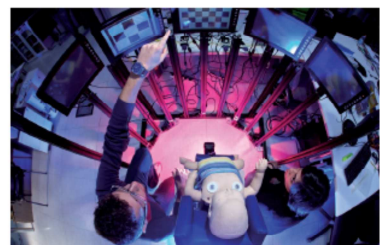
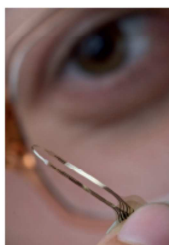
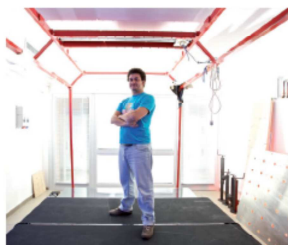
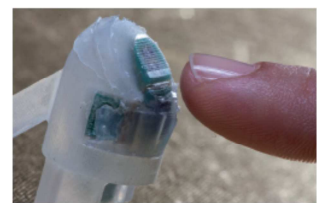
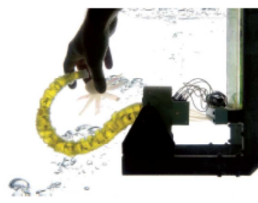
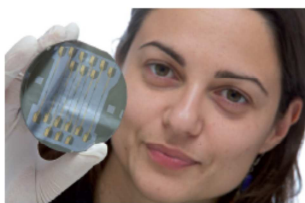
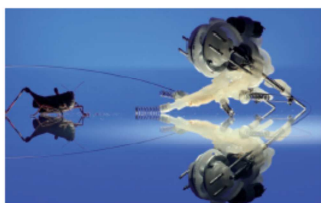
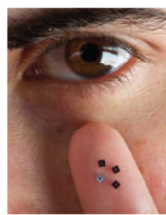
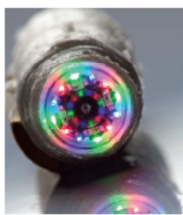
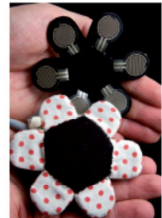


# BioRobotics Institute



Scuola Superiore  
Sant'Anna

di Studi Universitari e Perfezionamento



*BioRobotics: quest for fundamental understanding (science) and  
consideration of use (engineering)*

*Biorobotics Science: using robotics to **discover new principles**...*

*Biorobotics Engineering: using robotics to **invent new solutions**....*

# The BioRobotics Institute

*"The mission of the BioRobotics Institute is educating the Engineer of the 21<sup>st</sup> Century, a competent, interdisciplinary, creative inventor and entrepreneur, able to manage new technological and scientific challenges, ready to take up new opportunities for society and industry, and acting as a linking bridge towards centres of knowledge worldwide."*

Prof. Paolo Dario,  
Director,  
The BioRobotics Institute

High quality education, frontier research and exploitation of research results: this is the BioRobotics Institute.

The BioRobotics Institute wants to act as a linking bridge to international centres of knowledge and to create a new concept of engineers that are scientists, inventors, entrepreneurs, able to invent and solve problems.

The BioRobotics Institute intends to pursue new frontiers in engineering, by blending science and technology, and to support local development policies through the collaborations with local and national partners, start-ups and new high-tech companies, offering training and consultancy.

The BioRobotics Institute has built and consolidated a vast wealth of knowledge and expertise in the fields of surgical robotics, micro-nano-robotics, soft robotics, humanoid robotics, neuro-robotics, neural engineering, bio-inspired robotics, biomedical signal processing, marine robotics, service robotics and ambient assisted living, educational robotics and studies also their ethical, legal, social and economic implications.

The headquarter of the BioRobotics Institute is located at the Polo Sant'Anna Valdera established by the Scuola Superiore Sant'Anna (SSSA) as a research park in the industrial city of Pontedera, with a surface of 6,300 mq. The BioRobotics Institute has other 9 laboratories and research centres in Tuscany dedicated to research activities on: service robotics and ambient assisted living, rehabilitation bioengineering, movement assistance, translational neurorehabilitation, analysis and treatment of neuromotor disorders, neurodevelopmental bioengineering, marine robotics, industrial biorobotics. At the Polo Sant'Anna Valdera, the BioRobotics Institute has also a joint laboratory with one of the centres of the Italian Institute of Technology, that is the Centre for Micro-BioRobotics IIT@SSSA.

Thanks to the many collaborative projects and initiatives, the BioRobotics Institute has a dense network of collaborations in Italy, Europe and worldwide with the most important research institutes, universities and industrial representatives. Each year, The BioRobotics Institute welcomes a large number of international visiting researchers, faculty and lecturers and organizes international events and meetings.

At present the BioRobotics Institute includes over 200 people (16 faculty members, 75 Post docs, more than 90 PhD students, 12 technical and administrative assistants, research fellows, and a variable number of master students and visiting researchers around 30), and it is involved, as coordinator or as partner, in more than 65 projects (with 26M€ + total funding) and 25 spin-off companies.

# Education

With the goal of providing **graduate students** with the knowledge, experience, and skills to become leaders in robotics research and education, the BioRobotics Institute offers diverse opportunities at all levels of education, in order to inspire and educate the next generation of roboticists and bioengineers.

At the **BioRobotics Institute**, education involves a process starting from children up to PhD students. In this framework, the Institute has set up a local educational laboratory on robotics developing new tools that enables primary, middle and high school students to expand upon their interest in robots.

## **PhD course in BioRobotics**

The Ph.D. programme in Bio-Robotics aims at educating highly competent researchers with the potential to be leaders in this area. The students will be educated in a stimulating and multidisciplinary environment, both through high level courses and through a demanding, creative and original research work. Doctoral research projects will be carried on in very well equipped, state-of-the-art laboratories (in such fields as bio-robotics, micro- and nano-technology, biomimetics, prosthetics) and through personal and team work performed under the supervision of a committed full-time faculty.

The students will investigate how biological systems work from an engineering viewpoint, and will make use of such knowledge to pursue challenging research projects aimed at modeling, designing and building novel components and systems for biomedical applications, such as surgery and rehabilitation. The accomplishments of the students will be assessed by the number of papers published in peer reviewed international journals and by the number of patents filed.

At the end of the Ph.D. programme, students will possess solid scientific and engineering skills, the ability to conceive and carry out original research projects, and an autonomous entrepreneurship spirit.

Students are admitted to Ph.D. in BioRobotics further to a successful entrance examination. The Ph.D. Programme in BioRobotics is a three-year program of advanced studies and supervised research.

## **Master Courses at the Scuola Superiore Sant'Anna**

They are basically designed on the competence of SSSA students and involving hands-on activities on current research projects.

## **Master Courses at the University of Pisa**

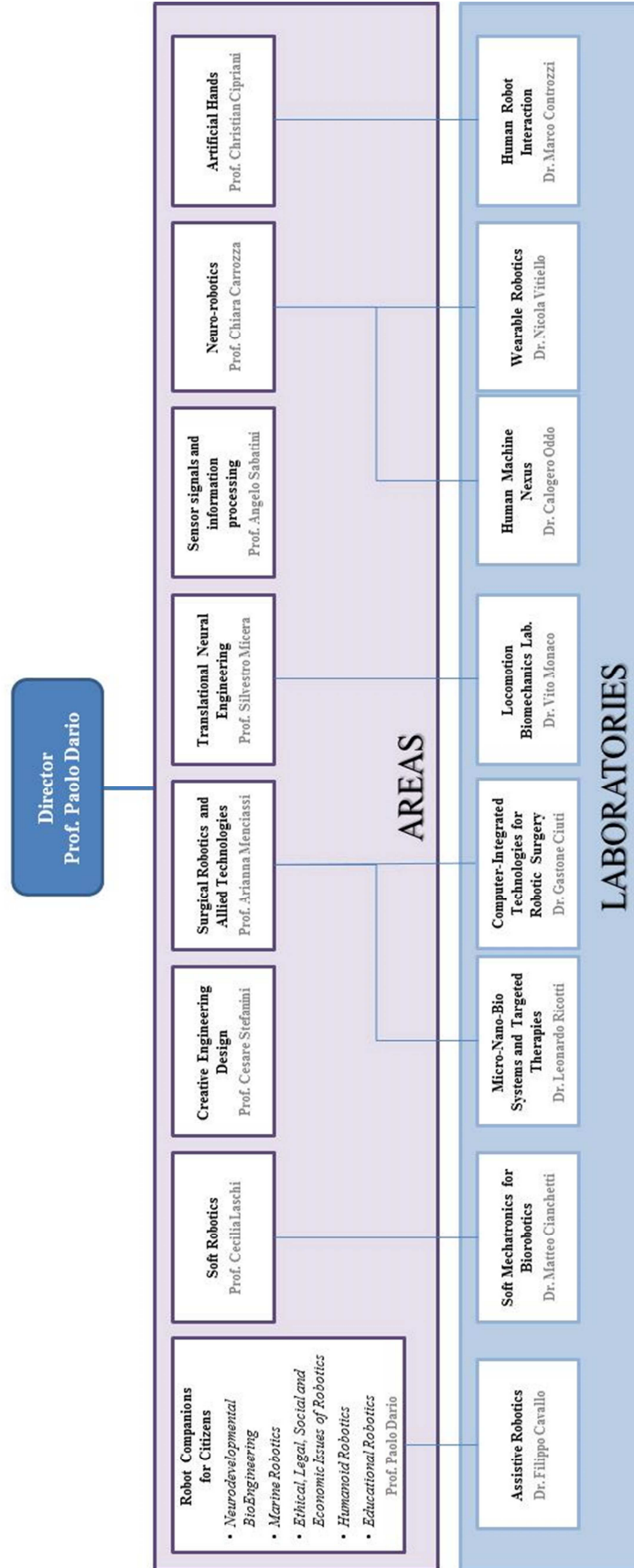
The Faculty of the BioRobotics Institute delivers courses in several disciplines related to Medical Robotics, Rehabilitation Robotics, Mechanical Engineering, Biomechatronics (Master Degree in Biomedical Engineering).

