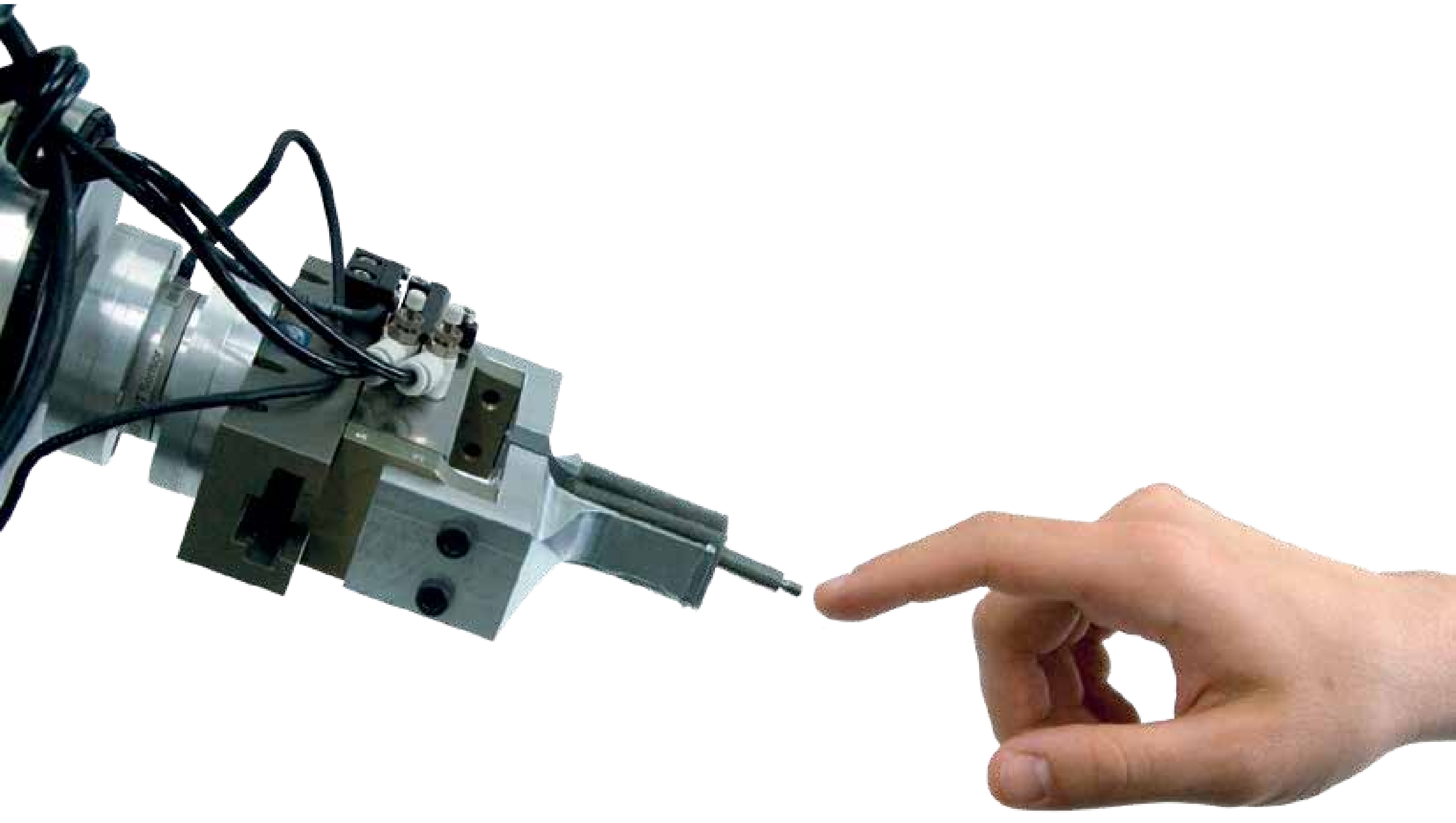
ECHORD
European Clearing House for Open Robotics Development

European Robotics Research Institutions



Technische Universität München

Università di Napoli Federico II

Universidade de Coimbra

Preface

The European funded ECHORD project "European Clearing House for Open Robotics Development" began in May 2009 with the ambitious goal of bringing together Europe's robotics manufacturers with the excellent European research institutions. This has been hugely successful!

ECHORD now comprises 53 universities and more than 80 industrial partners – the latter as partners within the experiments as well as suppliers of equipment. This was achieved by joint projects or "experiments" based on scenarios and research foci relevant to both the robot manufacturers and research institutions.

Obviously, there have been and will continue to be many long-term effects and benefits to the industry as a whole, but also more unexpected successes like the fact that the ECHORD team managed to actively motivate hardware suppliers to display their offer in the European showcase of robotics, which now displays nearly 300 items.

As part of our efforts to foster a "structured dialog" between academia and industry, we present here a new type of brochure on robotic research institutions from all over Europe. This document is based on information gathered from over 150 research institutions and will continuously be updated and expanded.

By showcasing the wealth of European labs we hope to make it easier for the robotic industry to find research partners from academia and to trigger considerably more academia-industry collaborations. The resulting knowledge transfer will provide European industry as a whole with tangible and measurable results by accelerating the development of new enabling technologies and by the deployment of robotics technology into new applications.

Prof. Dr.-Ing. habil. Alois Knoll

PD Dr. rer. nat. Florian Röhrbein

Dipl.-Psych. Laura Voss

Technische Universität München
Computer Science Department
Robotics and Embedded Systems

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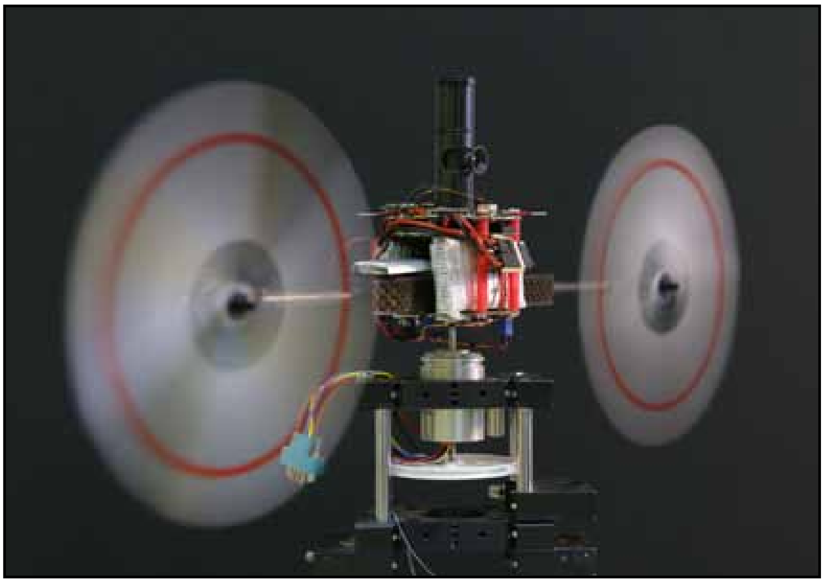
Aix Marseille University / CNRS

Institute of Movement Sciences
Department of Biorobotics



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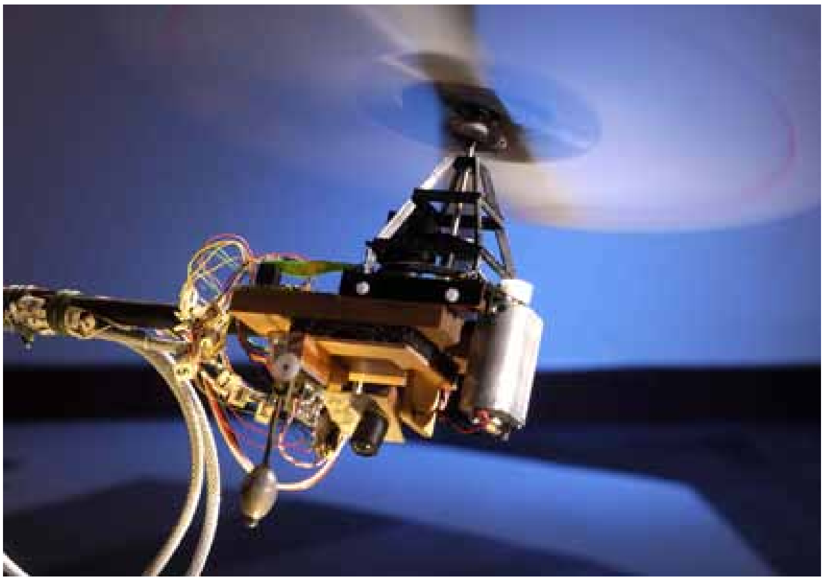
For almost 30 years, the Biorobotics department has acquired strong skills in the study of the visual system of invertebrates (especially fly and bee) and their behavior and sensorimotor control feedback loops (such as optic flow regulation) which are hard-wired into their brains.

