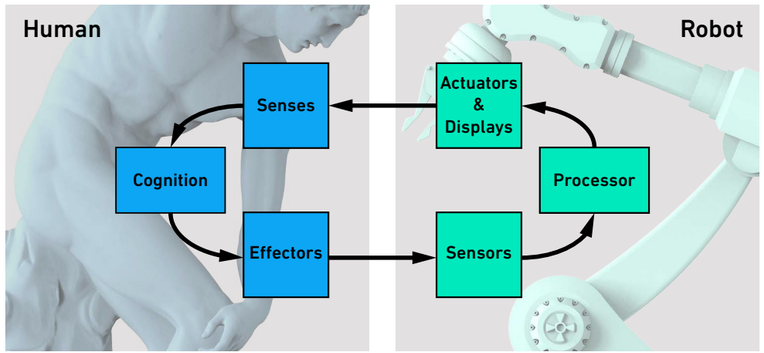
The Sensory-Motor Systems Lab

The Sensory-Motor Systems Lab is part of the Institute of Robotics and Intelligent Systems (IRIS) of the Department of Health Sciences and Technology (D-HEST) at ETH Zurich and part of the Spinal Cord Injury Center at Balgrist University Hospital. The Lab is developing unobtrusive sensor systems, sophisticated data processing techniques, innovative user-cooperative control strategies, individualized therapies, and versatile assistive devices applied in clinical rehabilitation settings or in daily life.

The Lab strives to establish effective and efficient robot-aided approaches along the continuum of care of neuromuscular diseases, to promote non-pharmaceutical, individualized treatments in the field of psychophysiological disorders, and to optimize athletic performance. Thereby, the Lab benefits from an interdisciplinary team, rapid prototyping facilities for the development and assembling of robots, and various clinical and industrial collaborations.



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Publisher: Sensory-Motor Systems Lab
Editor: Peter Wolf
Design: Stefan Schneller
Photos: Stefan Schneller, Matthieu Gafsou
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- Akina, Zurich
- Balgrist University Hospital, Zurich
- Cereneo, Vitznau
- Ecole Polytechnique Fédérale de Lausanne (EPFL)
- EMPA St. Gallen
- Fondazione Don Carlo Gnocchi Onlus, Firenze
- German Heart Center, Berlin
- Hocoma, Volketswil
- Kliniken Schmieder, Allensbach
- MyoSwiss, Zurich
- Ottobock, Vienna
- Rehaklinik Zihlschlacht
- Scuola Superiore Sant'Anna, Pisa
- Sensomative GmbH, Rothenburg
- Swiss Museum of Traffic, Lucerne
- Swiss Paraplegic Center, Nottwil
- University Children's Hospital Zurich
- University Hospital Bern
- University Hospital Zurich

Main Funding Sources:

- European Commission
- Innosuisse
- National Centre of Competence in Research in Robotics (NCCR Robotics)
- Swiss National Science Foundation (SNSF)
- Swiss Paraplegic Foundation, Nottwil

Sensory-Motor Systems Lab: Moving people and technology

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Sensory-Motor Systems Lab

Moving people and technology

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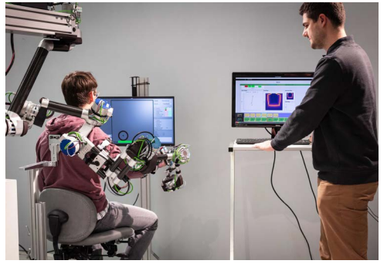
Current Research Projects

Arm Rehabilitation Robotics

Rehabilitation robots relieve therapists of physical work, complement quantitative analysis of therapy, and facilitate high-intensity training. This allows robots to free up therapists' time and focus on cognitively complex aspects such as assessing therapeutic efficacy, therapy planning and interpersonal communication, or supervising multiple patients simultaneously. To maximise the impact in clinical settings, robots should be able to support these aspects while providing therapeutic exercises for a variety of neuromuscular disorders.



Our research focuses on the development of the highly versatile upper limb exoskeleton ANYexo, which, in addition to precise haptic rendering, provides a workspace for almost all arm movements of daily life at a speed that allows full recovery. Together with the development of the highly modular software framework SIESTA, we achieve unsupervised, automated training while co-operating with the therapist on selection and modification of therapy tasks.

