

Robotics and new opportunities: applications, open access and technology transfer

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Robots out of the cages...



Robots out of the cages...




Human-Robot Cooperation




[Courtesy IIT]

Companion Robots



Assistive Robotics



[Bebionic hand]

A rounded rectangular box containing three images illustrating different types of human-robot interaction. The top image shows a person working with a robot arm, labeled 'Human-Robot Cooperation' with a credit to 'IIT'. The middle image shows a person gesturing towards a robot, labeled 'Companion Robots'. The bottom image shows a person using a prosthetic hand, labeled 'Assistive Robotics' with a credit to 'Bebionic hand'.

Direct Human-Robot Interaction

Robots out of the cages...




Human-Robot Cooperation




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Companion Robots



Assistive Robotics



[Bebionic hand]

A rounded rectangular box containing three images illustrating different types of human-robot interaction. The top image shows a person working with an orange robotic arm, labeled 'Human-Robot Cooperation' and '[Courtesy IIT]'. The middle image shows a person interacting with a red robot arm, labeled 'Companion Robots'. The bottom image shows a person using a prosthetic hand to hold a cup, labeled 'Assistive Robotics' and '[Bebionic hand]'.

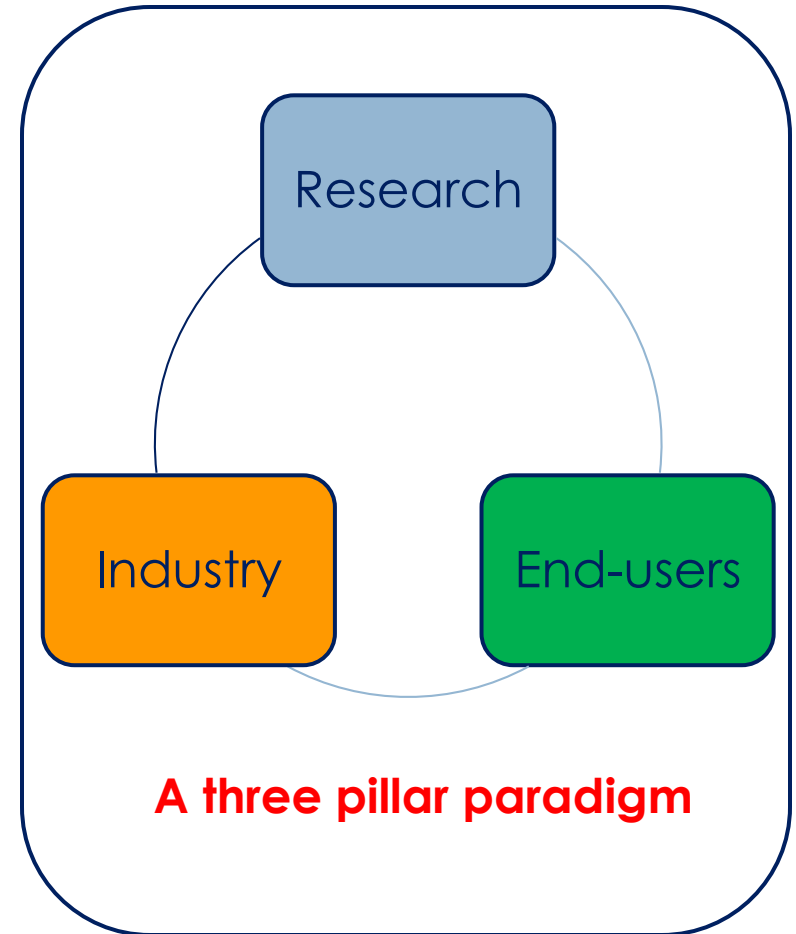
- New requirements for:
- Safety
 - Human-robot communication
 - Environment-interaction
- SOFT ROBOTICS**