The Biorobotics research team was one of the first to propose a model of the Elementary Motion Detector of the fly (EMD) derived from electrophysiological analysis under single photoreceptor stimulation.

The team built a variety of analog and digital visual sensors for optic flow sensing and object localization with hyperacuity, including aVLSI prototypes that realized an array of EMDs and also built several wheeled and micro flying robots.



Research and development activities

- Bio-inspired aerial robots
- Visual sensors
- Optic flow-based navigation
- Gaze stabilization
- Retinal micro-movements
- Insect behavior.

Keywords
Vision
Insects
Flying robots

INSTITUT DES SCIENCES DU MOUVEMENT ETIENNE JULES MAREY

BioRobotics

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Automation & Robotics Lab

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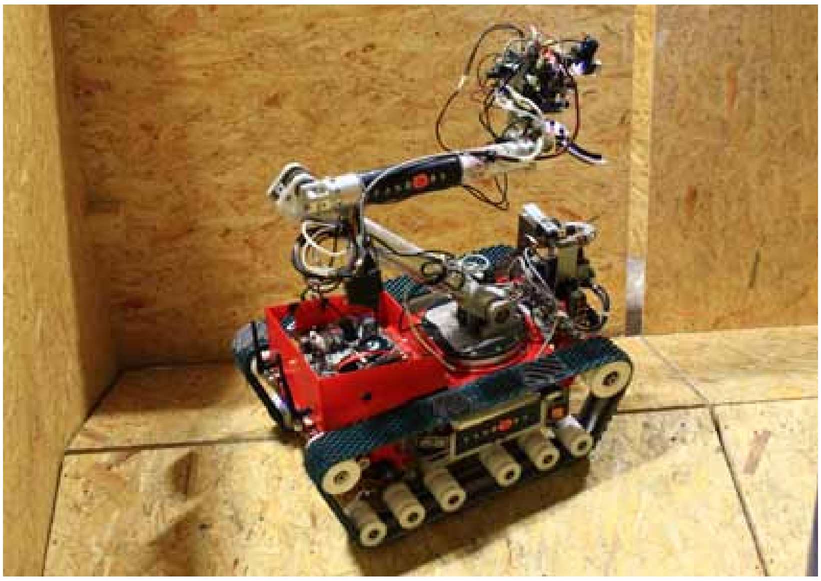
The Automation and Robotics Lab (ARL) deals with theoretical and basic research problems, algorithms and operational systems. It integrates research in the fields of robotics, intelligent systems, computational intelligence and automatic control to develop intelligent and autonomous systems and to control the behavior of complex systems.

In the robotics field the lab has expertise in mobile robots (autonomous systems, SLAM, navigation etc.). A mobile robot has been built named PANDORA with which we participated in a number of international RoboCup rescue competitions.

The lab also deals with robot control, grasping (especially grasping and manipulation of objects by multi-fingered hands) and remote manipulation. It has expertise in the area of handling of flexible materials such as textiles and leather.

Research in the field of intelligent systems consists mainly in the development of novel methods for processing (classification, clustering, segmentation, prediction, etc) of time series and heterogeneous data which arise in many contexts and real-world problems.
To this end the methodologies of neural networks, evolutionary computing and fuzzy systems are employed.

In the automatic control field ARL deals especially with complex and uncertain systems where there is no model of the system. Therefore techniques drawing on computational intelligence are employed.



Methods and algorithms from the above fields are used as tools by which an agent can develop various abstractions of the environment based on data from sensors. In this sense the problem of concept representation and semantic processing is addressed. This is believed to be a way to the design and development of cognitive agents / robots.

The lab has a lot of experience with funded projects. It participated and continues to participate in over thirty research projects funded by EU, Greek ministries and industry. Also participates in two EU networks of excellence, namely, EVONET (Network of excellence in Evolutionary Computing) and EURON (European Robotics Network).

Keywords
Mobile robots
Intelligent systems
Robot handling
Computational intelligence
Control of complex systems

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The chair for Applied Computer Science III (Robotics and Embedded Systems) was founded by Prof. Dr. Dominik Henrich in 2003. It deals with robots as information processing systems, which are able to capture their environment and modify and interact with it.

In research, the chair focuses on the coexistence and cooperation of humans and robots. The aim is to lift the strict spatial separation between humans and robots to combine their strengths synergistically.

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For this, the camera-based surveillance, collision detection, motion planning and intention recognition are considered. Another focus is the intuitive programming of robots. Goal is to reduce the high programming effort and to make the robot even for non-experts available and thus increase the potential applications. For this, the simple sensor integration, programming by demonstration as well as imperative and declarative approaches are considered.

In teaching, the chair focuses on robotics, computer vision, pattern recognition, embedded systems and operating systems in the form of lectures, tutorials, internships, projects and seminars.

Keywords
Collision detection
Motion planning
Visual surveillance
Human-robot cooperation
Intuitive robot programming
Sensor-based manipulation
Robot-assisted surgery

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BIBA - Bremer Institut für Produktion und Logistik GmbH

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The BIBA is a scientific engineering research institute dealing with the issues of production and logistics systems. It conducts research, develops technical and organizational solutions and applies them realistically in commercial and industrial companies of all branches, sizes and nationalities.

Intelligent Production and Logistics Systems (IPS)
The rapid development of Information and Communication Technologies and new possibilities for robot-supported automation of logistic processes, are strong forces for change in production and logistics systems. The research department IPS develops and realizes innovative solutions for automation of production and logistics processes. This includes two different research areas – sensor data analysis and design of robotic systems. The field of sensor data analysis comprises the development of suitable algorithms from 2D/3D computer vision and wireless technologies like RFID as well as developing appropriate sensor data fusion techniques. By means of a self-developed simulation software, realistic test data can be simulated, in order to develop and evaluate algorithms or complete sensor arrangements in advance without the need of a complete hardware setup.

BIBA

BIBA conceives and develops innovative solutions for robotics and automation, which exceed present production applications and which can be adopted in difficult and non-standardised logistic processes. Production and logistics have become increasingly intertwined due to the globalized production of goods in different locations, whereas the logistics, both internal and external, have gained more relevance. The operational processes, which have to handle mass flows e.g. in incoming and outgoing goods or in the stock turnover, are only conditionally able to adjust this development. The focus is placed on the high technological requirements of the logistic environment as well as the flexibility and scalability of solutions.

Application of Information and Communication Technologies in Production (IKAP)
High performing co-operations between independent companies with the aim to develop and to realize customized products are an important success factor for the competitiveness of the European industry. Due to immense political changes and global markets, new ways of co-operations, so called enterprise networks, can be seen in addition to the traditional supply chains. These enterprise networks are often formed to realize a single customers' order and play an important role during the conceptual phase (product design) as well as during the realization phase (production). The research unit IKAP prepares, develops and realizes methods and tools to support co-operative, inter-organizational enterprise networks. The research concentrates on efficient and effective collaborative design and production processes by applying innovative information and communication technologies (ICT). As focus can be seen the collaborative acting of enterprises during distributed design and production processes as well as during the late processes of the product life cycle such as the usage phase or the recycling phase.

Keywords
Robotics in logistics
Computer vision
Cyber physical systems
Production
Logistics
Dynamic planning and control
Automation
Product design
Supply chain
Enterprise networks
Product lifecycle management (PLM)

BIBA

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Faculty of Technology
Applied Informatics Group

Picture: Barbara Proschak

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The Applied Informatics Group (AGAI) is an interdisciplinary research group ascribed to the Faculty of Technology which is part of Bielefeld University. Altogether, the AGAI consist of more than 50 senior researchers and PhD students having a research focus on different topics with regard to mainly applied informatics and robotics.

These topics are, for instance:
Pattern Recognition, Computer Vision, Social Robotics, Speech and Dialog Systems, Cognitive Developmental Robotics, Human-Inspired Memory, Evaluation of Cognitive Systems, User Studies for Human-Robot Interaction, Software Architecture, Software Engineering / Automation.

The AGAI started to work on the topic of pattern recognition, but currently, one overall goal is to generally develop interactive systems which have learning capabilities to understand context as well as capabilities to interact socially and intuitively to users in certain contexts. Consequently, both several robots and specific research scenarios have been developed in the past years.

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The robotic systems used, and partly developed in Bielefeld by the AGAI, differ in their functional capabilities as well as aesthetical appearances:

- BIRON, the Bielefeld Robot Companion, developed by the AGAI
- BARTHOC and BARTHOC Jr., two highly anthropomorphic robot torsos developed at the AGAI
- Flobi, the social robot head, designed and developed by the AGAI
- iCub, developed by the Italian Institute of Technology (IIT)
- Nao, developed by Aldebaran Robotics, France.

