## SPECIAL EQUIPMENT

In addition to the world-class manufacturing and testing facilities available at The BioRobotics Institute, the AHA has specialized equipment in order to target its research vision.

- **Robotic hands** — IH2 Azzurra hand, Prensilia Srl. 5 DoFs anthropomorphic hands with self-adaptive grasping capabilities, position and grip force sensors. Platform for testing human-machine interfaces, control approaches, sensory feedback modalities, etc. Four hands available.
- **Robotic arm** — UR5, Universal Robots. 6 DoFs lightweight, flexible and collaborative industrial robot (payload 5 kg; working radius 850 mm). Platform for testing human-robot interaction strategies in domestic and industrial scenarios.
- **256 channels bio-signal amplifier** — EMG-USB2+, OT Bioelettronica. Records surface and intramuscular EMG signals, EEG and ECG signals both in monopolar and bipolar configurations.
- **18 sensors data gloves** — CyberGlove III Wifi 18 sensors, CyberGlove System LCC. Records human hand postures and movements during grasping and manipulation, wirelessly and in real time (sampling rate 100 Hz).
- **Skin conductance sensor** — Q sensor, Affectiva. Hand-held device, records wirelessly physiological parameters like skin conductance, temperature and acceleration.
- **Inertial motion capture suit** — 3-space IMU sensors, Yost Labs Inc. Records orientation of body segments relative to an absolute reference wirelessly and in real-time.
- **Optical motion capture system** — 6 cameras Bonita, Vicon Motion Systems Ltd. Records precise and reliable movement data of objects or people. At the MARELab, in Florence.
- **Hand assessment procedures materials** — Various tests like: SHAP, box and blocks, clothespin test, VET, etc.
- **Three-axis high precision characterization bench** — Three VT-80 linear stages (PI miCos), and one 6-axis load cell (Nano17 - ATI Industrial Automation). Produces stress-strain curves of biological tissues and artificial materials, and characterizes position and force sensors.
- **Optical 3D scanner** — croNos 3D Dual, Open Technologies. Scans and creates high precision 3D computer models of any object or body part by using structured light technology (two scan areas; resolution down to 106 µm).

## RECENT PUBLICATIONS


- F. Montagnani, M. Controzzi, C. Cipriani, "Indipendent Long Fingers are not Essential for a Grasping Hand," *Sci Rep,* vol. 6, no. 35545, pp. 1-9, 2016.
- M. Controzzi, F. Clemente, D. Barone, A. Ghionzoli, C. Cipriani, "The SSSA-MyHand: a dexterous lightweight myoelectric hand prosthesis," *IEEE Trans Neural Syst Rehabil Eng,* In press, 2016.
- F. Clemente, M. D'Alonzo, M. Controzzi, B. Edin, C. Cipriani, "Non-invasive, temporally discrete feedback of object contact and release improves grasp control of closed-loop myoelectric transradial prostheses," *IEEE Trans Neural Syst Rehabil Eng*, vol. 24, no. 12, pp. 1314-1322, 2016.
- F. Montagnani, M. Controzzi, C. Cipriani, "Is it Finger or Wrist Dexterity That is Missing in Current Hand Prostheses?," *IEEE Trans Neural Syst Rehabil Eng*, vol. 23, no.4, pp. 600-609, 2015.
- M. D'Alonzo, F. Clemente, C. Cipriani, "Vibrotactile stimulation promotes embodiment of an alien hand in amputees with phantom sensations," *IEEE Trans Neural Syst Rehabil Eng*, vol. 23, no. 3, pp. 450-457, 2015.