**Additional courses** are delivered at the Master Course of Medicine and Surgery and at the Master Course of Information Science.



# Research

## The BioRobotics Institute: Research Areas and Laboratories



# Robot Companions for Citizens Area

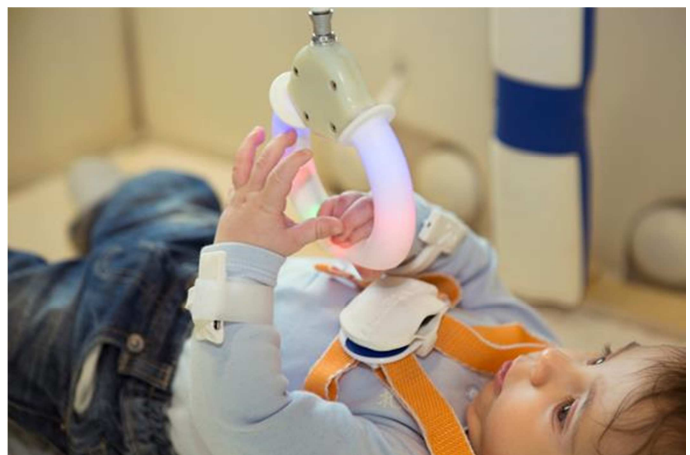
Major scientific and engineering breakthroughs are needed to develop high performance, complex artificial systems, like robots, as Companions that are safe, social, dependable, sustainable and skilled, literally going beyond the current mechatronics paradigm. Nature can be an extraordinarily rich and matchless reference for inspiring, conceiving and designing novel robotic systems.

The aim of this research area is to develop a new generation of assistive robot companions and underpinning technologies to help citizens of all ages, from infants to elderly, and in different scenarios (in the factory, at home, in farms, or in marine scenarios), that are characterized by an extremely high efficiency, robust behaviour in unstructured environments, low cost and novel design for acceptability. The use of robotics as a method to increase the quality of scientific and technical education in school and the ethical, legal, social and economic issues are also investigated. This new generation of robot Companions fully integrated in the society requires the mobilization of multidisciplinary scientific and technological excellence, the building of dedicated robotics research infrastructures, and the study of ethical, legal, social and economic implications.

The research area of Robot Companions for Citizens focus mainly, but not only, on the fields of: “Neurodevelopmental BioEngineering”, “Marine Robotics”, “Ethical, Legal, Social and Economic Issues of Robotics”, “Humanoid Robotics” and “Educational Robotics”, and it is correlated with the research laboratory on Assistive Robotics.

## Neurodevelopmental BioEngineering

Neurodevelopmental engineering is an interdisciplinary research area at the intersection of developmental neuroscience and biomedical engineering, mainly concerned with quantitative analysis and modeling of human behaviour during neural development. The aim of this research is the development of novel mechatronic devices for ecological, unobtrusive assessment of infant development. These tools could help in assessing motor impoverishment or sensitivity to therapy, but also experimenting new therapeutic interventions based on enriched environment and brain plasticity.

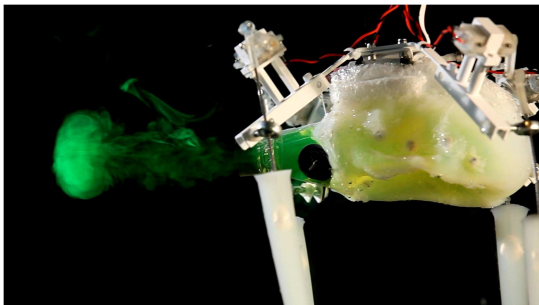


## Marine Robotics

Research activities in the field of marine robotics are carried out at The Research Centre on Sea Technologies and Marine Robotics. The laboratory is located in Livorno and it is specialized for the design, development and validation of new technologies and robotic systems for marine application.

In particular, research in marine robotics is conducted on:

- surface and underwater autonomous systems;
- underwater manipulator control and environmental sensors;
- bioinspired aquatic robots;
- novel concepts of soft marine robots.



*Photo credit: Massimo Brega*



## Ethical, Legal, Social and Economic Issues of Robotics

The ethical, legal, social and economic issues (ELSi) of robotics have been a concern since the start of research activities at the BioRobotics Institute.

In 2004, together with Kazuo Tanie and Ron Arkin, Paolo Dario founded the Technical Committee on Roboethics of the IEEE Robotics and Automation Society, bringing ethics in the heart of the international community of robotics. Since then, the Institute has organised many national and international events on ELSi, for both academics and laypeople, in collaboration with scientists, philosophers, theologians, sociologists, lawyers, economists, and artists. Currently, research on ELSi is carried out in the framework of two EU funded projects, Robot-Era and RoboLaw.

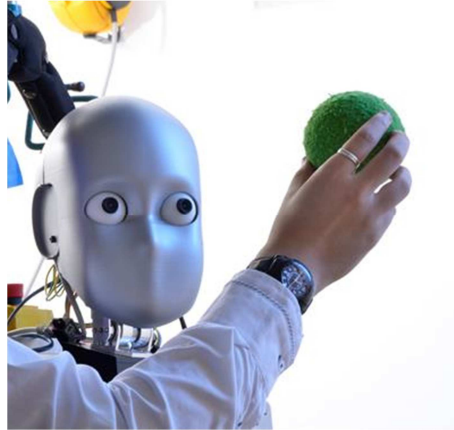
The objective of this research area is to study the ethical implications raised by robotics in research and applications, including social, legal, economic and anthropological issues. Some of the research topics of interests are: robotics and employment; robot market and insurance, legal status of robots; acceptance of social robots.



*Photo credit: Massimo Brega*

## Humanoid Robotics

The main objective of the humanoid robotics is the study and the robotic implementation of neuroscientific models of sensory-motor coordination on humanoid platform. This has a twofold benefit: improving the performances of the robotic platform interacting with the real world and validating the neuroscientific models through a comparison between robot and biological system performances. In particular the research focuses on the implementation of models of gaze control, sensory-motor anticipation, adaptive controllers based on neural networks and stabilization mechanisms for the biped locomotion.

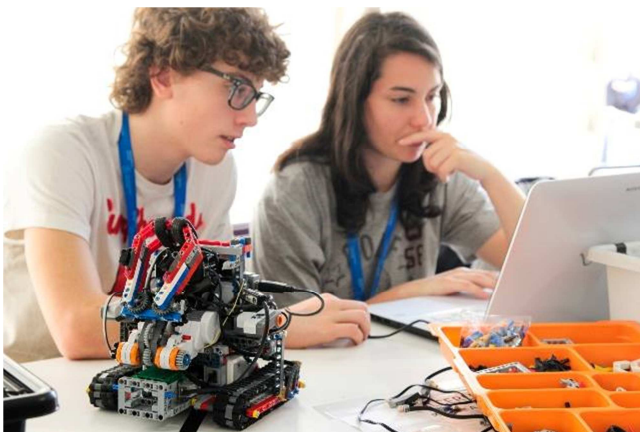


## Educational Robotics

Educational Robotics is an integrated system making use of Robotics as a method to increase the quality of scientific and technical education in school and, despite being appropriate for teaching science, math and technology, it has also many connections with other school subjects such as literature, arts and theatre.

Robotics is extremely motivating: learning with robots increase children engagement and a student-centred learning approach. It develops a problem-solving attitude, foster a trans-disciplinary approach and encourage team work.

Our Educational Laboratory on Robotics promote programs to educate primary, secondary and high school students on using robotic technologies with strong collaborations and synergies between municipalities, university, schools, enterprises, citizens, stakeholders.





# Assistive Robotics Laboratory

The aim of the Assistive Robotics Lab is to design and develop ICT and robotics solutions to provide support and assistance to citizens in daily life activities. Particularly the studies carried out in the "Active and Assisted Living" field aims to integrate robotics, internet, cloud, mobile and electronic technologies for applications, such as healthcare, agriculture, logistic and manufacture. The main scientific challenges to enhance the abilities and capabilities of robotic systems revolve around the physical and cognitive human robot interaction, the integration in intelligent environments and the dependable design.