Picture: Barbara Proschak

Furthermore, various scenarios have been established in order to test, to evaluate, and to gradually improve the AGAI's technical systems and the human-robot interaction (HRI). Established scenarios within the group are, for example:

- AR-intercepted Communication
- The Curious Robot Scenario
- Home Tour
- Different Tutoring Scenarios
- VAMPIRE (Visual Active Memory Processes and Interactive REtrieval)
- Little Red Riding Hood Scenario.

Keywords
Human-robot interaction
Software engineering
Pattern recognition

Finally, the Group is involved in several interdisciplinary research projects, namely:

- The Center of Excellence 'Cognitive Interaction Technology' (CITEC)
- The Research Institute for Cognition and Robotics (CoR-Lab)
- The Collaborative Research Centre 'Alignment in Communication' (CRC 673)
- The Project 'Sozirob' in collaboration with the German Aerospace Center (DLR)
- The Leading Edge Cluster Intelligent Technical Systems OstwestfalenLippe (it's OWL).

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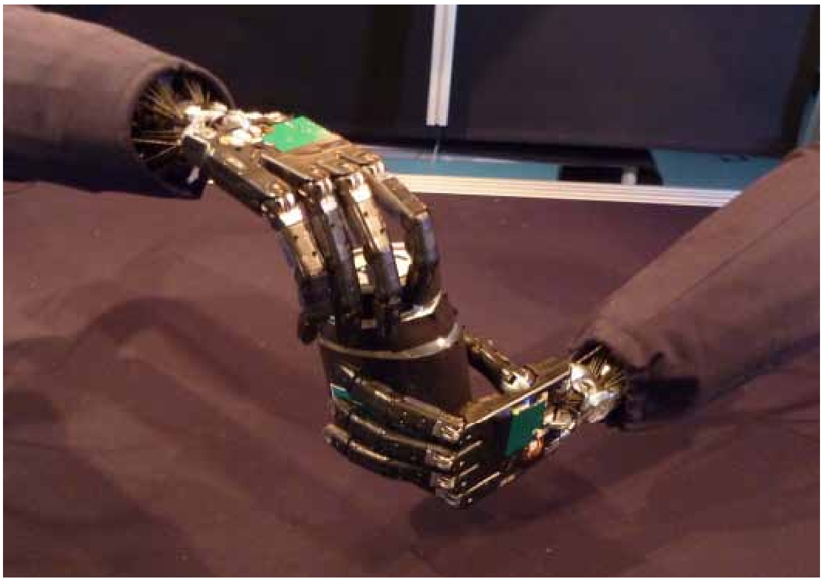
Bielefeld University

Faculty of Technology
Neuroinformatics Group



Picture: Bielefeld University

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Our research is guided by the belief that neural networks have been evolved to control movements and sophisticated patterns of interaction. While today`s engineered systems have to rely on an almost complete specification of their numerous details, neural systems are shaped to a large extent by self-organization, adaptation and learning.

To gain insights into the working principles of these systems and to replicate similar functions in technology, we are bringing together methods from neural networks, machine learning, computer vision, dynamical systems and control, embracing topics such as data mining, brain-machine interfaces, evolutionary computation and complex systems integration, and drawing cross-disciplinary inspiration from brain science, psychology and linguistics.

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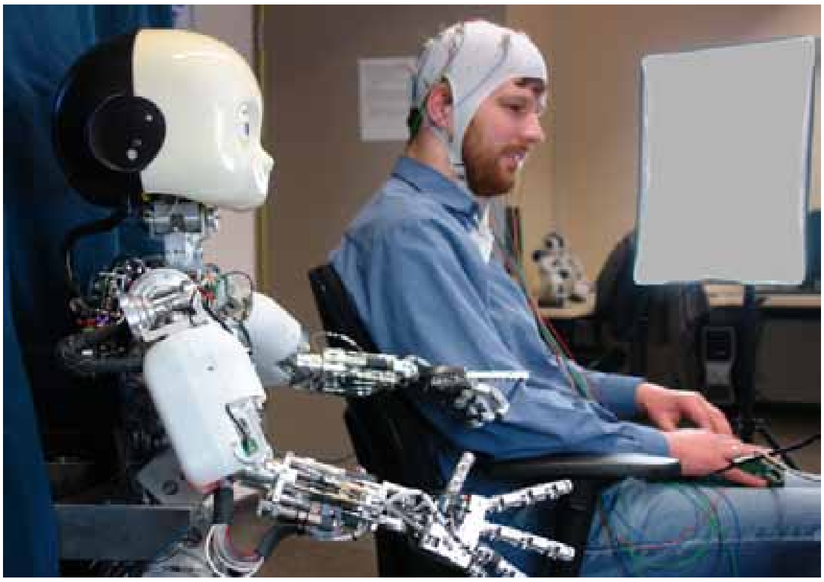
Due to the intimate connection between neural networks and the control of behavior we consider robotics as our major testbed. Here, our focus is on manual intelligence, i.e., the highly developed skills to use hands for complex, goal-directed action sequences and the ability to acquire and refine such skills through learning.

Besides joint work with other robotics groups, we collaborate with cognitive scientists to understand how humans grasp and manipulate objects, we contribute databases to enable new routes to a systematic analysis of such actions, and we devise robot algorithms that replicate manual skills for multifingered robot hands.



Picture: Bielefeld University

Major research lines in the group focus on the topics of hand-eye-coordination, bimanual coordination, and the role of touch for guiding motion and for the recognition of objects and object states. We are also exploring ideas for intelligent interfaces exploiting touch and haptics, such as active tangible objects for highly intuitive, directly manipulable interfaces, or objects that „feel" how they are handled. We also study interfaces based on (non-invasively) recorded brain signals to achieve „thought control" of robots or VR environments. Large part of our research is tied together by an overarching interest in adaptive and self-organizing systems and machine learning approaches for their realization.

Keywords
Robot learning
Grasping and manipulation
Tactile sensing
Intelligent interfaces

We are regularly involved in numerous projects, ranging from the national to the international level. A significant part of our research and of our local cooperations is intimately connected with the Center of Excellence Cognitive Interaction Technology (CITEC), the Research Institute for Cognition and Robotics (CoR-Lab) and the DFG Collaborative Research Centre 673 „Alignment in Communication".

Neuroinformatics Group

Bielefeld University

Center of Excellence Cognitive Interaction Technology (CITEC)

Picture: CITEC, Bielefeld University

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The Center of Excellence Cognitive Interaction Technology (CITEC) pursues the vision of technical systems that are able to understand tasks and situations so that they can learn, communicate with, and support humans in natural and intuitive ways and are easy and safe to use for everybody.

To create the necessary insights leading from basic research to prototypical applications, the cluster brings together the expertise of more than 30 research groups from five Faculties: Biology, Linguistics and Literary Studies, Physics, Psychology and Sports Science, and from the Faculty of Technology. Additionally, CITEC offers a shared roof to the research groups in the Bielefeld Research Institute for Cognition and Robotics (CoR-Lab) and the DFG Collaborative Research Centre 673 „Alignment in Communication".

Founded in 2007 as one of 37 clusters of excellence within the highly competitive framework of the German Excellence Initiative, CITEC has meanwhile become a major research institution in its field. Its scientific reputation, visibility and position has been underscored by an extension of its funding for a second period 2012-2017 within the Excellence Initiative.

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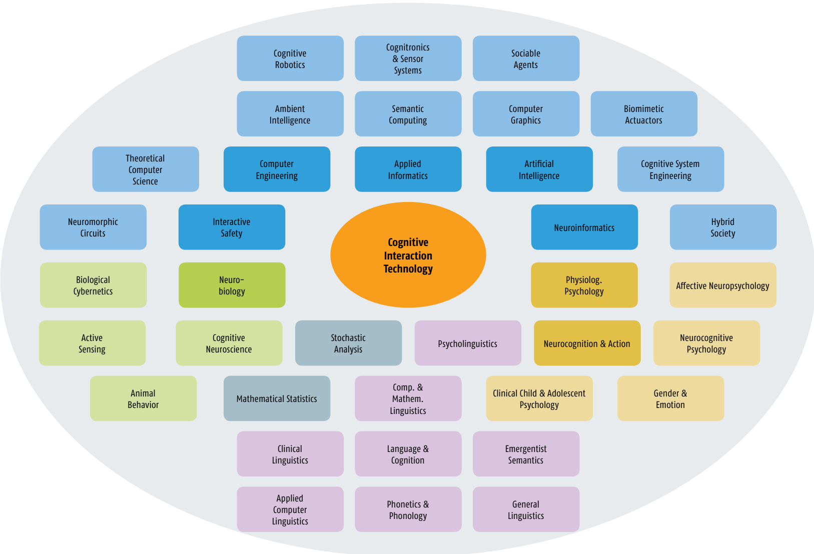
CITEC's research agenda is focused on four key areas of cognitive interaction:

- Motion intelligence
- Attentive systems
- Situated communication
- Memory and learning.