Wearable Exoskeletons

We design and validate soft, lightweight wearable robots that provide users with an additional layer of artificial muscles. The Myosuit and the Myoshirt support walking and shoulder movements against gravity, respectively. Both devices consist of functional textiles and lightweight structural components and can be worn on top of one's everyday clothes. These features not only make them easy to wear, but also limit the interference of the robot with the wearers movements, allowing them to selectively assist their users only when needed.

For these reasons, the Myosuit and the Myoshirt are useful not only to facilitate rehabilitation training in clinical environments, but also to assist people in performing Activities of daily life. The SMS Lab collaborates with its spin-off MyoSwiss AG to validate the technology on its target population and to use these devices as a platform to answer fundamental scientific questions about human motor control.

Sleep Robotics

Sleep plays a fundamental role in health and wellbeing. Poor sleep hygiene, sleep deprivation, and sleep diseases raise The risks of cardiovascular diseases and worsen mood and cognitive performance. Together with physicians across Switzerland, we investigate how autonomous robotic beds can be used to treat sleep-related breathing disorders such as obstructive sleep apnea and alleviate symptoms of neurological disorders like Parkinson's Disease.

Our two most recent robotic beds are the Intelligent Sleep Apnea Bed (ISABel) and the Somnomat Casa. ISABel uses unobtrusive sensors to detect sleep apnea episodes during the night and motors to change the position of the users from supine to lateral. With the Somnomat Casa, we investigate the effects of nocturnal translational rocking on people suffering from Parkinson's Disease as other forms of vestibular stimulation could show significant improvements.

Robotics in Sports

The combination of knowledge from different engineering disciplines with the understanding of human psychophysiology and biomechanics enables the development of new training approaches and the comprehensive analysis of sports performance. Thus, we develop robotic training scenarios and multimodal feedback strategies for different performance levels and develop measurement technologies for performance analyses in different sports.

We focus on concurrent feedback strategies, i.e., information on performance given during movement execution, and on concepts that automatically switch between feedback modalities to promote efficient, individualized learning of complex motor tasks. We are currently focusing on rowing and climbing, and we are interested in supporting both amateur and professional athletes with our newly developed tools.

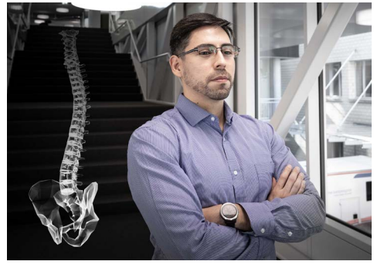
Digital Tools for Mental Health

About 25% of the world's population experience a mood disorder during their lifetime. However, diagnosis and monitoring mood disorders, such as depression, is still challenging. A high percentage of patients are not responding even after several rounds of treatments, indicating the need for alternative and personalized treatment approaches.

Within the MoodifAI project, our goal is to improve the diagnostic and treatment of mood disorders by exploiting artificial intelligence and technology. Digital health data generated from smartphones and wearables will give us an insight into the individuals' physiological and behavioural status, the so-called digital phenotyping. The continuous quantification of the health status can result in clinically valuable markers that we can use to build digital twins and, eventually, tailor treatment choices, detect early signs of relapse, and develop new treatments.

AI for Spinal Cord Injury

Funded by the Swiss Paraplegic Foundation, the Spinal Cord injury Artificial Intelligence Lab (SCAI Lab) was founded as a branch of the SMS Lab. The SCAI Lab is located at the Swiss Paraplegic Center in Nottwil. The Lab uses innovative data acquisition and processing techniques to improve ambulatory care for people with spinal cord injury.



The SCAI Lab aims at identifying risk factors for complications typical of paraplegia at an early stage to prevent consequential disabilities or to treat them in a targeted manner. In the long term, a «continuum of care» will be established that enables individualized and cost-optimized care and improves the quality of life of those affected. The continuum of care is further extended by activities of the RESC (Competence Centre for Rehabilitation Engineering and Science), another branch of the SMS Lab that aims at making the environment and society more inclusive for people with movement impairments.