the partner universities.

ADVANCEMENT OF WOMEN

The issue regarding the low numbers of women in science and technology, especially at higher levels has been well reported.

The Master's internship mentioned in the education section are offered exclusively for female students. So far, more than a dozen female students have benefitted from a grant to spend 3 to 6 months in an NCCR Robotics lab.

We also work with the equal opportunities office at EPFL to provide courses on robotics specifically for women. For example, "Robots are indeed for girls" is a robotics workshop destined to girls aged 11 to 13 years old, where they are taught to build and program a robot. The workshop is open to 50 girls per semester, and has already welcomed 300 girls since its launch.

Our Equal Opportunities Committee constantly elaborates and adjusts internal and external strategies to ensure equal opportunities are guaranteed.



COMMUNICATION

As a part of our external communications strategy, we use “news bulletins” to issue press releases to journalists (please register [here](#) if you wish to receive press releases) and communicate through our external newsletter, which keeps subscribers up to date once a month with all our scientific and non-scientific news. We also regularly post news to our website, on [Twitter](#), [Facebook](#), [LinkedIn](#) and on [robohub.org](#).

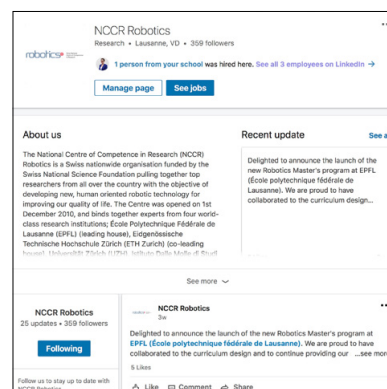
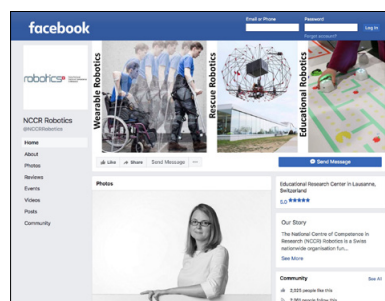
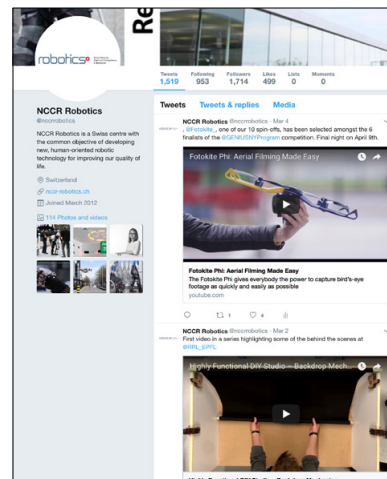


Photo credits: **Twice** – Twice // **MyoSuit** – Kai Schmidt, SMS Lab, ETH Zurich // **Mano** – Inaki Iturrate and CNBI Lab // **Drone** – Philipp FoeHN and RPG Lab // **PackDrone** – Alain Herzog and NCCR Robotics // **ANYmal 2** – ANYbotics AG // **K-rock** – Alain Herzog and NCCR Robotics // **Cellulo** – Alain Herzog and NCCR Robotics // **Thymio** – Ramun Riklin and Thymio // **Soft 3** – Inaki Iturrate and CNBI Lab // **ReGait** – SMS Lab, ETH Zurich // **Cyathlon** – Alessandro Della Bella and Cyathlon // **SDA** – Alain Herzog and NCCR Robotics // **Drone Days** – Alain Herzog and NCCR Robotics