CITEC research groups aligning their research on Cognitive Interaction Technology

Using a concept of transfer chains supported by Central Lab Facilities, cutting edge research in each of these areas is integrated into demonstrator systems, such as robots, intelligent rooms, or interactive virtual agents.
To keep basic research connected with applications, CITEC cooperates with strategic partners selected to cover major cognitive interaction technology application fields, and to address societal challenges arising from demographic change. These range from cognitive media over household appliances to future robot systems to assist the elderly and people with special needs. CITEC is also a partner in the BMBF Leading Edge Cluster Intelligent Technical Systems OstwestfalenLippe it's OWL, started in 2012 as one of nationwide five clusters in the BMBF High-Tech-Strategy and connecting CITEC with more than 100 regional companies.
To create a strong link between research and education of young scientists and engineers, CITEC has an integrated Graduate School with more than 80 students. A Virtual Faculty of more than 40 internationally leading researchers world-wide is part of CITEC's network into the research community and a strong factor to connect CITEC scientists and students with leading institutions around the globe.

Keywords
Human-centred robotics
Assistive environments
Interactive learning
Cognitive architectures

CITEC

Bielefeld University

Research Institute for Cognition and Robotics (CoR-Lab)

Picture: Alicia Weirich, Bielefeld University

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Founded in July 2007, the Research Institute for Cognition and Robotics (CoR-Lab) is a central scientific institute at Bielefeld University with the goal to promote the potential of learning and cognitive technology through excellence in research and transfer in joint industrial projects.

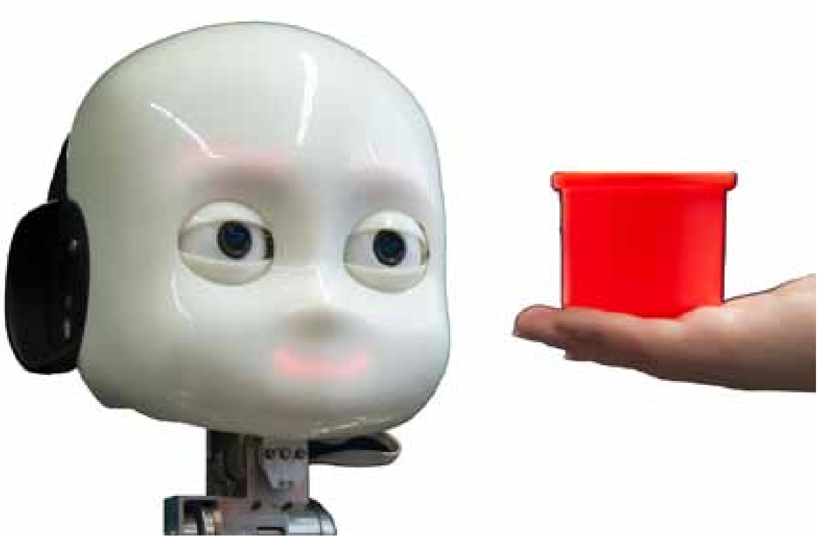
Participation in several FP7-EU research projects, research cooperations with partners from Japan and North America, as well as collaborations with industrial partners like the Honda Research Institute Europe GmbH, Miele & Cie. KG or the HARTING Technology Group contribute to the profile of CoR-Lab.

The institute is involved in the Leading Edge Cluster Intelligent Technical Systems OstWestfalenLippe "it's OWL", funded within the framework of the Federal Government's Hightech Strategy, in order to strengthen the competitiveness of the region's industry in intelligent technical systems through the employment of learning, human-machine interaction and advanced technology for energy efficient computation.

Universität Bielefeld

The training of highly-qualified engineers in CoR-Lab's Graduate School also contributes to the innovative strength and the economic development of the region East-Westphalia and Lippe (OWL) and beyond. In the medium and long-term global competition, this technological edge will be kept only by integrating new intelligent and cognitive technologies.

Robots are used in CoR-Lab as a new type of research tools in interaction studies with children and adults. CoR-Lab investigates in particular how humans perceive a robot and react to its behavior and operates with humanoid robots like iCub or Nao, anthropomorphic hands, flexible arms or with Bielefeld's service robot BIRON.



Picture: Sebastian Gieselmann, Bielefeld University

All of them shall become more intelligent, capable of learning and more communicative. CoR-Lab maintains an international research network, specifically through EU-projects (iTalk, AMARSi, HUMAVIPS and RobotDoc).

The increasing demand for just-in time and custom-tailored production calls for fast and flexible reconfigurable work cells and human-robot co-worker applications. CoR-Lab's researchers are convinced that redundant robot-arms like Kuka-LWR will play a key role due to their flexibility, but current technology requires for each new task costly and tedious reprogramming by experts.

By making such applications more attractive for small and medium-sized enterprises Bielefeld's scientists bridge the gap between humans and machines, for example in the project MoFTaG (Model-free flexible trajectory generation) in the framework of the FP7 program ECHORD, which targets to put laboratory set-ups towards practical usability based on available, but advanced technology.

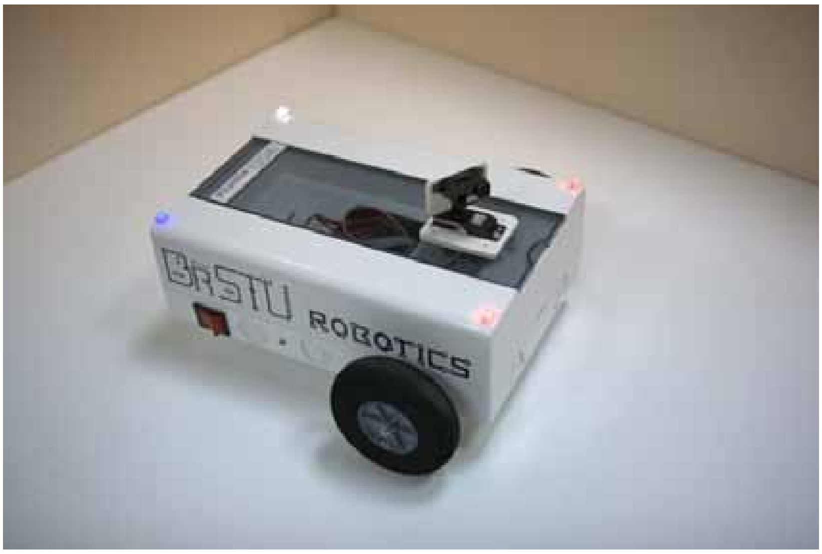
Keywords
Physical human-robot interaction
Human-robot co-worker applications
Machine learning
Flexible reconfiguration
Human-robot communication

CoR-Lab

Research Institute
for Cognition and Robotics

Brest State Technical University

Faculty of Electronic Information Systems
Department of Intelligent Information Technologies
Robotics Lab



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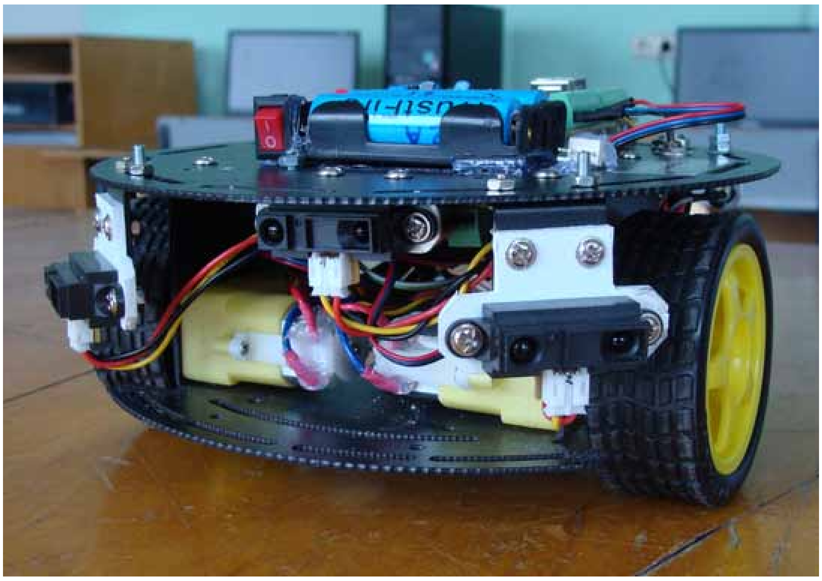
The Brest State Technical University Robotics Laboratory (BrSTU Robotics) is the main innovative robotics research group in Republic of Belarus. BrSTU Robotics has a variety of functions including research projects, organizing and hosting events and competitions related to robots and robotic technologies, supporting development and demonstration experiments.