Direct Human-Robot Interaction

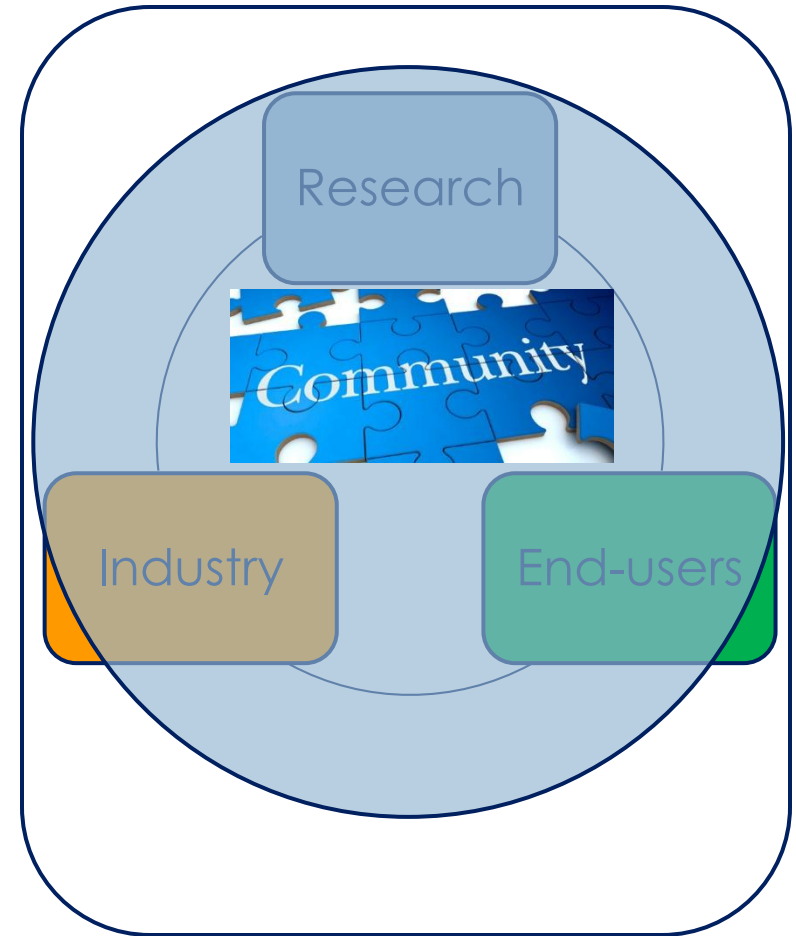
Soft Robotic Manipulation



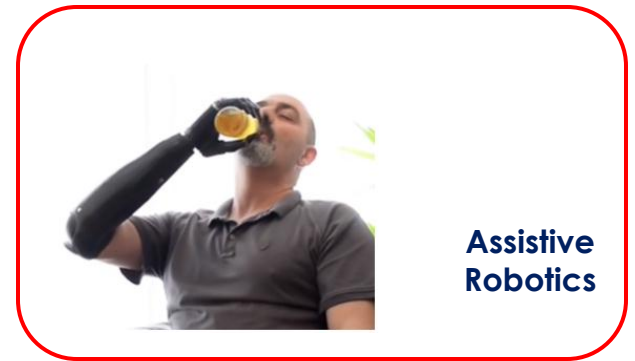
Robots out of the cages...



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**Assistive
Robotics**



SoftPro

Synergy-based Open-source Foundations and Technologies for Prosthetics and Rehabilitation



Horizon2020

Objectives

To **assist** people with **upper limb amputations** or **motor disabilities** providing them with **robotics-enabled aids**



Objectives



To **produce new technology** and **better performing devices** and make them **accessible** to **real people** with **real needs**