# Soft Robotics Area

The growing need for robots in service tasks, in unstructured environments, in contact with humans, is leading to release the basic assumption of rigid parts in robotics.

The role of soft body parts to increase adaptability and robustness appears clear in natural organisms. Compliance, or softness, are also needed for implementing the principles of embodied intelligence, or morphological computation, a modern view of intelligence, attributing a stronger role to the physical body and its interaction with the environment.



*Photo credit: Jennie Hills, London Science Museum*

Soft robotics is an interdisciplinary field in robotics that deals with robots built out of soft and deformable materials capable to actively and safely interact with humans and the environment. Soft robotics is not just a new direction of technological development, but a novel approach to robotics, unhinging its fundamentals, with the potential to produce a new generation of robots, in the support of humans in our natural environments.



*Photo credit: Massimo Brega*

# Soft Mechatronics for Biorobotics Laboratory

Soft, elastic and deformable systems with variable stiffness are key factors for safe and effective interactions with physical unknown environments, opening to robots a wide range of application possibilities.

Soft robotics can show all its potentiality only if all the components of the system are contextually taken into consideration, going beyond even the biomechatronic approach in terms of integrated design.

Several efforts have been focused on the development of new sensors, actuators, batteries and mechanisms that are based on soft, flexible or variable stiffness technologies, but the most has yet to be done.

In particular, actuators represent the real bottle neck, but in the last few years new and promising soft mechatronics technologies are emerging thus offering new possibilities to fill the gap between natural and artificial muscles.



*Photo credit: Massimo Brega*



# Creative Engineering Design Area

Merging creativity with robust engineering approaches and methodologies is the key to the development of radically new machines and usable systems.

Creative engineering design in robotics and biorobotics is a way to bridge research and industrial innovation, to develop acceptable and sustainable robots, and to educate creative students.

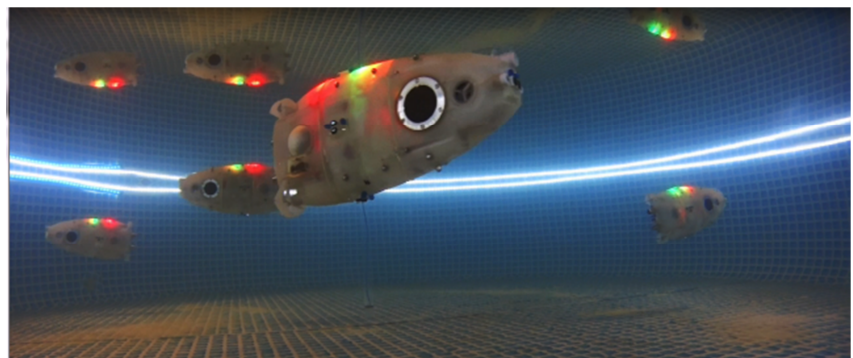
The area of Creative Engineering Design at the BioRobotics Institute of Scuola Superiore Sant'Anna is focusing on this effort, by adopting specific approaches such as Design Thinking and Human Centered Design.



*Industrial collaborations (2013 to date)*

A small team of motivated, creative and competent young researchers with multidisciplinary background works on challenging research projects, often in the framework of industrial collaborations.

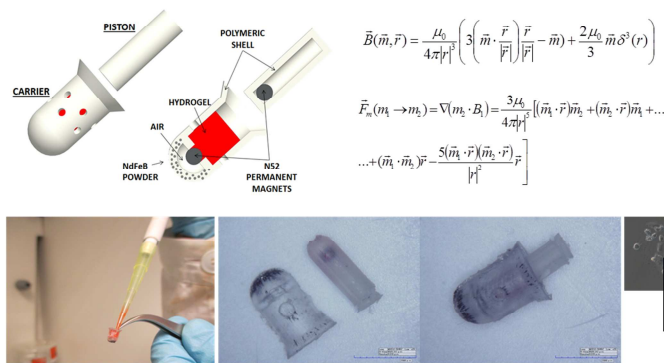
Level of success is measured by evaluating results on a regular basis, in terms of number of original articles published on international journals, exploited IP, alumni placement



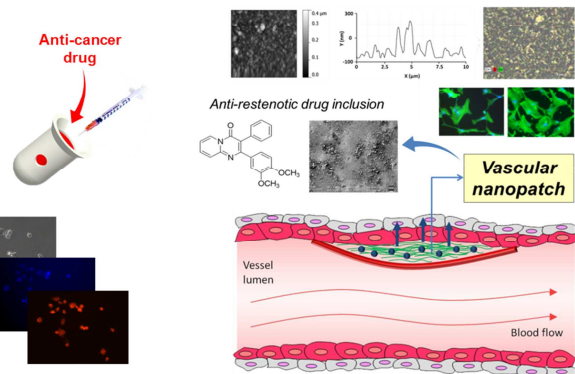
# Surgical Robotics and Allied Technologies Area

Investigating problems, identifying enabling technologies and developing solutions for addressing the field of minimally invasive and targeted therapy and diagnosis. Development of endocavitary robots, capsules, instrumented catheters, and probes able to operate and navigate in the human body for diagnostic and therapeutic applications. Therapy and diagnosis can be performed in the human abdomen, in the cardiovascular system, in the gastrointestinal tract, but also in other hard-to-reach districts.

## Magnetic milli-robots for targeted drug delivery

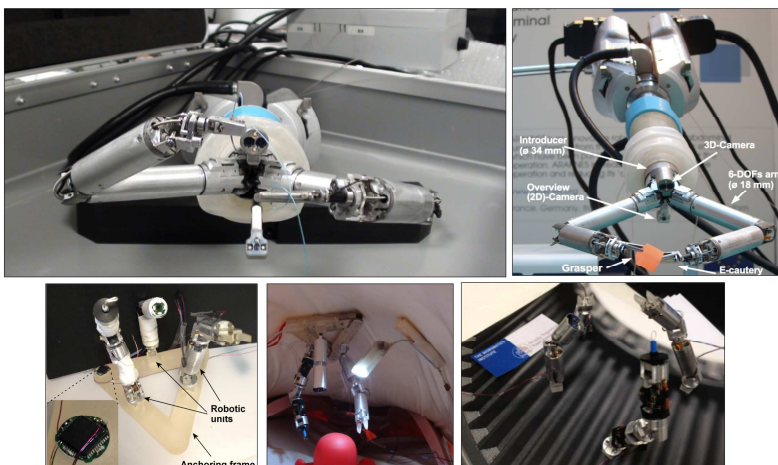


## Ultra-thin films for advanced medical treatments

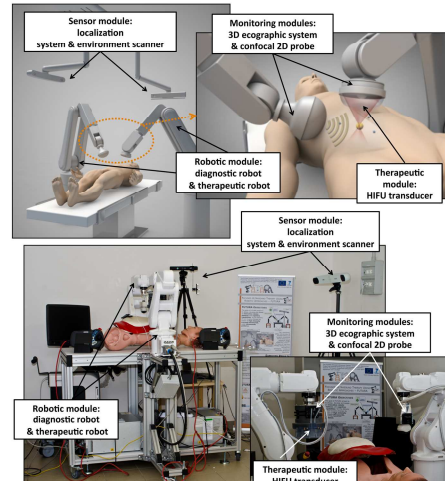


Within this framework, the mission of the Surgical Robotics and Allied Technologies Area, that includes the Laboratories of “Computer-Integrated Technologies for Robotic Surgery” and “Micro-nano-bio systems and targeted therapies”, is to combine micro/nano/bio technologies, molecular biology, chemistry, physics, robotics/microrobotics/computer-integrated technologies, for enabling future high quality (accurate and repeatable), early and minimal invasive key technologies.

## Innovative robotic devices for single port, minimally invasive surgery



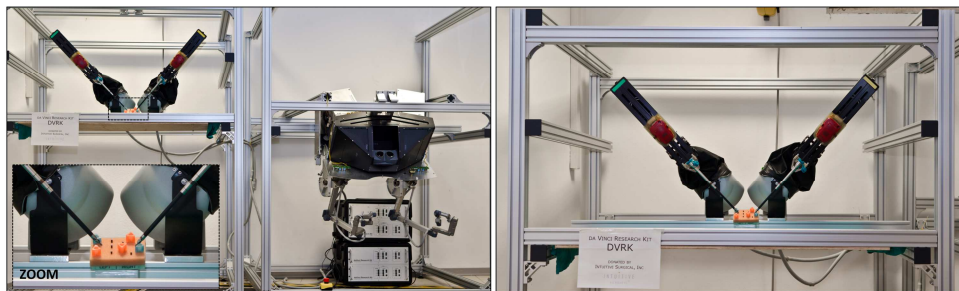
## Computer integrated robotic platform for focused ultrasound therapy



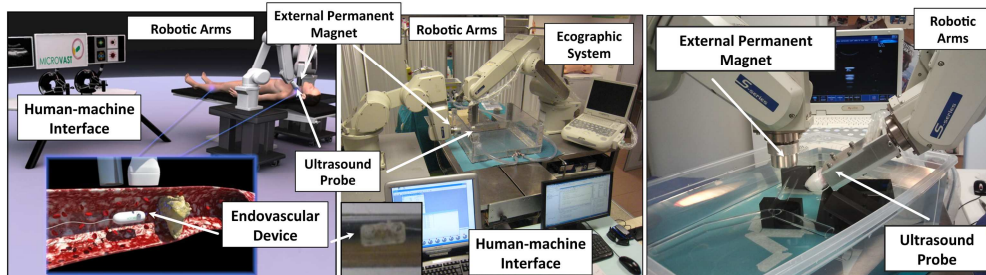
# Computer-Integrated Technologies for Robotic Surgery Laboratory

Medical robots have a significant potential to fundamentally change surgery and interventional medicine as part of a broader, information-intensive environment that exploits the complementary strengths of humans and computer-based technology. Robotic systems for surgery are computer-integrated systems (i.e., surgical CAD/CAM or surgical assistants) in which the robot/tool itself is just one element, i.e. the end-effector, of a larger system designed to assist (with a pre-programmed/semiautonomous, teleoperated or hands-on compliant control) a surgeon in carrying out a surgical procedure that may comprise preoperative planning, intraoperative registration to presurgical plans, use of a combination of robotic assist and manually controlled tools for carrying out the plan, and postoperative verification, analysis and follow-up.