The laboratory is constantly working with 8 teachers around 20 students who are participated in the 5 major projects (see projects section). Areas of research include mobile robotics, robot control systems, artificial intelligence, robotics, collective behavior and adaptive systems, reinforcing learning, computer vision.

One of the key directions of our lab is the popularization of robotics in Belarus. In this way we see robotics as cross-disciplinary movement where each project requires collaboration of different people with different skills and knowledge. Our mission is to teach students from different disciplines through projects in robotics. As example of such education project is the international Belarusian - Ukrainian mobile robot competition RoboRace, where robotics teams compete on the track.

Our projects

Robot-guide. The aim of this project is to develop a Robot-guide prototype. The main task is to provide some kind of guided tours in exhibitions and museums. The robot-guide should provide multimedia information about the exhibits, as well as move freely between them on a pre-planned or visitors formed route. Naturally when moving the robot must not collide with any people, nor with any obstacles to its movement. To do this, it must not only move on statically formed trajectory, but also to build dynamically a new trajectory. Robot-guide should respond to all changes in its environment, and adapt to them.



Robot for education. MARVIN (Mobile Autonomous Robot & Virtual Intelligent ageNt) – the aim of the project is to develop an educational complex containing a personal mobile robot and its computer models for research in robotics and related courses in various disciplines at the university. As a result of project students and PhD students will get a set of software and hardware for research in the field of robotics, embedded systems and artificial intelligence. This Belarusian educational platform adopted for Belarusian marked, is designed to use hardware available in place, e.g. low cost sensors.

Keywords
Mobile robots
Intelligent systems

Intelligent multi-purpose mobile robotic platform. It is planned that this will be a universal operator-controlled mobile robot for different tasks. There are business areas, where manual labor rights may not be possible or economically inefficient, e.g. monitoring climate, where people have access should be restricted; working in harsh conditions, simply inaccessible. This applies to high-tech industries that require control of the microclimate in the premises of the work in harsh conditions (chemicals, radioactivity, emergencies at work, etc.). We need to take the next step in the development of automated systems in these areas.

BrSTU ROBOTICS

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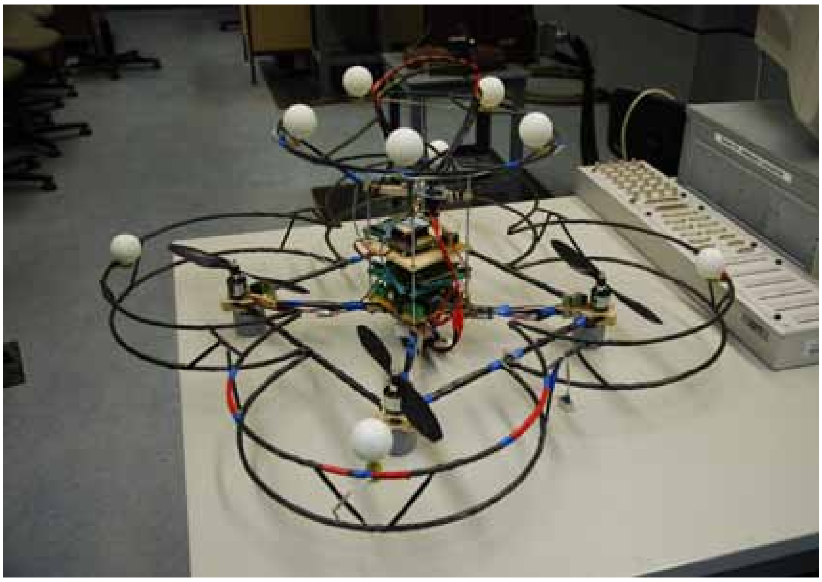
Faculty of Electrical Engineering and Informatics
Department of Control Engineering and Information Technology
Laboratory of Intelligent Robotics



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The Department of Control Engineering and Information Technology (formerly Department of Process Control) was established in 1964, and it was joined to train engineers for the research and industry of instrumentation and process control in the frame of the Department of Measurement and Instrumentation and Department of Automatization.

Starting with research in the field of control theory 28 years ago, since then it has diversified its research objectives and has become a well respected center of computer applications. According to the main research directions and courses being taught, the Department has formed five groups concerning control theory, instrumentation, robotics, software engineering, digital design and computer architecture.

The Department (along with 12 other departments) is responsible for the educational programs in both Sections of the Faculty of Electrical Engineering and Informatics.

The Department has strong international relations, in particular, to German universities. Faculty members also maintain ties to universities in France, the United Kingdom, Italy and the USA.

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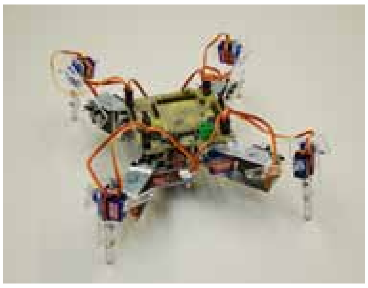


The research work at the Department covers broad fields. Faculty members have been doing collaborative research with institution abroad and founded research supported by the government. In addition, contracts for applied research and development strengthen the ties to the industry.

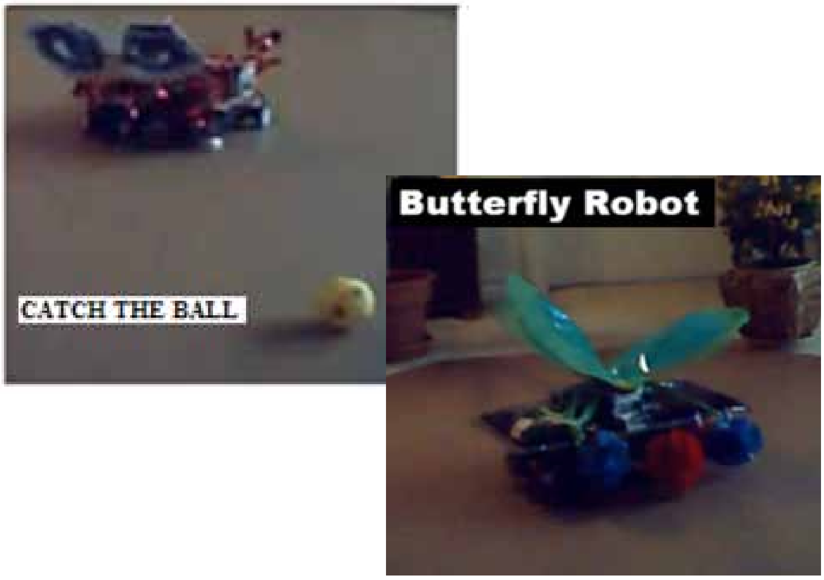
Research and development activities:

- Artificial intelligence
- Computer graphics
- Computer networks
- Industrial control systems
- High-level logic synthesis
- Measurement and process instrumentation
- Robot control
- TRAFICC European FieldBus Technology Transfer Project.

Keywords
Robot manipulators
Quadrotor helicopter
Intelligent vehicle control
Mechatronic control systems
Mobile robot team coordination

Bulgarian Academy of Sciences

Institute of Mechanics
Laboratory of Control in Mechanics



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The Laboratory of control in mechanics considers mainly objects as manipulation and mobile robots. The theoretical research covers structural optimization of dynamic models and their appropriate parameterization. Time optimal and adaptive control algorithms are synthesized based on the derived specific models of dynamics.

The control systems design incorporates hardware and software components for specific robotic scenarios included serial linked robotic manipulators, autonomous mobile robots and swarms.

The perspective research is directed towards theory and modeling of complex control systems, intelligent behavior control and bio-control techniques.

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1869

Current Research

- Manipulation and mobile robots
- Kinematic and dynamic modeling and simulation of serial linked rigid bodies
- Identification of inertial parameters of controlled mechanical systems
- Manipulator dynamics modeling based on matrix transformations;
- Time optimal position control
- Trajectory and adaptive control
- Cognitive control systems
- Complex control systems
- Robot team behavior modeling.

Further research and practical work

- Design of specific mechanical models
- Integration of computer control modules
- Synthesis of novel control algorithms
- Practical experiments with existing robots
- Development of complex control Systems.

Keywords

Intelligent robot control
Robot manipulators
Mobile robots

BULGARIAN ACADEMY of SCIENCES 1869

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The research and realization of "seeing" machines and "intelligent" robots has been a main focus of the Intelligent Robots Lab (formerly known as "Institute of Measurement Science") since 1977. Our aim is both a basic understanding of vision, autonomy and intelligence of technical systems, and the realization of intelligent, seeing robots. These should be able to function dependably in the unpredictable and ever-changing real world and to fulfill various tasks autonomously or in cooperation with humans.