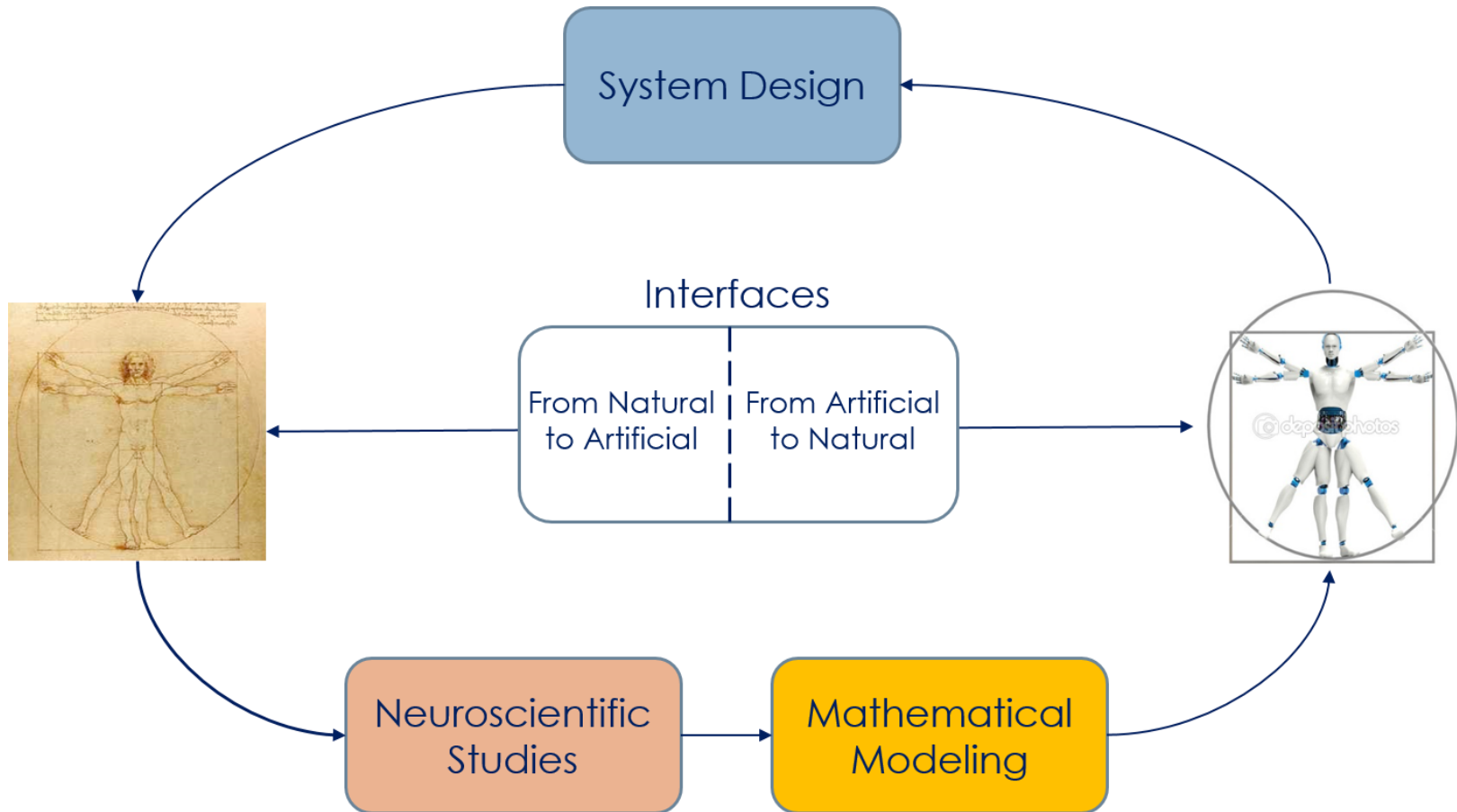
Relation to the work program

To **advance key technologies** for service robotics in the domain of **healthcare** (scope of the call for Research & Innovation Actions):

- **improving** adaptation, manipulation, motion and perception **abilities**, by **producing breakthroughs in Human-Robot Interaction, mechatronics, perception**
- priority market domain of **enabling robotics technologies for disabled people** (upper limb disabilities and/or amputations) allowing them to **gain functionalities with exoskeletons or prostheses**



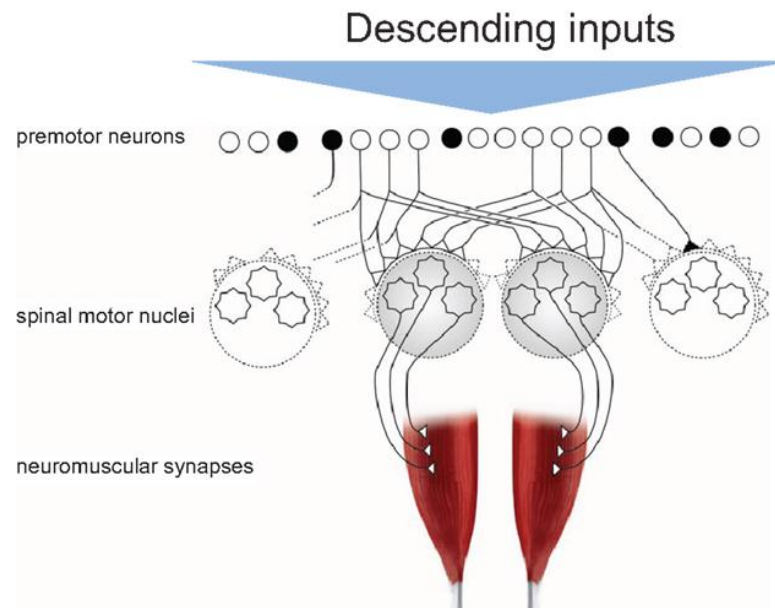
From humans to robots and back again



Concept and approach - Overall concepts

To achieve these goals **SoftPro** will leverage on **six crucial enablers**:

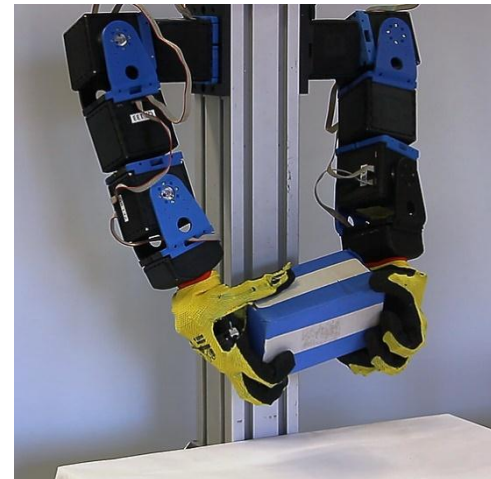
1. a solid neuroscientific theoretical basis on **sensorimotor synergies** as the elementary alphabet of human motor control primitive



Concept and approach - Overall concepts

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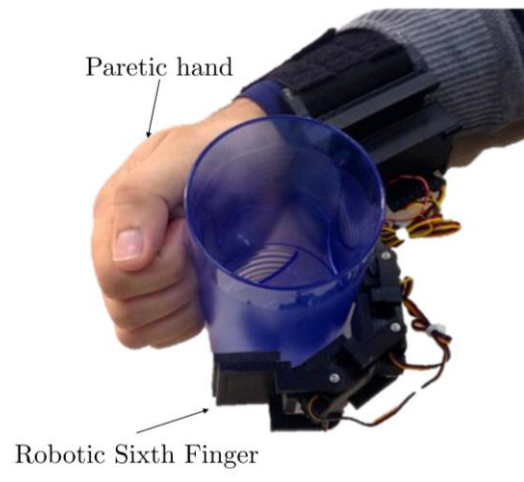
2. the theory and technology of **soft robotics**, enabling controllable impedance and adaptability in physical human-robot interaction



Concept and approach - Overall concepts

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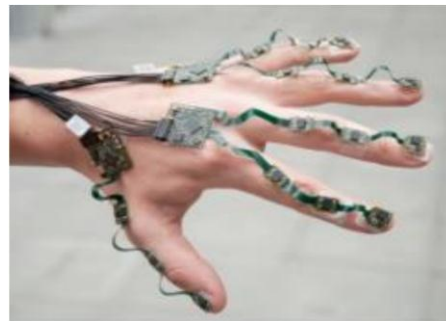
3. a **principled simplification** approach to artificial hand and arm technology development, allowing the development of the simplest technology fulfilling a desired assistive goal