## GRANTS


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European Commission

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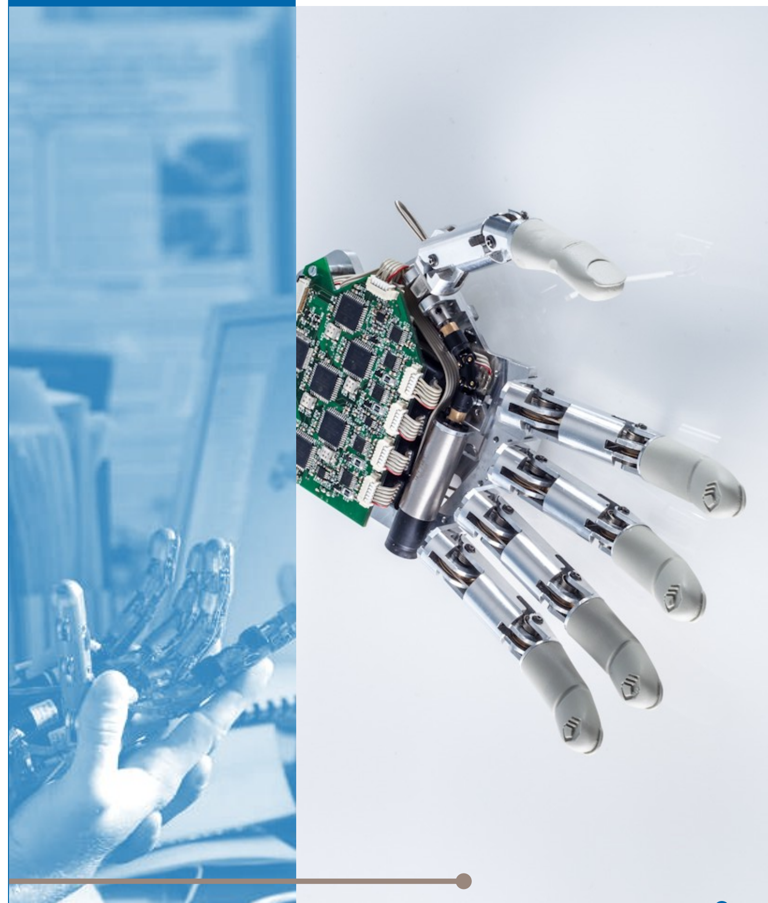
Jan 2017
http://www.santannapisa.it/en/institute/biorobotics/artificial-hands-area

THE BIOROBOTICS INSTITUTE

Sant'Anna
School of Advanced Studies – Pisa



# ARTIFICIAL HANDS Area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# ARTIFICIAL HANDS AREA AT GLANCE

The Artificial Hands Area (AHA) is one of the eight research Areas at the BioRobotics Institute of the Scuola Superiore Sant'Anna, Pisa, Italy.

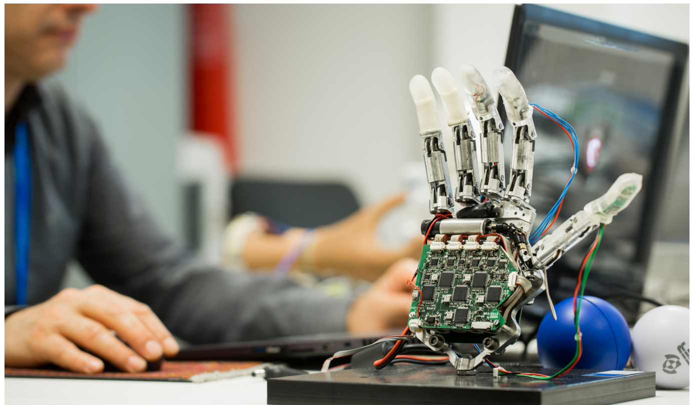
The AHA pursues research in **mechatronics** and **human-machine interfaces** (HMI) with the goal of developing advanced robotic limbs to be used as **thought-controlled prostheses**. Current research topics include: the (high-tech) observation of the human hand; the design of artificial hands, digits, wrists and elbows, their transmission and artificial sensory system; the design of control architectures and intuitive control strategies; the use of biological signals for the physiological control of prehension; the development and clinical validation of bi-directional non-invasive (wearable) interfaces through novel assessment tools; the investigation and comparison of shared-control strategies between user and the prosthesis; the incorporation of sensory feedback strategies into one's sensorimotor control.

The AHA includes the **Human-Robot-Interaction Lab**, coordinated by Dr. Marco Controzzi, working towards achieving a safe and efficient interaction between robots and humans in industrial and domestic settings.

The AHA co-founded with INAIL Prosthetic Centre the **REPAIR Lab** (Rehabilitation Engineering and Prosthetics Applied Innovation & Research) in Budrio (Bologna).