### The daVinci Research Kit (dVRK) robotic platform

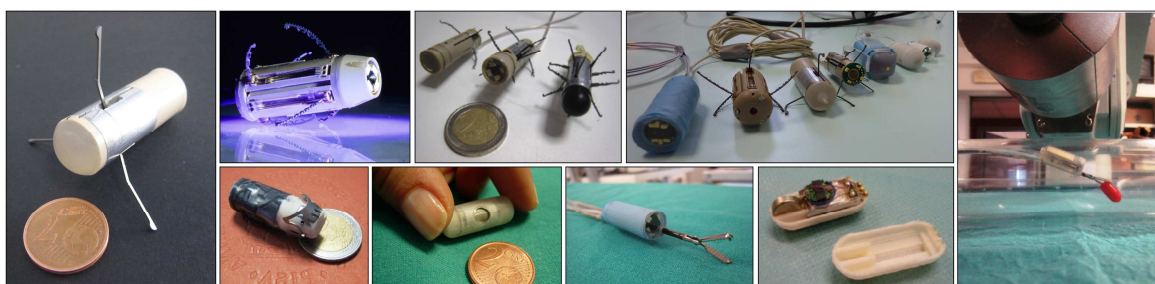


### Computer-integrated platform for cardiovascular procedures (magnetic locomotion and US tracking)



Within this framework, the mission of the Computer-Integrated Technologies for Robotic Surgery Laboratory is the invention, prototyping and clinical validation of computer-integrated platforms and smart devices as means for effective, reliable and minimally invasive diagnosis and therapy.

## Active locomotion endoscopic devices with diagnostic and therapeutic capabilities for the gastrointestinal tract

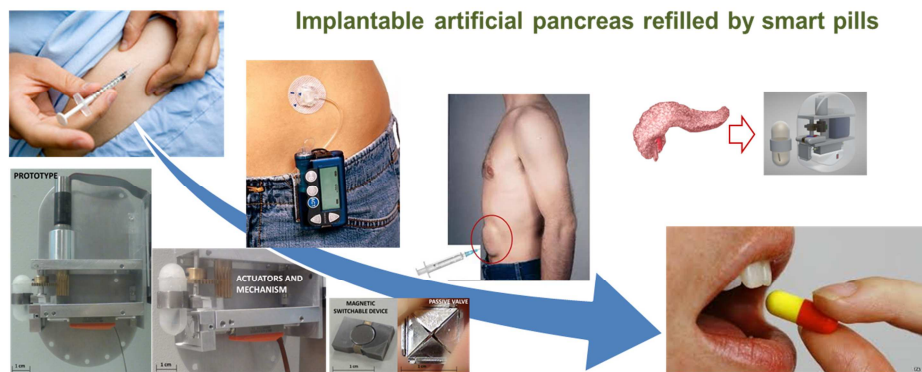




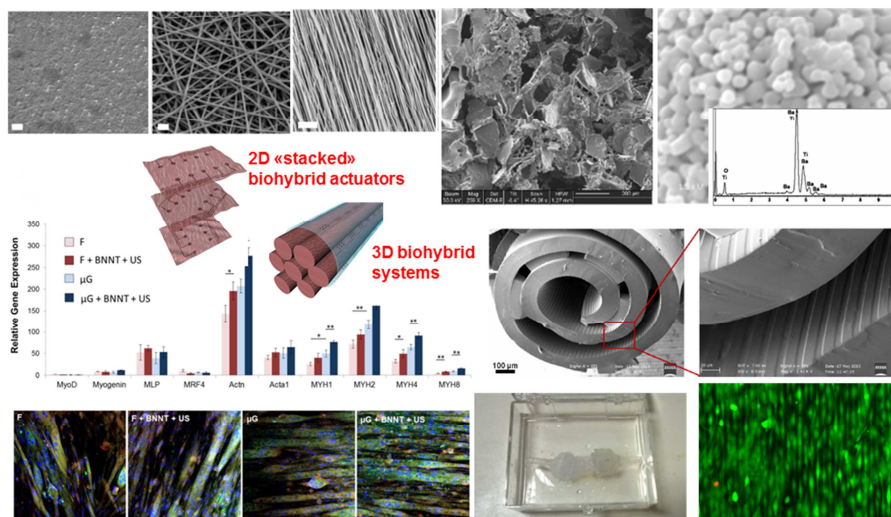
# Micro-Nano-Bio Systems and Targeted Therapies Laboratory

The research mission of the Lab is grounded on a strongly interdisciplinary approach and on the hypothesis that a properly driven cross-fertilization between mechatronics, materials science, biotechnologies and molecular biology can produce: (i) disruptive technological advancements for the development of new flexible and scalable machines, based on smart materials and biohybrid devices, integrating living cells and tissues with artificial components; (ii) a dramatic improvement of targeted and minimally invasive therapies, enabling an important leap of several medical treatments: to achieve this objective, a combination of insights coming from applied physics and materials science (e.g. concerning novel responsive materials), surface functionalization strategies and ad hoc technological tools will be needed; (iii) innovative technological tools enabling significant discoveries in Life

Sciences: heterogeneous ICT-based microdevices and nanostructured materials may give a key contribution to tissue engineering and regenerative medicine, allowing at the same time to unveil fundamental principles related to healthy or diseased cells/tissues and their organization in 3D functional structures.



## Micro/nano-structured materials for regenerative medicine and bio-hybrid devices

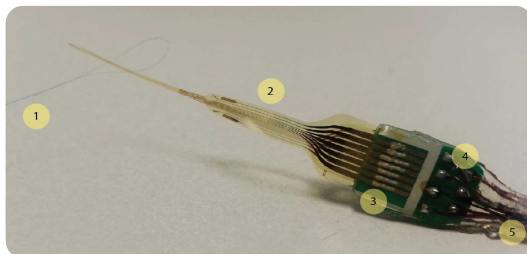


# Translational Neural Engineering Area

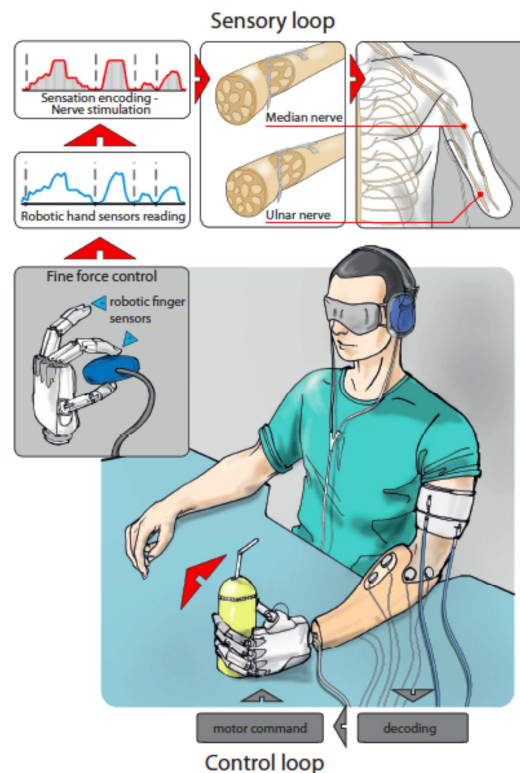
Neuroengineering is a novel discipline combining engineering including micro and nanotechnology, electrical and mechanical, and computer science with cellular, molecular, cognitive neuroscience with two main goals: (i) increase our basic knowledge of how the nervous system works; (ii) develop systems able to restore functions in people affected by different types of neural disability. In the past years, several breakthroughs have been reached by neuroengineers in particular on the development of neurotechnologies able to restore sensorimotor functions in disabled people.

In this framework the goal of the TNE Laboratory is to develop personalized neuroprostheses to improve the quality of life of disabled people by exploiting the potentials of neuroscience-driven approaches. In particular, we are working on the development of novel implantable neural interfaces, neuroprosthetic technologies to restore locomotion and grasping sensory-motor functions, bionic artificial limbs, advanced computational algorithms, novel approaches to understand motor control.