Concept and approach - Overall concepts

To achieve these goals **SoftPro** will leverage on **six crucial enablers**:

4. a **quantitative assessment-based** development philosophy, that measures real progress in subjects through new methods and technologies

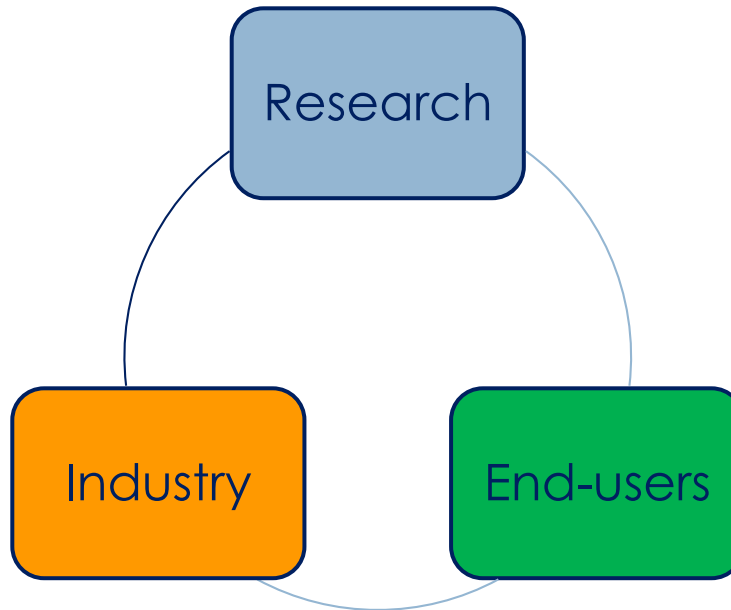


Concept and approach - Overall concepts

5. an **open approach to innovation**, that promotes open access not only to data collected¹, but also to technology developed, e.g. through Open-Source HW and SW repositories, thus building a contributing community of users and developers



Concept and approach - Overall concepts



6. a **tight connection of research centers, clinical institutions, and agile SMEs** that are ready to participate in innovation and pick up results, transforming them in product prototypes

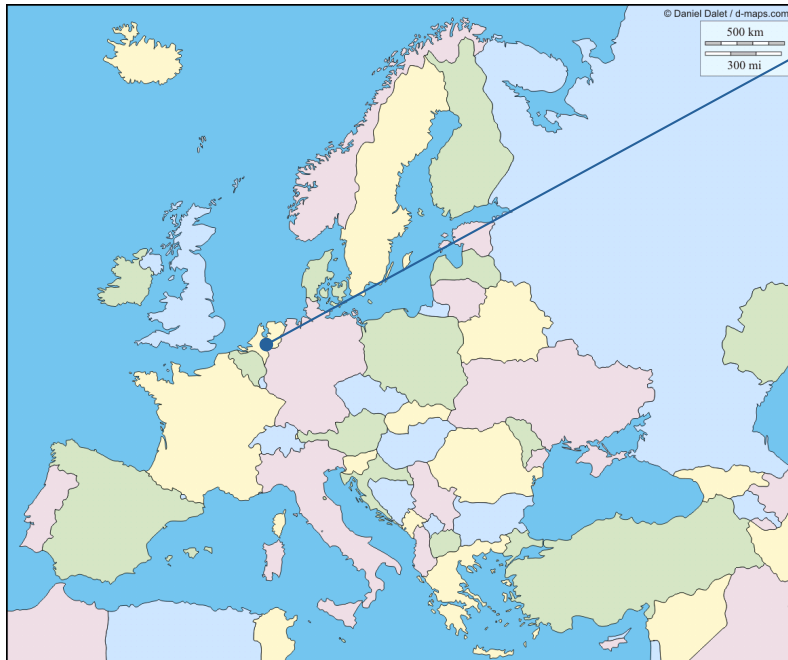
Research Institutions

Istituto Italiano di Tecnologia (IIT) – Coordinator
University of Pisa (UP)
University of Siena (US)



