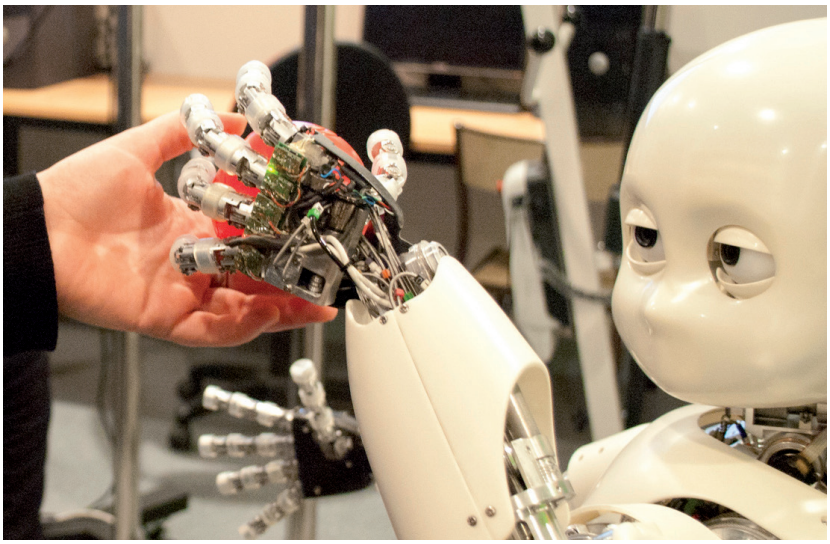
Robotics

Robotics combine several domains, including mechanical, electrical and electronics engineering as well as computer science. Robotics has also strong interactions with areas such as Life Sciences, Neurosciences, Psychology and Philosophy to address interdisciplinary areas such as cognition, learning and human-machine interaction.



The Institute of Intelligent Systems and Robotics (ISIR)

ISIR is a multidisciplinary research laboratory that brings together approximately 50 researchers and faculty from different disciplines, and 85 PhD students and post-docs. ISIR is a joint laboratory of UPMC and CNRS, as well as INSERM* for one ofits four teams (AGATHE).

Research at ISIR addresses modeling, analysis and design of dynamic systems and perception systems in several areas of robotics and develops synergies with life sciences, neurosciences, cognitive sciences and psychology. Through theoretical research and experimental developments, ISIR studies both autonomous and interactive capacities in robotics as well as various types of architecture that integrate complex mechatronics systems and software controllers.

The main applications areas are in field, service and domestic robotics, manipulation of biological objects at the micro scale, medical robotics for minimally invasive surgery, and rehabilitation robotics for motor and cognitive impairments.

RESEARCH TEAMS

AGATHE

Assistance to Gesture with Applications to Therapy

Research in the AGATHE team is aimed at developing the concept of co-manipulation, which consists of combining actions from a human operator and a robot to synergistically realize a task. A broad range of assistive functions are considered, e.g., guidance, stabilization, force magnification, and haptic percepts superposition.

The AGATHE team particularly focuses on the application of co-manipulation to medical applications, from surgery to rehabilitation and assistance to the elderly.

AGATHE's multidisciplinary projects involve modeling (biomechanics, human sensorimotor system), mechatronics, robot control (force control, visual servoing), and evaluation methodology from the lab to the clinical context. This translational approach has shown to be efficient in transferring lab research projects into clinical practice.

AMAC

Architectures and Models for Adaptation and Cognition

The AMAC team's research has two main purposes:

- Contribute to a better understanding of biological mechanisms in living systems
- Develop robotic control architectures to improve cognitive and motor abilities in robots by integrating learning and decision-making processes

The objective is to conceive of computational models of perceptual, motor and cognitive functions and to synthesize control and cognitive architectures integrating these functions.
The methodology is anchored in inter-disciplinary interaction between computational neuroscience

* UPMC: Pierre and Marie Curie University
CNRS: French National Centre for Scientific Research
Inserm: National Institute of Health and Medical Research

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and engineering science tools, techniques and concepts. Biological knowledge and data are used to inspire robotic developments, while engineering tools and methods are used such as modeling, optimization and validation techniques applied to biological hypotheses.

LabEx

SMART: Intelligent Human-Machine Interactions in the Digital Society

SMART, awarded funding as a Laboratory of Excellence, is addressing the underlying scientific questions of Human-centered digital systems and devices in a comprehensive way.

The research program is organized in five topics:
- Modeling of humans
- Interfaces and Interactions
- Humans at the convergence of digital and real environments
- Autonomic Distributed Environments for Mobility
- Human autonomy and e-health

INTERACTION

This team studies issues arising when intelligent environments or entities interact mechanically, optically or acoustically. Areas of specific interest to the team include:

- The mechanics of tactual perception through haptic interfaces developed in-house. Based on studies in skin biomechanics and biotribology, these interfaces enable the identification of the mechanisms of haptic perception behaviorally and also at the level of the neural correlates of somatosensation.
- Analysis of social interactions and behaviors between humans and/or artificial agents (personal robots, embodied conversational agents). This is applied to the recognition, interpretation and prediction of socio-emotional signals and behaviors with a lifespan perspective (infants to elderly – including disorders such as Autism and Alzheimer), as well as the development of natural human/machine interfaces.
- Active, multimodal artificial perception including the auditory and visual modalities. Multimodal inputs are essential for robots to understand their environments. The research proposes models that are based on the theory of a strong sensorimotor coupling.
- Studies in micro- and nano-robotics focusing on the development of tools to manipulate and characterize objects of small and very small dimensions. Examples include carbon nanotubes or cells. A strong component of the activities is the development of human-machine interfaces that let users interact efficiently with objects at intangible scales.

SyRoCo: Complex Robotic Systems

The SyRoCo team develops methods for the design and control of robotic systems. It covers several fields of robotics, from manipulation with redundant arms and multi-fingered hands to locomotion systems for robots operating in air, water or on ground. Research is primarily interested in low-level control loops, which involve one or more operational objectives and a certain level of knowledge of the environment in which the robot operates. The developed controls are formalized in the operational space to take into account various types of tasks.

Research areas include:
- Grasping, manipulation and redundancy
- Mobility and redundancy
- Control of dynamic systems, and/or underactuated mobile robots
- State estimation and multisensory data fusion

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