The TNE lab is also actively involved in three joint laboratories on “neural control of movements” (with the University of Pisa and the University Hospital of Pisa, Prof. Bruno Rossi and Dr. Carmelo Chisari) and on “translational neurorehabilitation” (with the Institute of Neuroscience of the Italian National Research Council, CNR, Dr. Matteo Caleo). The TNE Lab also collaborates with the “Movement assistance and rehabilitation laboratory (MARE Lab)” (led by Dr. Nicola Vitiello).



Electrode developed in the TNE Lab



Closed-loop controlled bionic hand prosthesis

# Locomotion Biomechanics Laboratory

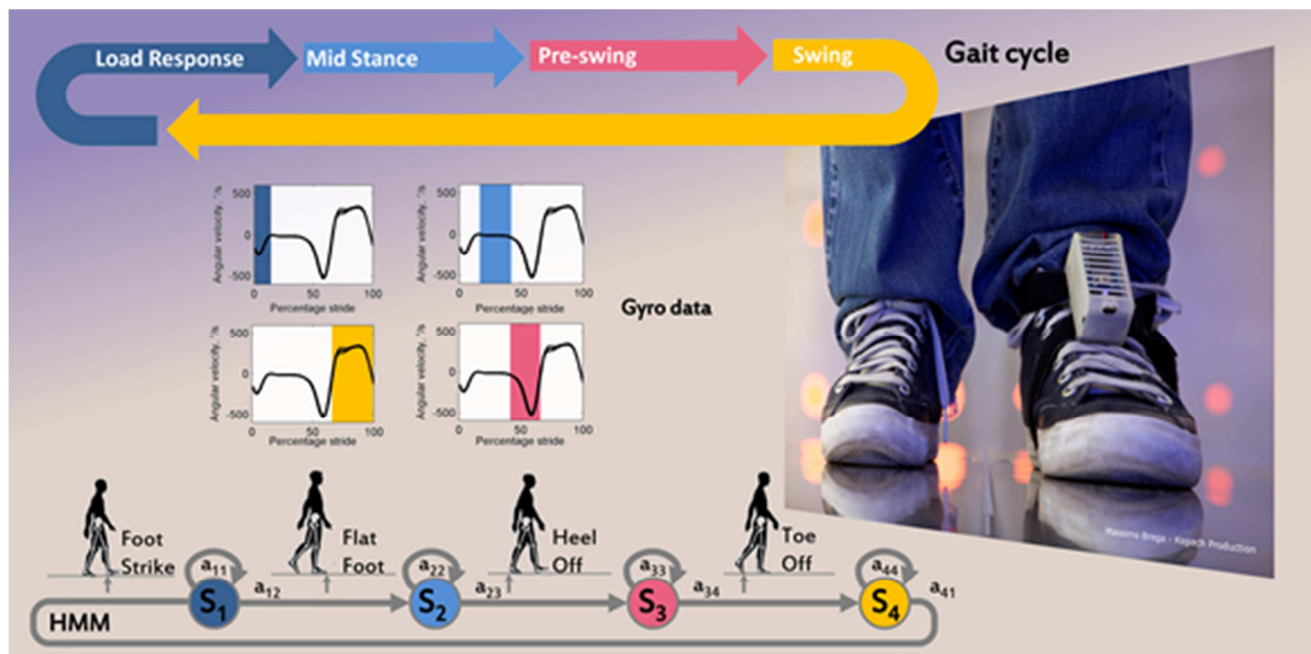
The main aim of the Locomotion Biomechanics Lab consists in investigating neuromuscular adaptations resulting by ageing and neuro-musculo-skeletal disorders, which affect both walking and keeping the balance during dynamic motor tasks. Results coming from this research fields are expected to help diagnosis of people with movement disorders, to design novel robotic-aided rehabilitative interventions, and to develop strategies to prevent the risk of fall. Moreover, they are expected to contribute to understand the coordination roles underling inherently unstable motor tasks such as walking.



# Sensor Signals and Information Processing Area

The research activities mainly concern the design, development, and validation of wearable sensor systems for applications in the field of human motion monitoring, functional assessment, fall detection and fall risk assessment.

The core activity of the lab is based on deploying body area networks that are built around custom-made magneto/inertial measurement units, enriched with, e.g., monocular camera systems and barometric altimeters.



Of special interest to the group is the development and validation of the computational methods, either machine learning or stochastic filtering methods, that are needed for automatically recognizing the human activity (context detection), and for estimating the biomechanical parameters of relevance to each recognized activity (functional assessment).



# Neuro-robotics Area

*The dream: to develop wearable robots allowing the human-robot symbiosis*

Symbiosis: “a close, prolonged association between two or more different organisms of different species that may, but does not necessarily, benefit each member” (American Heritage Dictionary). The robot becomes a physical, mechanical agent which actively supports (healthy, elderly and disabled) people in performing activities of daily living.

*Is “physical” human-exoskeleton symbiosis doable?*

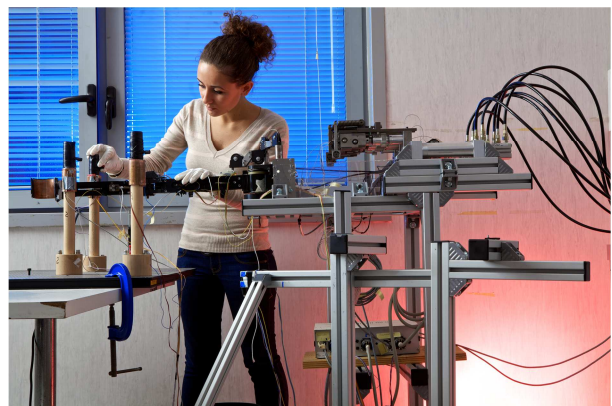
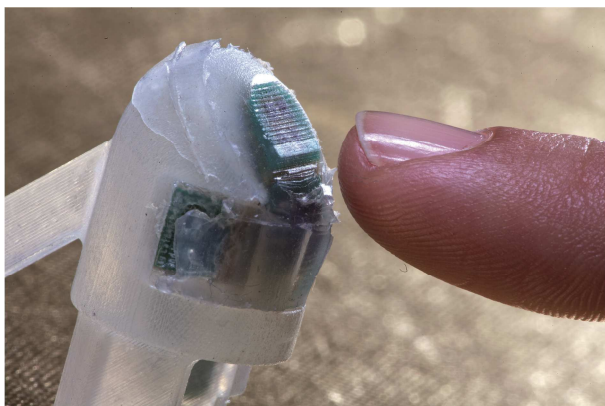
In 1960s, in Man-Computer symbiosis, J.C.R. Licklider formulated a vision of human-computer symbiosis in which computers and humans would become fluidly interdependent and share goals. In 2010s, in many tasks, human and computer share goals and are interdependent.

*The method*

The neuro-robotics paradigm is a design approach mainly aimed at the fusion of neuroscience and robotics to design and develop advanced robotic devices for the rehabilitation of the human upper and lower limbs. We develop robotic models (physical platforms) for the investigation of neuroscience theories - in this case, the robot is the object itself of the investigation - and we exploit results of the neuroscience investigation to design and develop robotic systems.

*Research Topics:*

- Wearable assistive machines
- Artificial sense of touch
- Rehabilitation robotics and tele-rehabilitation



*Photo credit: Massimo Brega*

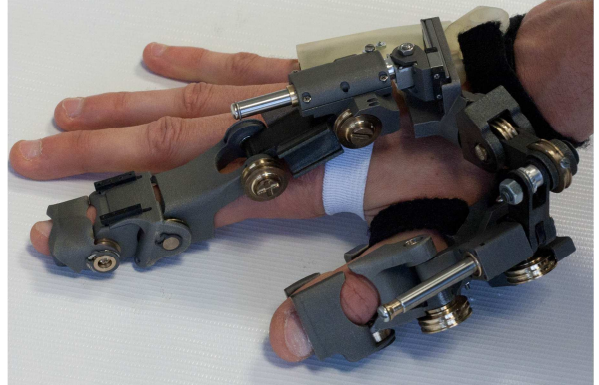
# Wearable Robotics Laboratory

Ageing population affects society welfare sustainability. The ageing of the population is one of the most critical challenges current industrialized societies will have to face in the next years, and threatens the sustainability of our social welfare.

In 40 years from now, nearly 35% of the European population will be older than 60, hence the urgency to provide solutions enabling our ageing society to remain active, creative, productive, and – above all – independent.

Among many diseases, gait disorders and upper-limb impairment are common and often devastating companions of ageing, leading to reductions in quality of life and increased mortality.

Within this framework, the mission of the Wearable Robotics Laboratory is the invention, prototyping and clinical validation of wearable robots (also called exoskeletons or powered orthoses) for assisting, rehabilitating or augmenting human movement.