From the very beginning our research work has been essentially guided by the rule that all research results have to be verified and demonstrated by practical experiments under real-world conditions. While this approach is very demanding, it has the great advantage over simulations that it leads to more reliable and practice-oriented results. The fact that our research projects were often carried out in cooperation with industrial partners also led to a better applicability and practicability.

Universität der Bundeswehr München

Similar to most animals, all our robots use machine vision as an effective sensor modality. The hardware of our vision systems often includes a PC, in some cases augmented by simple microprocessors, digital signal processors or transputers.

A vision system architecture ("object-oriented vision") we have developed enables the systems to be so efficient that real-time vision became possible as early as 1980 with the then available 8-bit microprocessors. Communication bottlenecks are avoided by wide band video busses and high-speed links between the processors.

When using modern hardware in combination with an efficient and robust feature extraction on the basis of controlled correlation as well as a situation-dependent control of gaze direction and camera sensitivity, these systems give our robots a highly developed visual sense.

Main research topics

- Architecture and realization of robot vision systems
- Motion stereo for accurate range measurement and spatial interpretation of image sequences
- Calibration-free robots
- Object- and behavior-oriented stereo vision as a basis for the control of such robots by direct transition from sensor data to motor control commands
- System architecture for behavior-based mobile robots
- Recognition of dynamically changing situations in real time as the basis for behavior selection by robots and for man-machine-communication
- Machine learning, e.g. for object recognition, motion control, and knowledge acquisition for navigation and interaction with humans
- Integration of very complex robotic systems, such as our humanoid robot HERMES
- Dependability and long-term tests of complex robotic systems.

Keywords

Autonomous navigation
Calibration-free manipulation
Human-robot interaction

Universität der Bundeswehr München

Cognitive Systems Research Institute (CSRI)

Embodied Language Processing and Multisensory Cognition Group

Location
Greece
Athens

Website
http://www.csri.gr

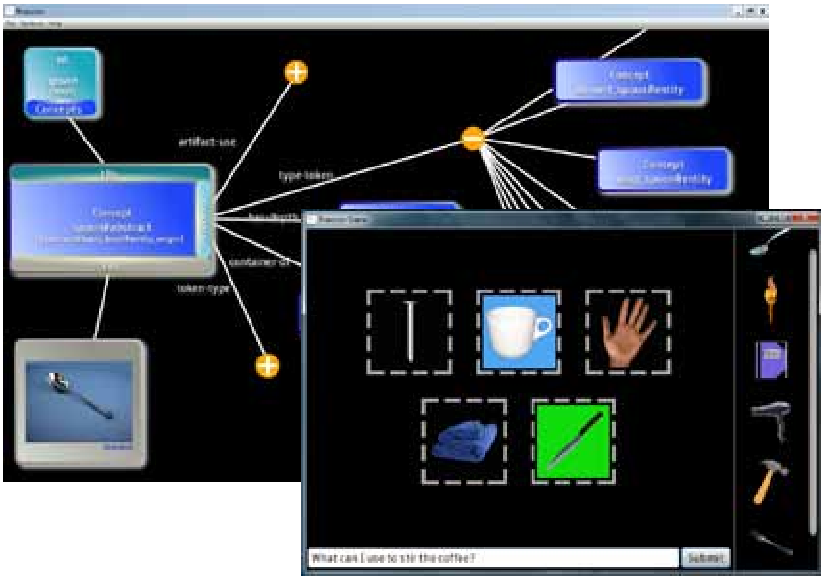
Contact
Dr. K. Pastra
kpastra@csri.gr

CSRI is a non profit research organization that specializes in the highly interdisciplinary field of Cognitive Systems and Robotics. The institute carries a unique expertise in this field, which is related to bridging the gap between language, perception and action for biology inspired intelligent technology.

The institute sprung out of the realization that ROBOTS NEED LANGUAGE, for communication, for multisensory cognition, for reaching human-level intelligence. Research and development towards this direction has the potential to revolutionize not only cognitive robotics, but also a number of other disciplines, including computational linguistics, computer vision and multimedia processing. CSRI has established a research track along this new direction with European-funded projects that span more than 8 years of focussed research and development along these lines (2008-2015). The projects include POETICON++ and its predecessor POETICON (*http://www.poeticon.eu*) which are coordinated by the CSRI director, Dr Katerina Pastra. CSRI research and development is committed to providing open source software and open access data to the public.

Research and development in CSRI comprises theoretical modelling, experimental exploration and software development for:

- Inclusion of language in the robot seeing, robot acting, robot learning loop, taking advantage of its hierarchical and compositional structure for behavior generalization and creativity
- Endowing artificial agents with a semantic memory (PRAXICON) and with reasoning mechanisms for handling uncertainty, unexpected situations and new experiences with flexibility
- Enhancing artificial agents' skills with multisensory perception and in particular, with time perception abilities.



Indicative CSRI innovations comprise:

- **Embodied Language Processing.** A new theoretical and computational look at language as an active system in multimodal cognition applications. CSRI has developed the first suite of embodied language processing tools, which it uses for the automatic population of the first large-scale semantic memory for robots: the PRAXICON.
- **Multimodal Cognition.** Formal analysis of perception and action that allows interaction and integration of language with the sensorimotor space. CSRI has developed the first generative grammar of action (in the sensorimotor space) for use by robots. Furthermore, it has developed parsers and reasoning tools that integrate language, perception and action for a number of robotics applications, including visual scene understanding and verbal instruction-based human-robot interaction.
- **Multisensory Perception.** Experimental research on multisensory event and time perception, as well as on language modulated perception of object saliency and affordances. Findings from these experiments are published in international journals and are fed directly to all software developed by CSRI.

Keywords
Cognitive systems
Robotics
Semantic memory
Action grammar
Embodied language processing

Collaborative Center for Applied Research on Service Robotics (ZAFH)

Location
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Ulm

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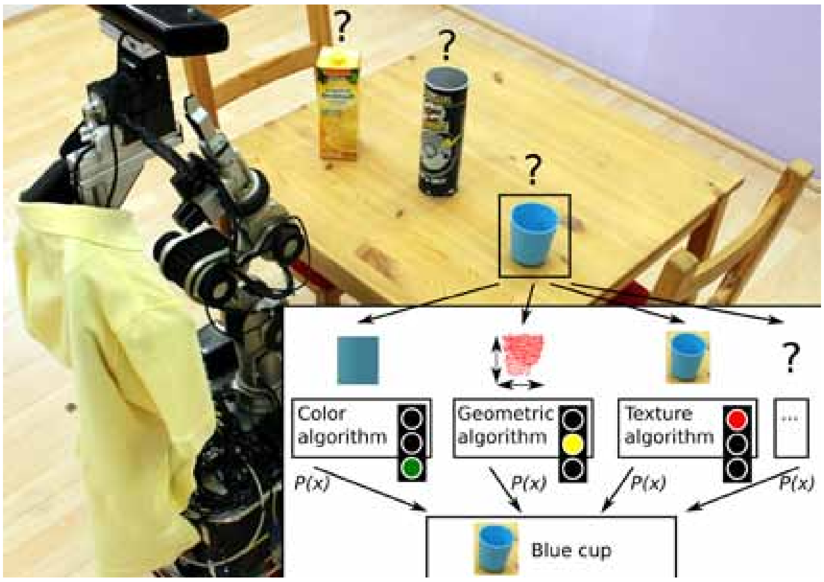
Service robots shall very soon autonomously provide services in all spheres of life. They have to execute demanding and complex tasks in a dynamic environment, collaborate with human users in a natural and intuitive way and adapt themselves to varying conditions. Acting in an everyday life environment imposes great demands on the engineering and development process. Although matured algorithms and solutions exist for subproblems, a methodology to open up a systematic engineering approach for service robotic applications is still missing.

Thus, this project aims at developing a methodology for building service robotic systems. The major approach is to extend and merge so far separated techniques under the objective of suitability for everyday use. The overall goal is to substantially facilitate development of autonomous mobile service robots and to make another step towards intelligent adaptive and robust systems.

The ZAFH Autonomous Mobile Service Robots is a project for achieving applicable research results in the field of intelligent mobile robots. Its focus is on tools for systematic engineering of service robotic applications and on robust and efficient key functionalities and components.



It is run by a network of three Universities of Applied Sciences with funding from State of Baden-Württemberg and EU EFRE:

- HS Mannheim
- HS Ravensburg-Weingarten
- HS Ulm.

The ZAFH Autonomous Mobile Service Robots contributes to the following topics:

- Model-driven software development for robotics
- Resource-aware SLAM (Simultaneous Localization and Mapping)
- Learning from demonstration for manipulation tasks
- Task-nets for context and situation-aware task execution
- Probabilistic fusion of multiple algorithms for object recognition
- Anytime algorithms for object recognition
- Active object recognition with information-driven sensor placement
- Safety properties.