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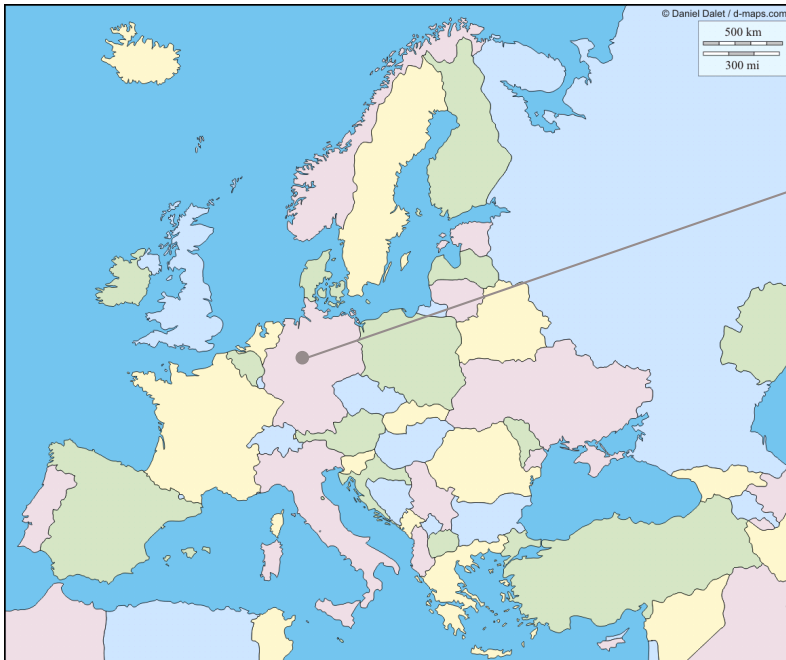
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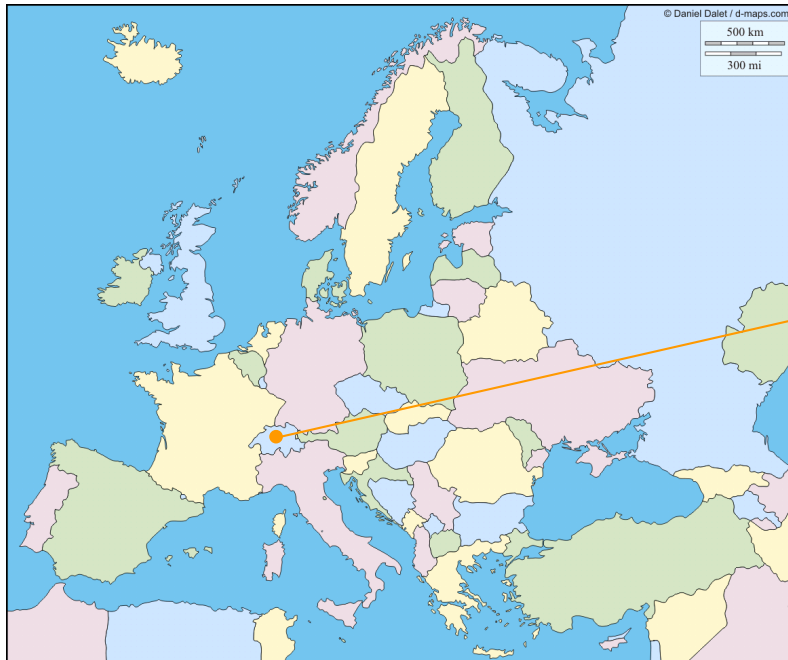
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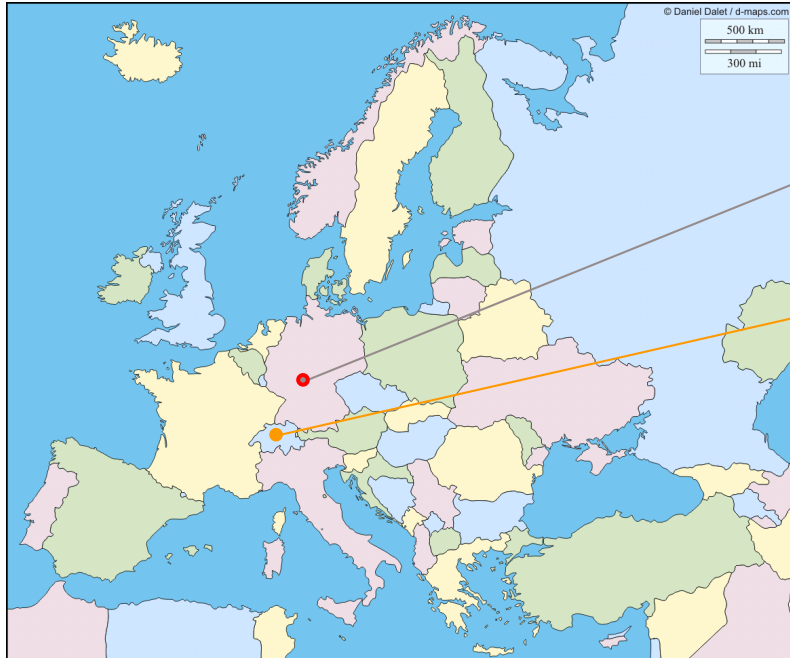
University of Twente (UT)

Leibniz Universität Hannover (LUH)

Swiss Federal Institute of Technology in Zurich (ETHZ)



Clinical Partners



Medical School & University
Hospital in Hannover (MHH)

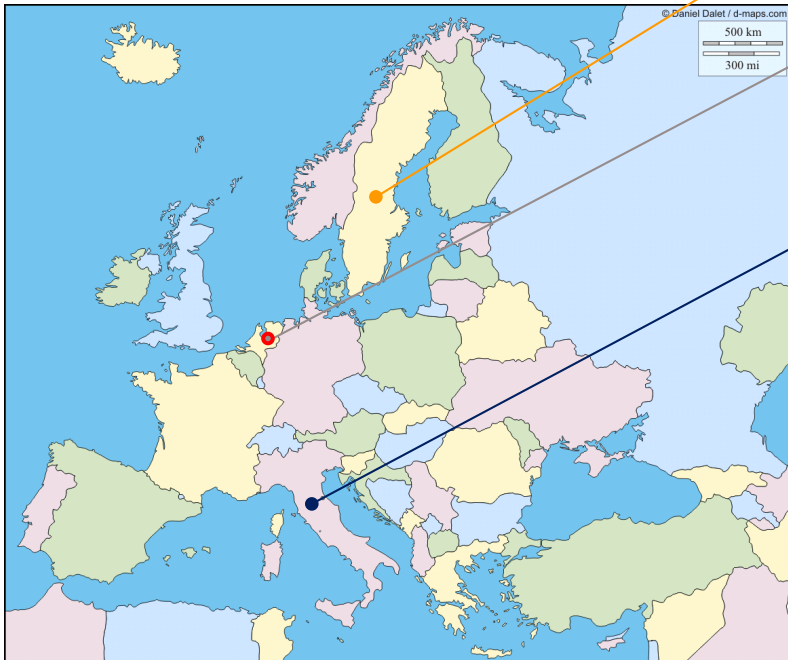
University of Zurich (UZ)