The AHA spun out **Prensilia** (www.prensilia.com), a company that develops and commercializes artificial hands worldwide, since 2009.

The AHA is coordinated by Dr. Christian Cipriani.

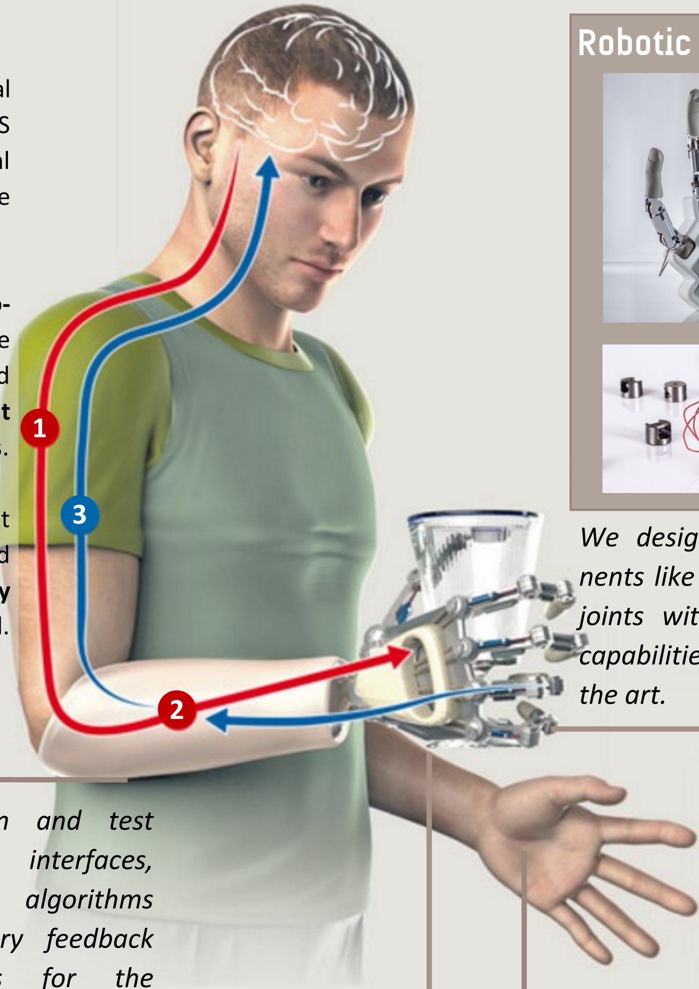


# Closing the loop

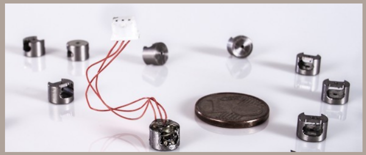
1. The **motor intentions** of the individual are naturally dispatched from the CNS to the PNS, in the form of electrical signals which in turn contract the **residual muscles** in the forearm.

2. The **actual movement** or the **myoelectric signal** associated with the muscle contraction can be detected and decoded for controlling **different movements of the robotic prosthesis**.

3. **Sensors** in the digits detect salient events in the motor task and physiologically **appropriate sensory feedback** is provided to the individual.



## Robotic hands and sensors



*We design mechatronic components like hands, digits and other joints with sensing and motion capabilities beyond the state of the art.*

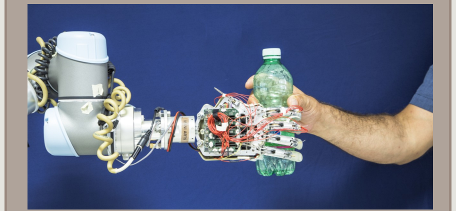
## Interfaces

*We design and test wearable interfaces, decoding algorithms and sensory feedback approaches for the closed loop control of hand prostheses and other assistive devices.*

## Pre-clinical assessment

*We validate our ideas, prototypes and concepts using state of the art procedures. We design new procedures able to assess the advantages brought by novel techniques.*

## Human hand function



*We study how humans grasp, manipulate and exchange objects and tools in order to build robots that mimic such behaviours and interact more safely with human beings, at home and at work.*