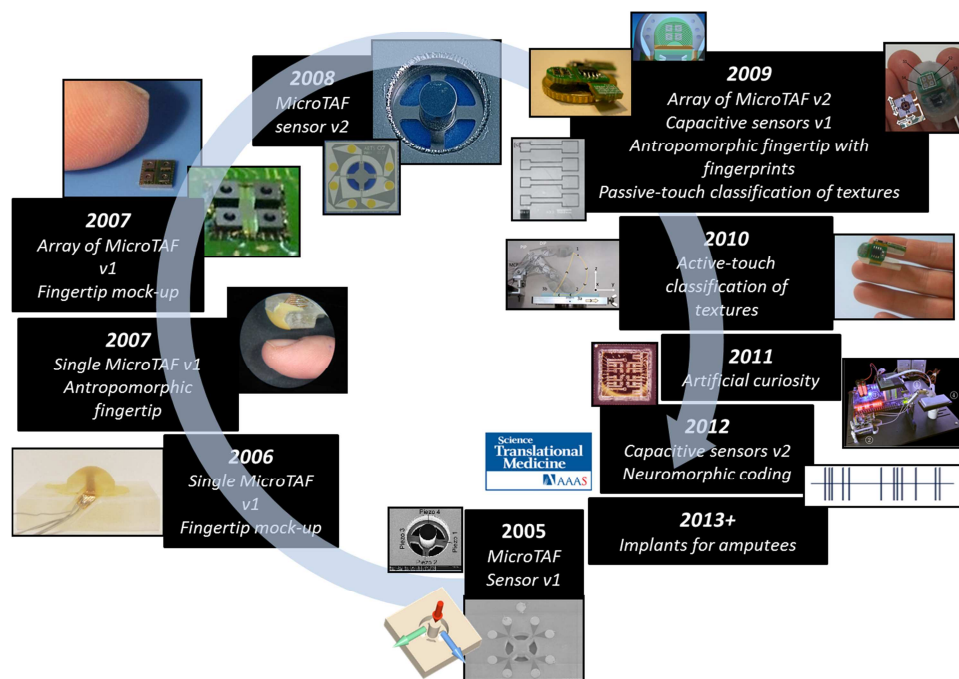
# Human Machine Nexus Laboratory

The Human Machine Nexus laboratory mainly targets the engineering of an artificial tactile sense in parallel to the investigation of human touch.

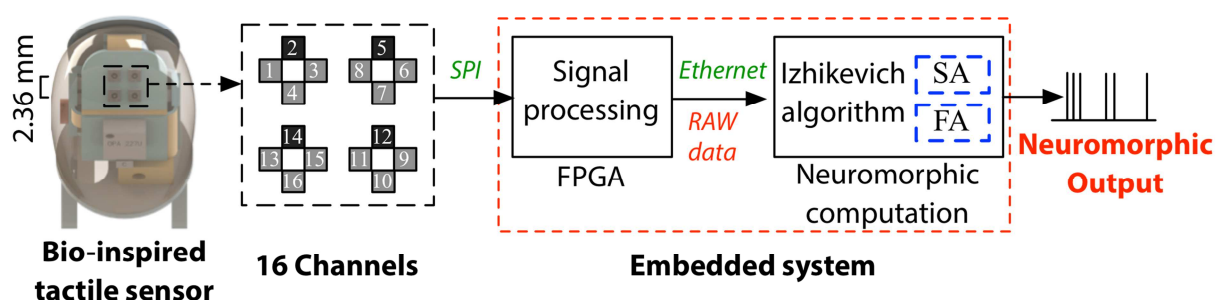
We develop and integrate novel transducers, both synthetic and bio-hybrid. We implement neuromorphic systems, with natural spiking coding of tactile information.

We analyse neural data to unveil the neuronal processes underlying the human sense of touch, and we implement behavioural protocols to characterize the perception of tactile features.

## Artificial touch



This body of neuroscientific knowledge and the developed biorobotic technologies converge in a key application domain in upper limb neuroprosthetics, with complementary interests stemming towards safe human-machine co-work, tele-presence for medical robotics and hand-held consumer electronics.



# Artificial Hands Area

The Artificial Hands Area of the BioRobotics Institute conducts research into mechatronics and human-machine interfaces for advanced robotic limbs to be used as thought-controlled prostheses. Current research topics include upper-limb prosthetics, robotic hands and dexterous grasping, non-invasive human machine interfaces for the physiological control of prehension, robust artificial tactile sensors, wearable sensory feedback devices, closed loop control prosthetics.

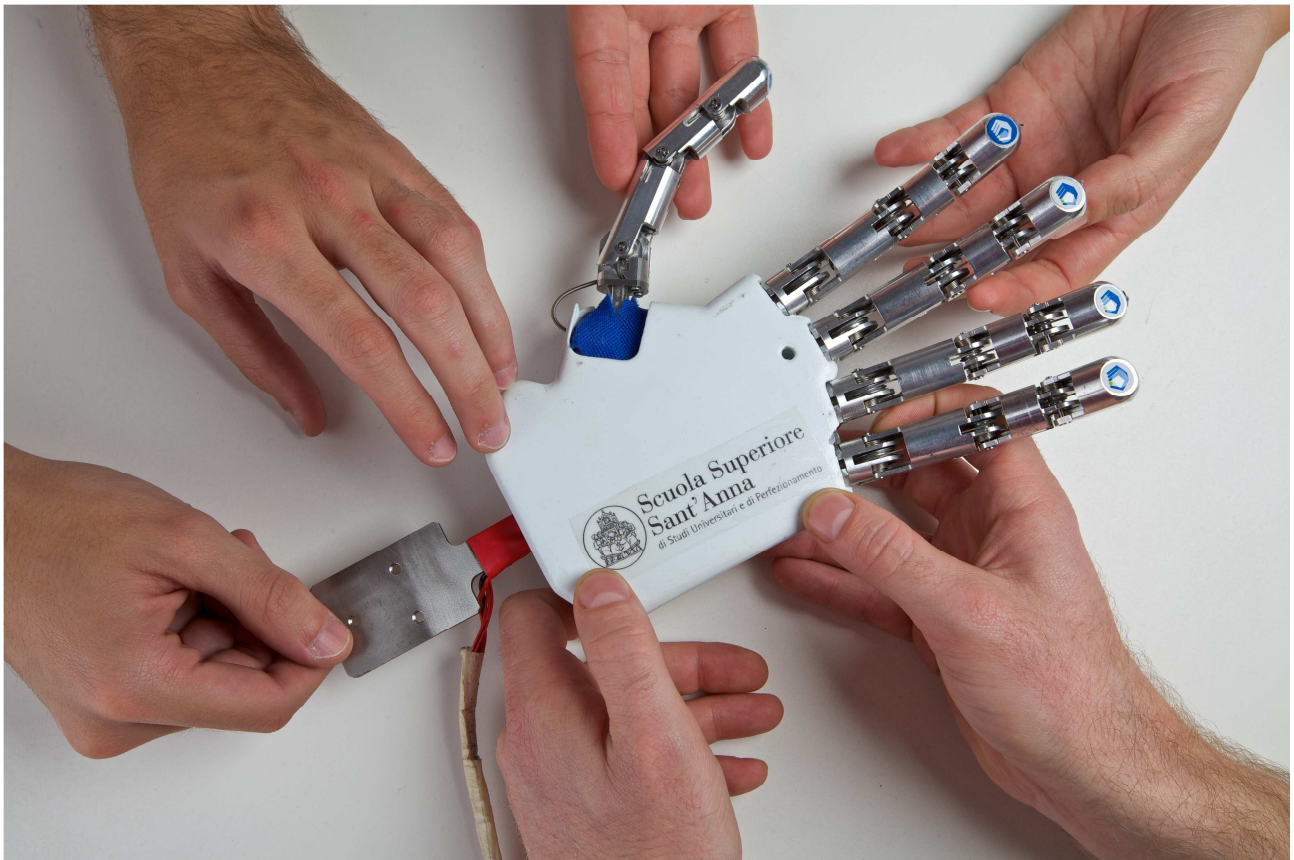


In addition the group is involved in Consortiums dealing with cognitive robotics, human-robot interaction and neuro-controlled prosthetics. Prensilia ([www.prensilia.com](http://www.prensilia.com)), which develops and commercializes artificial dexterous hands worldwide, is the company that spun out from this group.



# Human Robot Interaction Laboratory

The Human-Robot-Interaction Laboratory is part of the Artificial Hands Area of the BioRobotics Institute. Current research topics include robotic hands and dexterous grasping, cognitive robotics and human-robot interaction.