SMEs

BioServo Technologies AB (BS)

Twente Medical Systems International B.V. (TMSi)
Hankamp Rehab (HR)

qrobotics s.r.l (QB)



Affiliated Partners



Mayo Clinic (MC) - Rochester

**School of Biological and Health
Systems Engineering, Arizona
State University (ASU)**



**Brain Information Communication
Research Laboratory Group,
Advanced Telecommunications
Research Institute (ATR)**

Advisors' role: End Users

- ❑ **Patients**, their **care-givers** and **involved health professionals** will be involved throughout the project by their representation in the **Advisory board** that will be established at the start of the project
- ❑ Patients will be involved in experimental evaluations **in all phases of the project** and in the final clinical validation towards the end of the project

Concept and approach - Overall concepts

How to promote an open access approach without compromising technology transfer?

1. an **open approach to innovation**, that promotes open access not only to data collected¹, but also to technology developed, e.g. through Open-Source HW and SW repositories, thus building a contributing community of users and developers



Concept and approach - Overall concepts

The right trade-off between “maker-oriented” and performance

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Concept and approach - Overall concepts

The right trade-off between “maker-oriented” and performance



Need for a community!



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NATURAL MACHINE
MOTION INITIATIVE



NATURAL MACHINE MOTION INITIATIVE

Main contributors



ISTITUTO ITALIANO
DI TECNOLOGIA

Natural Machine Motion Initiative is a modular **open platform** aiming to provide the scientific community with tools for **fast** and **easy** prototyping of articulated **soft robots**

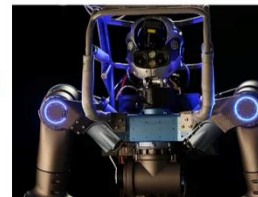
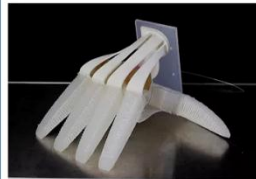
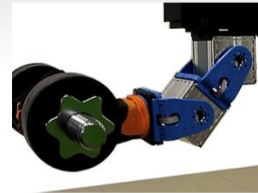
NATURAL MACHINE MOTION INITIATIVE

Home

Platform

NMMI Events

Community



< 1/3 >

NMMI

Natural Machine Motion Initiative (NMMI) is a community tool built, used, and maintained by researchers, industrial partners and enthusiasts to support the philosophy of a joint and open development of Natural Motion.

Nobody knows exactly how robots of the future will be. However, we all know they will not be like the heavy, bulky, rigid machines dangerously moving around in old-fashioned industrial plants.

Robots of the next generation will be physically compliant and adaptable machines closely interacting with humans. They will be moving safely, smoothly and efficiently – in other words **robots will be soft!**

Natural Machine Motion is "the third way" of Robotics: it is a principle to design, realize and control simple, affordable, yet smooth, strong, and accurate machines. Just like natural muscles, soft actuators can store an release energy, absorb impacts, regulate stiffness, and enable the design of adaptable machines that can face the challenges of tomorrow.

The Natural Machine Motion Initiative is a place for soft robotic makers to meet and share their ideas, designs, and applications. It was launched and initially supported within the EU FP7 SAPHARI project.



Natural Machine Motion Initiative



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[Click here to access Github repositories!](#)

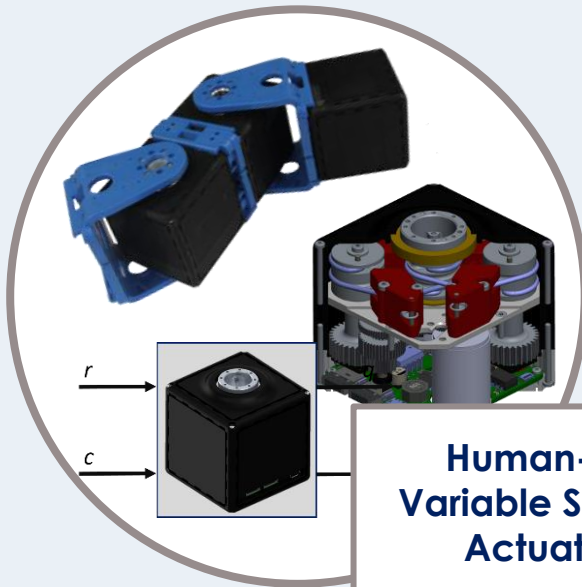
naturalmachinemotioninitiative.com

NMMI: building blocks

Interconnection Layer
(Software, electronics, mechanics)



