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.

Main Collaboration Partners:
- Akina, Zurich
- Balgrist University Hospital, Zurich
- Bern
- École Polytechnique Fédérale de Lausanne (EPFL)
- EMFA St. Gallen
- Fondazione Ossorio Carlo Gnocchi Onlus, Firenze
- German Heart Center, Berlin
- Hocoma, Volketswil
- Kliniken Schmieder, Allensbach
- Myoswiss, Zurich
- Ottobock, Vienna
- Rehabilitation Zittau
- Scuola Superiore Sant’Anna, Pisa
- Sensomative GmbH, Rotthurburg
- Swiss Museum of Traffic, Luzerne
- 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

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Current Research Projects

**Sense Sensory-Motor Systems Lab**

**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.

**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 clothes. These features not only make them easy to wear, but also limit the interference of clothes.

**Sleep Robotics**
Sleep plays a fundamental role in health and wellbeing. Poor sleep hygiene, sleep deprivation, and sleep disorders such as obstructive sleep apnea and restless legs syndrome can impair daily activities. This brain-computer interface (BCI) couples physiological monitoring with real-time feedback to enhance sleep quality. 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.

**Digital Tools for Mental Health**
About 25% of the world’s population experience a mood disorder during their lifetime. However, diagnosis and monitoring of 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.

**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.