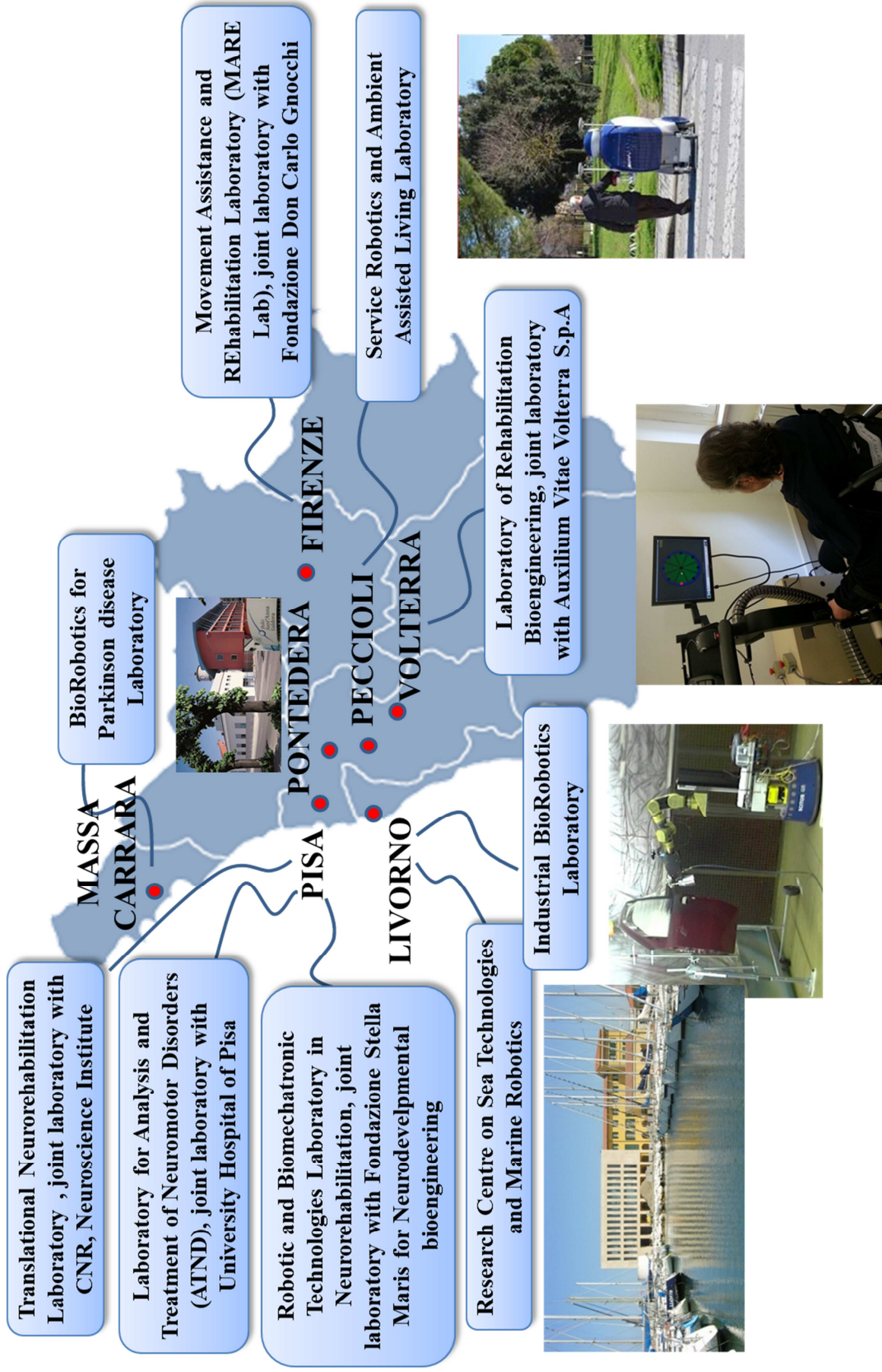


*Photo credit: Massimo Brega*

# Joint laboratories and research centres

The BioRobotics Institute has also 9 additional laboratories and research centres located in Tuscany:

- Service Robotics and Ambient Assisted Living Laboratory (Peccioli, Pisa)
- Laboratory of Rehabilitation Bioengineering, joint laboratory with Auxilium Vitae Volterra S.p.A (Volterra, Pisa)
- Translational Neurorehabilitation Laboratory, joint laboratory with CNR, Neuroscience Institute (Pisa)
- Laboratory for Analysis and Treatment of Neuromotor Disorders (ATND), joint laboratory with University Hospital of Pisa (Pisa)
- Robotic and Biomechatronic Technologies Laboratory in Neurorehabilitation, joint laboratory with Fondazione Stella Maris for Neurodevelopmental bioengineering (Calambrone, Pisa)
- Research Centre on Sea Technologies and Marine Robotics (Livorno)
- Industrial BioRobotics Laboratory (Interporto Toscano Amerigo Vespucci S.p.A., Collesalvetti, Livorno)
- Movement Assistance and REhabilitation Laboratory (MARE Lab), joint laboratory with Fondazione Don Carlo Gnocchi (Firenze)
- BioRobotics for Parkinson disease Laboratory (Massa Carrara)





# Service Robotics and Ambient Assisted Living Laboratory

The Service Robotics and Ambient Assisted Living Lab's main research themes focus on cloud and social robotics, ambient assisted living, wireless and wearable sensor systems, biomedical processing, dependability and acceptability.

It consists of a permanent infrastructure for tests and benchmarks in real indoor and outdoor environments, addressing application areas, such as healthcare, waste management, logistic, public transportation, edutainment, agriculture, etc.

The working team is composed of a multidisciplinary and creative group of scientists, engineers, designers and medical staff that closely cooperates with sociologists, economists, psychologists and lawyers.

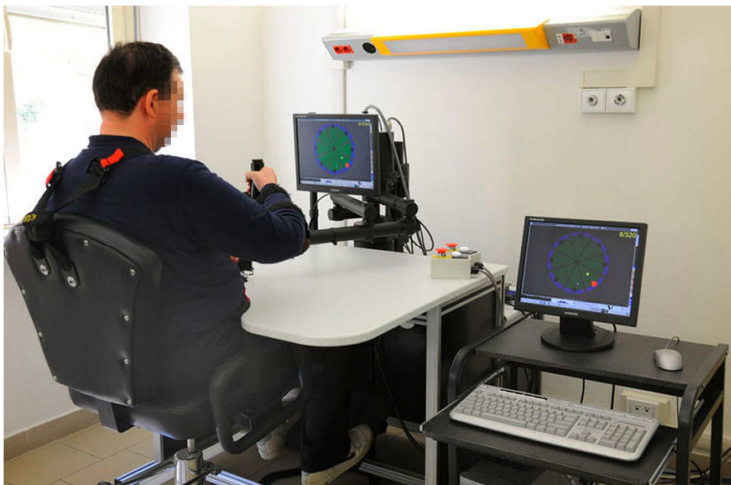
Additionally roadmapping activities for definition of Strategic Research Agenda for EU Commission in the field of Ambient Assisted Living and ICT technologies are developed.



# Laboratory of Rehabilitation Bioengineering

Founded in 2011, the Laboratory of Rehabilitation Bioengineering has been established through an agreement between Auxilium Vitae Volterra S.p.A. and Scuola Superiore Sant'Anna, Pisa.

The main mission of the joint research laboratory is to design, develop and validate innovative technologies for neurological, musculo-skeletal and cardio-pulmonary rehabilitation through a daily collaboration between bioengineers and healthcare professionals. Ongoing research activities include: Robot-assisted neurorehabilitation; Assistive robotics; Telerehabilitation and telemonitoring applications for cardio-pulmonary rehabilitation; Analysis of patient-ventilator interaction; Analysis of athletes ventilatory response to exercise; Upper limb and locomotion functional assessment.

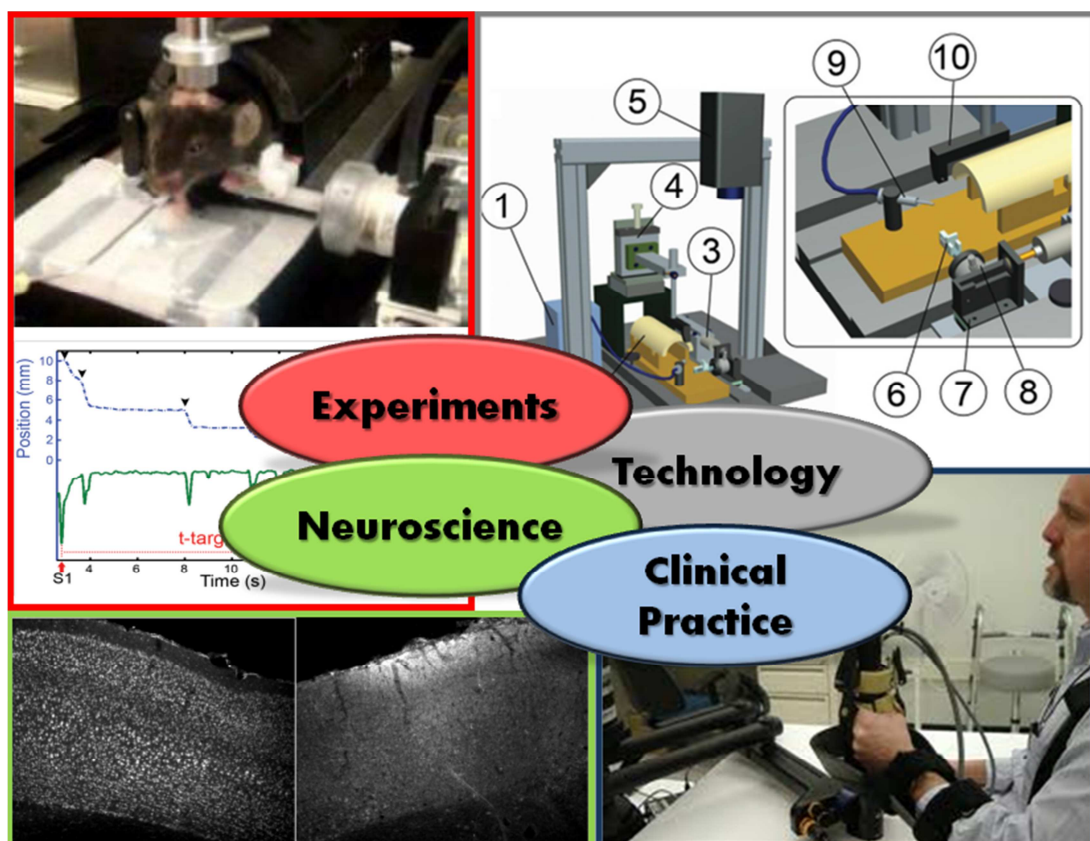


# Translational Neurorehabilitation Laboratory

The Translational Neurorehabilitation Laboratory provides a closer interaction between basic neuroscientists, neural and rehabilitation engineers, and clinical neurologists. Our mission is to expand current understanding of brain function and disease by performing preclinical experiments on animal models of nervous system disorders, and translate this knowledge into novel therapies by developing innovative robotic and ICT-based applications.