Soft End Effectors



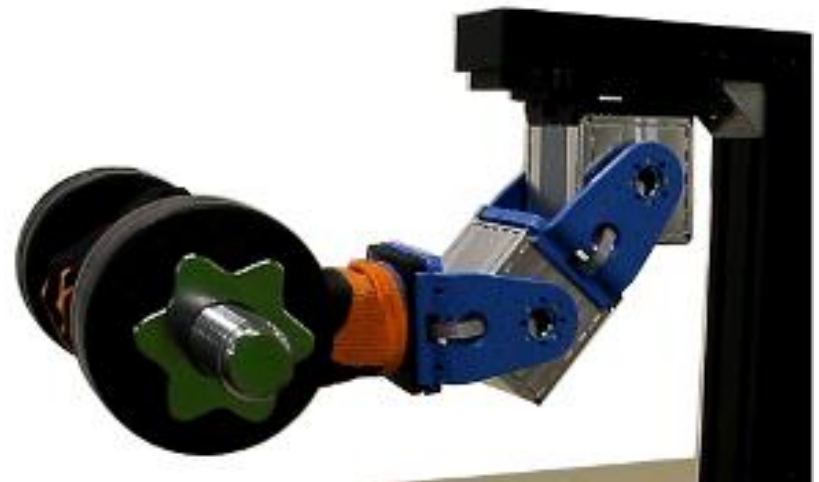
**Human-like
Variable Stiffness
Actuators**



**Application
Specific Add-ons**

Articulated soft robots

The described building blocks can be easily combined to obtain complex soft robotic structures to investigate **human like motion** in robotics





SIZE AND GROWTH

- ❑ founded in 2011 as a spin-off company of the University of Pisa, Centro "E.Piaggio" and the Italian Institute of Technology
- ❑ 9 employees (2017)
- ❑ 2016 annual revenue 550,000€
- ❑ 60% yearly capital growth (all re-invested in the company)
- ❑ World presence: EU, USA, China, Korea, South America
- ❑ Headquarter: Navacchio-Pisa Technological Cluster



EXPERTISE

- ❑ All production process are internal
- ❑ Testing robotics laboratory - qblab
- ❑ R&D department with Centro "E.Piaggio"
- ❑ Top background employees in robotics field
- ❑ ISO/CE standard certifications
- ❑ Only certified European suppliers

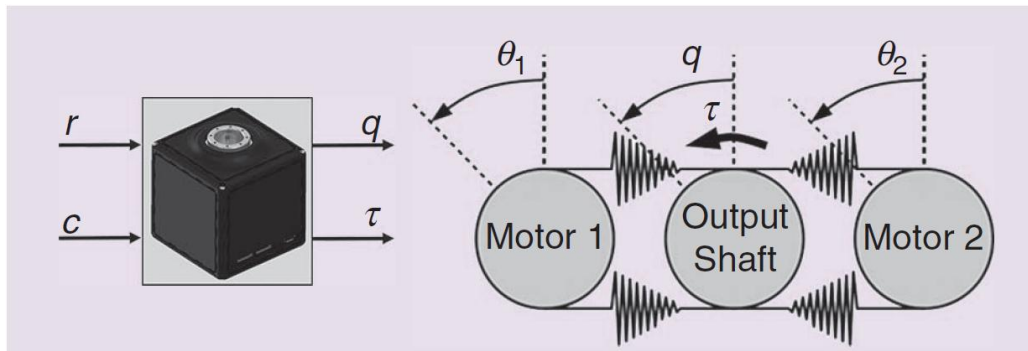


co-creator of **Natural Machine Motion Initiative**

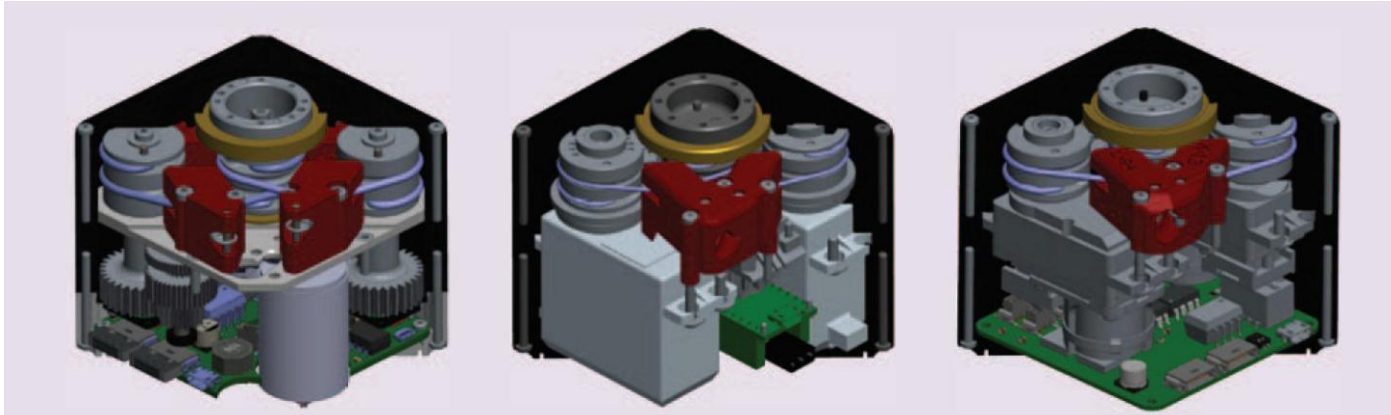
Open Access and Commercial Exploitation

QbMove Example

- ❑ **Qbmoves** are VSAs designed to be modular and user friendly
- ❑ They offer the possibility of **moving their output shaft** while **simultaneously adapting the mechanical stiffness** of the shaft itself, similar to natural musculoskeletal systems