Keywords
Service robotics
Robot development process
Mobile manipulation
Learning from demonstration
Model-driven software development
Multi-modal active object recognition

Hochschule Ravensburg-Weingarten
University of Applied Sciences

hochschule mannheim

Danish Technological Institute

Robot Technology

Location
Denmark
Odense

Website
http://robot.dti.dk

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Danish Technological Institute (DTI) develops, applies and transfers robot technology to the industry and society. Our focus is innovation - applying new research results and robot technologies to create the robot solutions in the markets of tomorrow. DTI is a leading European robotics-innovator with a staff of more than 85 robotic experts, well-equipped labs in Denmark and USA with more than 16.000 users every year as well as more than 125 robotic projects in the portfolio.

Focus is always on creating positive impact for end-users of robotic technologies as well as being the first mover on developing and deploying new breakthrough solutions into the market. Our motto is: „Robotic-innovations that change your world!"

Robot technology is a growth driver with exponential progression and is therefore of high relevance to a broad range of branches and application domains. DTI is committed to create positive impact in as many branches as possible.

DANISH
TECHNOLOGICAL
INSTITUTE

Some of the most dominant branches are:
- Manufacturing industry
- Health care and welfare
- Play and education
- Farming and agriculture
- Energy and environment
- Urban space and buildings.

Our products and services delivered to companies, public organizations and others cover:
- **Robotic Solutions.** End-user centered design and set up of business cases, development of robotic systems as well as competences and organizational capabilities at end-user sites, deployment of robotic solutions.
- **Test & Documentation.** Performance measures on robotic systems in end-user realistic lab set ups or in real end-user environments as well as documentation and dissemination of test results to specific segments.
- **Training & Education.** Tools, methods and theories transferred to end-users, system integrators, technology specialists, key stakeholders in robotic industries and users hereof with a focus on practical built up of skills.
- **Analysis & Consultants.** Identify robotics application potentials in current practices, resolve and troubleshot malfunctioning robotic solutions, comparative studies on technologies and application specifics, counseling.
- **Networking & Events.** Workshops, conferences, exhibitions, study tours, awards and statistics centered around robotics in different branches with a focus on personal relations, initiation of collaborations, know-how.
- **Advanced Pilot Production.** Development and manufacturing of robotic solutions or components with advanced high-tech features, establishment of advanced robot-based manufacturing of advanced products.
- **Research, Development & Innovation Programs.** Breakthrough innovations based on strategic and advanced product design, consortia establishment, iterative cycle-based work plans, budgets, fundraising, proposal writing, contracting.

Expertise in technological domains covers at least:
- Modelling, simulation and programming of (robot)motions
- Mechanics, electronics and construction
- Sensors, signal processing and sensor fusion
- Modern Artificial Intelligence
- Human-Robot Interaction.

DTI is a networking organization that teams up with companies, public organizations, research institutes, branch representatives and other key stakeholders in order to join forces and maximize the positive robotics impact on end-users. More than 2.500 collaborating partners from Denmark and globally are included in the network. The DTI robot technology activities are organized at the Centre for Robot Technology in Odense, Denmark, and at DTI Robotics US, Inc. in Atlanta, USA.

Keywords
Robot co-worker
Industrial assembly robots
Manufacturing
Health care
Welfare
Innovative break-through in markets
End user-/customer-/market-centered
Research-/technology-based
Robotics innovations centre

DANISH
TECHNOLOGICAL
INSTITUTE

Delft University of Technology

Robotics Institute

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Delft

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Our mission is to introduce novel robotics technology that will enable robots work together with humans, so contributing to all kinds of manual labor beyond standard factory environments.
We research in a coordinated fashion the key aspects of modern robotics with a focus on bio-inspired robot design, human-robot interaction, autonomous control and machine learning.

Research Groups

- Cognitive Robotics
- Biomechanical Engineering
- Precision and Microsystems Engineering
- Delft Center for Systems and Control
- Precision and Microsystems Engineering
- Embedded Software
- Software Engineering
- Pattern Recognition

(cont.)

TU Delft Delft University of Technology

(cont.)

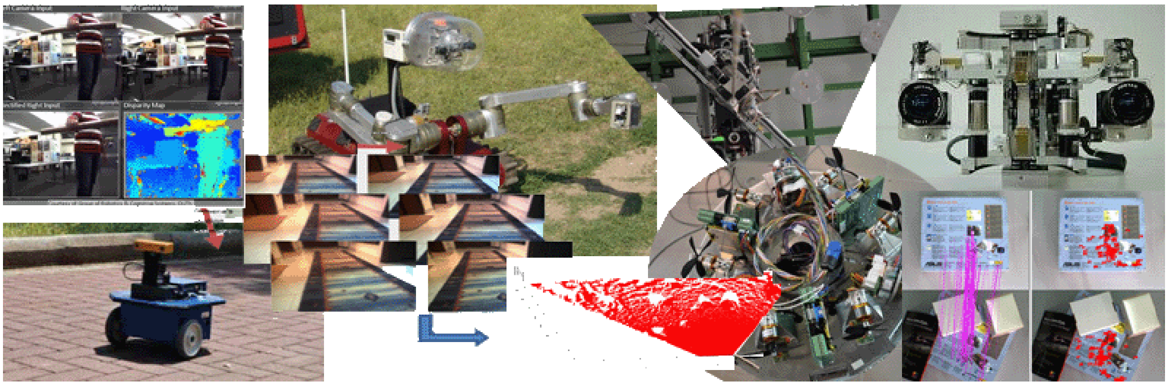
- Electronics Research Lab
- Control & Simulation
- Space Systems Engineering
- Moral Philosophy and Technology
- Systems Engineering
- Section ICT
- Mechatronics
- Physical Ergonomics
- Hyperbody
- DELFT ROBOTICS RoboCup@Home Team.

Keywords
Bio-inspired robot design
Intelligent grasping solutions
Legged locomotion
Learning systems and control
Visual servoing and vision-based control
Quadrotors
Swarm robotics

TU Delft Delft University of Technology

Democritus University of Thrace

Department of Production and Management Engineering
Group of Robotics and Cognitive Systems



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Keywords
Visual odometry
Visual SLAM
3D reconstruction
Object recognition
Multi camera systems
Stereo vision

The Group of Robotics and Cognitive Systems performs and promotes research in application problems that rise in the area of robotics, computer vision, multimodal integration, image analysis and understanding, visual surveillance, intelligent sensory networks, sensory fusion, and other relative topics.

The group utilizes state of the art tools to expand the scientific and technological front in the respective research areas

- Artificial vision (including cognitive and robot Vision);
- Intelligent systems (such as fuzzy systems and artificial neural networks)
- Pattern recognition.

The group possesses a long standing experience in collaborative projects in European level, with several industrial and academic partners.

DFKI - German Research Center for Artificial Intelligence GmbH

Robotics Innovation Center

Pictures © DFKI GmbH

Location
Germany
Bremen

Website
www.dfki.de/robotics

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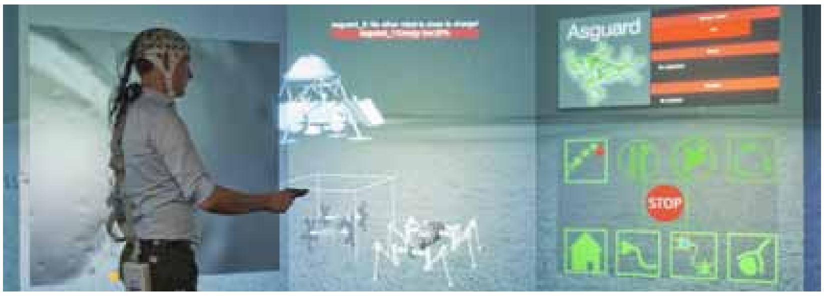
The Robotics Innovation Center and its branch office at the University of Osnabrück belong to the Bremen location of the German Research Center for Artificial Intelligence (DFKI GmbH). The DFKI, based in Kaiserslautern, Saarbrücken, Bremen and leading a project office in Berlin is the world's largest research center in the field of Artificial Intelligence.
In the framework of direct industrial orders or publicly funded joint projects, the DFKI Robotics Innovation Center designs and realizes intelligent robots for a variety of fields of application, such as underwater, space, SAR (Search and Rescue) and security robotics, logistics, production and consumer (LPC), cognitive robotics, e-mobility, and rehabilitation robotics. The focus lies on a rapid transfer of results of basic research into real-world applications.
This not only requires a design according to latest mechatronic developments but also programming based on complex, massive-parallel embedded systems solutions. The team benefits from interdisciplinary cooperation: computer scientists and design engineers meet biologists, mathematicians, computer linguists, industrial designers, electro engineers, physicists, and psychologists. (cont.)