Current research activities include:

- study of brain function after stroke (anatomy, electrophysiology, behaviour)
- robot-based motor rehabilitation in a rodent model of stroke
- epilepsy-induced modifications of visual function
- closed-loop detection and suppression of epileptic seizures



# Laboratory for Analysis and Treatment of Neuromotor Disorders (ATND)

The ATND Lab provides a closer interaction between rehabilitation engineers and physicians to study neurobehavioral changes in people with neuromotor disorders, and to develop new clinical approaches and technologies for motor rehabilitation.

Current research activities and tools include:

- Analysis of movement (kinematics, kinetics) to assess post-stroke motor impairment and post-rehabilitative modifications
- Advanced analysis of neurophysiologic modifications following stroke (electroencephalography, electromyography, transcranial magnetic stimulation)
- Robot-based upper- and lower-limb post-stroke rehabilitation (MOTORE, Lokomat)



# Robotic and Biomechatronic Technologies Laboratory in Neurorehabilitation

The "Robotic and Biomechatronic Technologies Laboratory in Neurorehabilitation" is a place where different but convergent experiences and competences meet together; the purpose is the design, the clinical testing and the maintenance of new methods and instruments aimed at the behavioural study of the neurobiological mechanisms, which are basic for the early development of the human brain, as well as the motor, perceptual and integrative functions (visual exploration, grasping, manipulation, locomotion, navigation), both in healthy children and with neuromotor disabilities.

Furthermore, starting from these experiences, knowledge and prototypes can be transferred in rehabilitation, or created ex novo, in order to re-educate the functions explored.



# Research Centre on Sea Technologies and Marine Robotics

The Research Centre on Sea Technologies and Marine Robotics is the laboratory of the BioRobotics Institute specialized for the design, development and validation of new technologies and robotic systems for marine applications.



Research is conducted on surface and underwater autonomous systems, underwater manipulator control and environmental sensors as well as on bioinspired aquatic robots.

The Centre is equipped with testing tanks to test robots in a controlled environment and it has direct access to the sea to assess robots' performance in a real environment.

The Centre is also equipped with: FDM 3D Printer, laser cutting, mechanical workbench, electronic workbenches, chemical workbench with laboratory fume hoods, aquariums, 3D tracking system, high-performance workstations, laboratory vacuum oven.

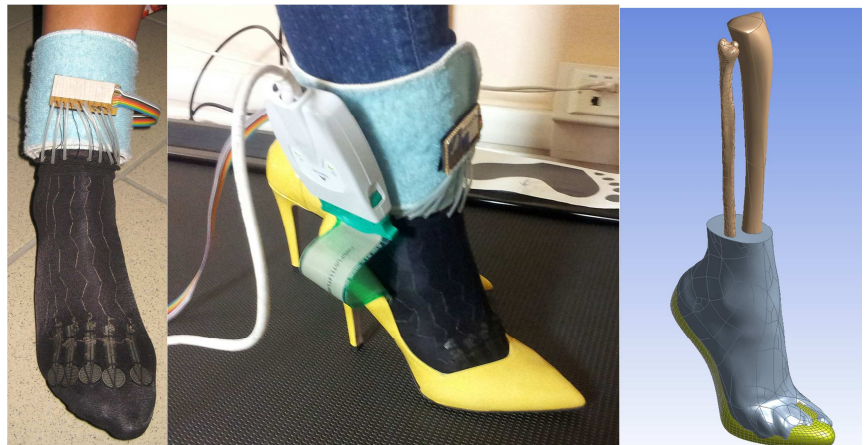


*Photo credit: Massimo Brega*

# Industrial BioRobotics Laboratory

Applied research, innovative solutions and systems to improve industrial growth and competitiveness:

our research is mainly focused on companies' needs in the field of robotics, automation and mechatronics. We cope with unstructured problems and find innovative solutions taking inspiration from nature. Our aim is to drive our partner to develop new products and processes.





# Movement Assistance and REhabilitation Laboratory (MARE Lab)

Movement Assistance and REhabilitation Laboratory (MARE Lab), joint laboratory with Fondazione Don Carlo Gnocchi (Firenze)

MARE Lab is a joint laboratory between The BioRobotics Institute and the centre for rehabilitation "Fondazione Don Gnocchi" located in Florence.

This laboratory aims at carrying out the experimental validation of wearable robots for motion assistance and rehabilitation with real end users such as elderly people affected by gait disorders, transfemoral amputees or hemiplegic patients. This laboratory is equipped with a motion tracking system, a EMG recorder, a device to monitor human physiological parameters, direct/indirect calorimeters and the SENLY platform for investigating fall biomechanics and strategies for its risk mitigation.

This laboratory is currently exploited by members of different laboratories/areas of The BioRobotics Institute, such as: Wearable Robotics Laboratory, Translational Neural Engineering Laboratory, Locomotion Biomechanics Laboratory and Human-Machine Nexus Laboratory.



# BioRobotics for Parkinson disease Laboratory

The BioRobotics for Parkinson disease Laboratory focuses on prevention, monitoring and management of Parkinson's disease (PD) and its co-morbidities, from screening for pre-frailty states (e.g. subjects with idiopathic hyposmia), to early diagnosis, rehabilitation and assistance according to the level of the pathology.

The activities concern the combination of mHealth applications, cooperative ICTs, Cloud technologies and wearable / portable integrated devices, which empower patients to pursue healthy lifestyles and to manage their health and disease in cooperation with their formal and informal caregivers and with professional medical staff across different care settings and environments.



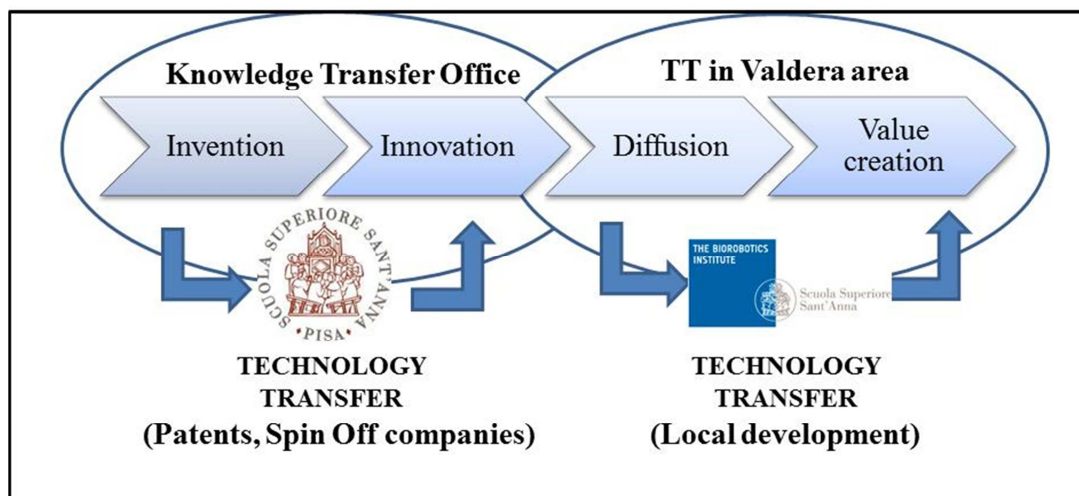
# Technology Transfer

The BioRobotics Institute supports local development policies by applying the results of frontier and excellence research to the needs for quality-of-life improvement as well as to the social, economic and cultural development of the territories in which it operates, by:

- "transferring" people "trained" to innovation and new technologies that are suitable for creating new products to the socio-economic and business context;
- working in close collaboration with local and national institutions, with public and private entities and, on a broader scale, with all the stakeholders (schools, enterprises or organizations) who share a common interest in a strong, sustainable and measurable growth.

## Our concept of Technology Transfer

*To create value from knowledge: Innovation and Technology Transfer*



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