QbMoves



Maker

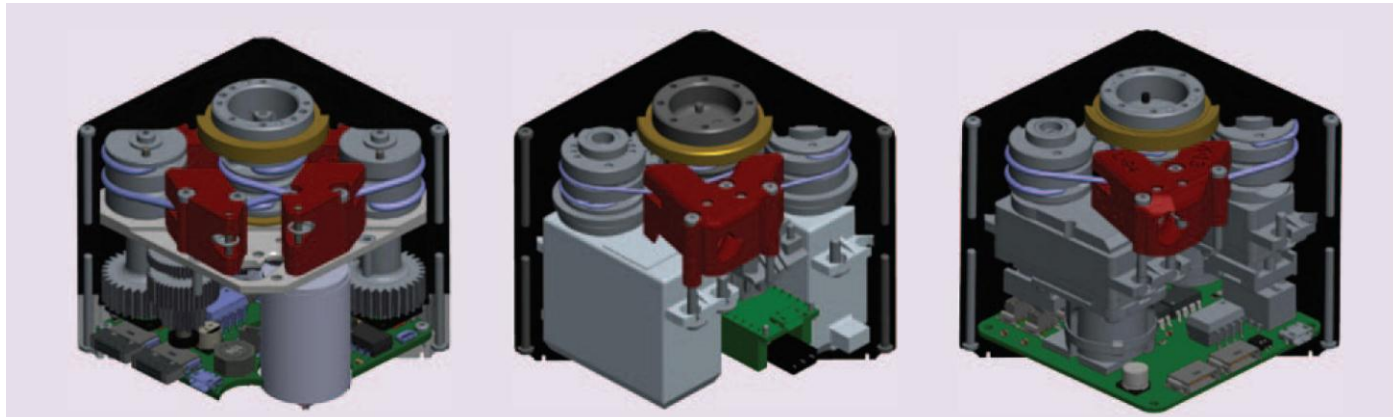
Maker-Pro

Advanced

Table 1. The performance of the three Qbmoves versions.

	Nominal Torque (N·m)	Nominal Speed (rad/s)	Stiffness Range (N·m/rad)	Rotation Range (°)
Maker	0.6	3	0.2 – 2	± 90
Maker Pro	1.3	7	0.5 – 13	± 180
Advanced	6.0	10	0.6 – 30	± 180

QbMoves



Maker

Maker-Pro

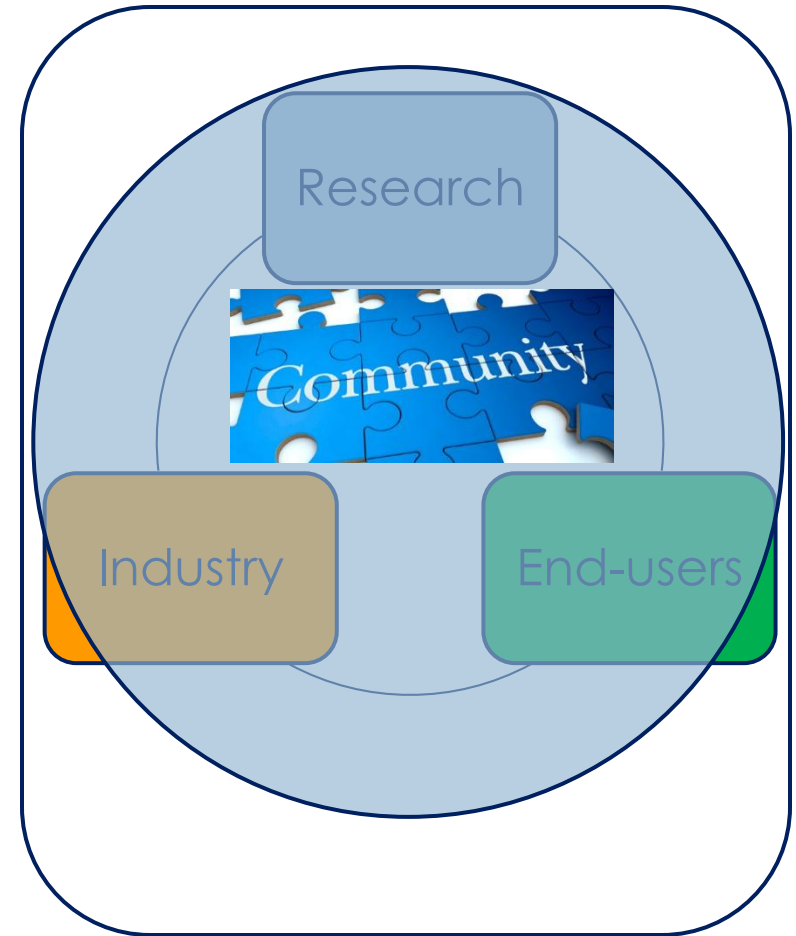
Advanced

Performance



qbrobotics®

Robots out of the cages...



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Discussions???