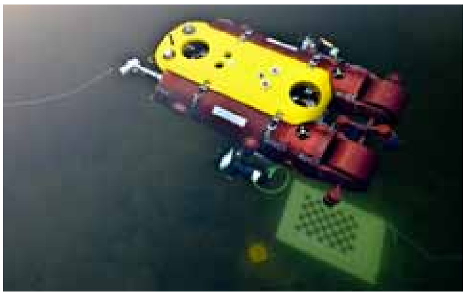
German
Research Center
for Artificial
Intelligence

(cont.) Currently, a staff of about 100 employees from all over the world works in research and development. More than 50 student assistants support the individual projects. The DFKI Robotics Innovation Center uses the basic research of the Robotics Group at the University of Bremen headed by Prof. Frank Kirchner.

Project examples:

- **RIMRES (Reconfigurable Integrated Multi Robot Exploration System).** The aim of the project is the development of core technologies for modular, reconfigurable robotic systems to support the efficient and robust execution of complex tasks in uncooperative and difficult-to-access areas. Besides new methods for autonomy, navigation, and locomotion, the focus is on a highly modular system concept consisting of modules for different functions, i.e., locomotion, energy supply, data recording, autonomy, and navigation which are intended to be compatible with each other and will be linked via a uniform mechatronical interface.
- **EurEx (Europa-Explorer).** The project is a pilot survey for future missions to Jupiter's moon Europa. It focuses on the aspect of navigation of robotic systems on and especially under the ice-shield of Europa. Below the surface an ocean comprised of liquid water is expected. After penetration of the ice-shield an





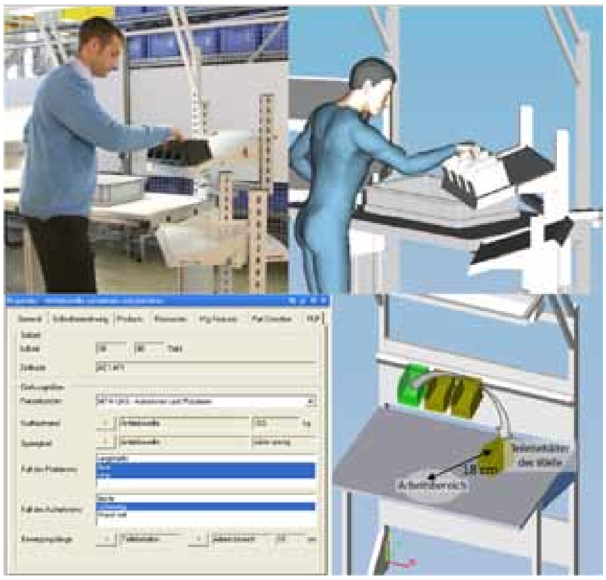
exploration can be conducted. A possible mission scenario is drafted, which covers all aspects of an exploration from the time of landing until the transmission of the survey results. In order to demonstrate the feasibility of this scenario, an experimental test platform will be constructed, which is able to be used in an analog mission at a suitable test site on earth. The results of this research can be used for planning purposes of real missions to Europa.
- **IMMI (Intelligent Man-Machine Interface – Adaptive Brain-reading for assistive robotics).** The aim of the project is the development of key technologies that allow adaptive real-time brain reading (BR). Essentially, BR in humans comprises the objectives of estimation of mental states and the prediction of behavior, based on analyses of brain activity.
- **Capio (Dual-arm exoskeleton).** Capio develops an universal, wearable, lightweight upper-body dual-arm exoskeleton, primarily targeted at teleoperation tasks. A study concerning robotic rehabilitation will establish a basis for research activities in this area. Sensor information of the remote systems will be applied directly to the operator's body in real time through a feedback mechanism that relies on the actuated system.

Keywords
Mobile robots
Space robotics
Underwater robotics
E-Mobility
Cognitive robotics
Search and rescue (SAR)
Logistics, production and consumer (LPC)
Rehabilitation robotics
Human-computer interaction
Simulation
Sensor data interpretation
Plan-based robot control
Action planning

German Research Center for Artificial Intelligence

Dortmund University of Technology

Faculty of Mechanical Engineering
Institute of Production Systems



Location
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Website
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Prof. Jochen Deuse
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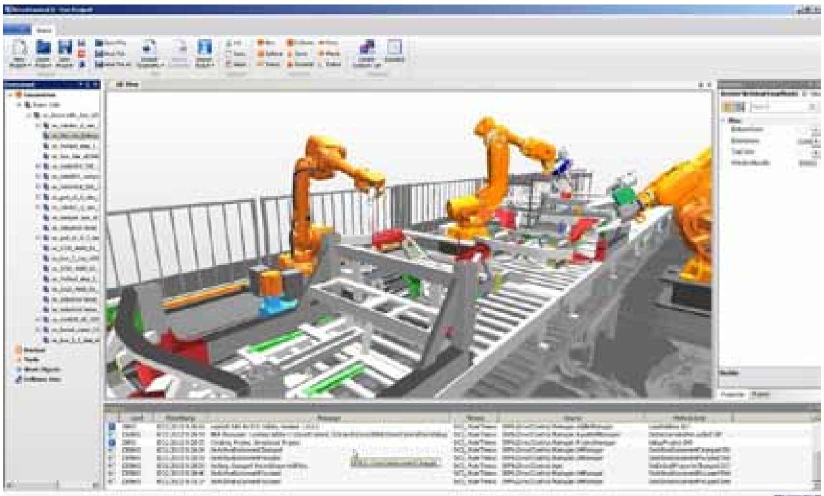
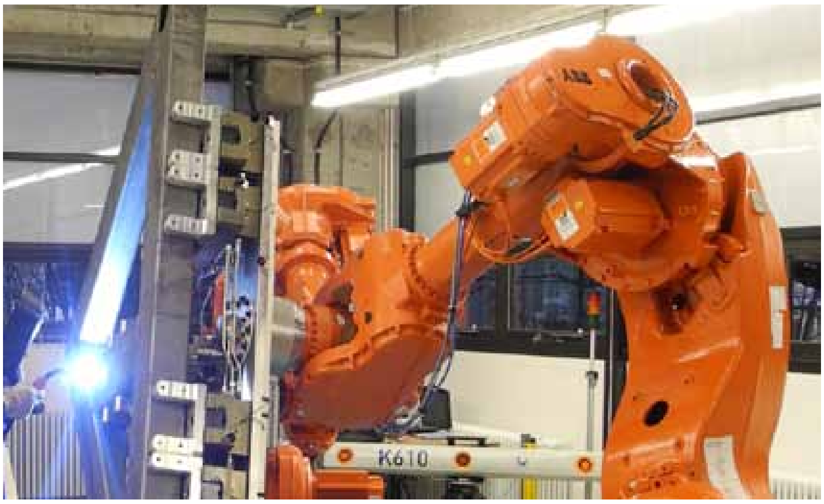
The Institute of Production Systems focuses on research and development of technical and socio-technical systems.

Beside the design of work systems and automation, fields of actions are systems engineering, lean production, digital factory, industrial robotics and service robotics, industrial assembly, labor and time studies and human-machine interaction.

technische universität
dortmund





Keywords
Labor and time studies
Automation systems
Digital factory
Industrial assembly
Industrial robotics
Service robotics
Human-machine interaction
Socio-technical work systems
Systems engineering
Factory physics

IPS
Institute of Production Systems

École Centrale de Nantes

Physics and Engineering Sciences
Research Institute of Communications and Cybernetics of Nantes (IRCCyN)
Robotics Team

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The Robotics Team at IRCCyn has four applicative research topics:

Industrial robotics. The following two main challenges are addressed:

- Is it possible to adapt existing robots to new industrial requirements (using robots as machine-tools, working in large environments, sharing operator workspaces)?
- If not, how to design new robot architectures that better fit to the new industrial processes?

These issues are addressed through the definition of new tools for robot design, analysis and modeling, and through the proposition of advanced control schemes.

Humanoid robotics
Humanoid robots aim at behaving the same way as human beings in their daily life environment. Our aim is to set scenarios in common human situations, including basic human tasks: develop particular competencies in dynamics behaviors applied to manipulation, locomotion, perception, and more general higher level behaviors: interpretation, path planning, data fusion, learning, adaptation and human motion imitation.

Mobile robotics

- Sensor-based navigation (followed by subsea infrastructure, urban and peri-urban navigation, automatic landing and takeoff, inspection of structures, convoy mission or training, reactive navigation in cluttered environment, multi-sensor navigation)
- Localization (localization of subsea infrastructure, fusion of CAD model and local measures, localization in sensory memory, site mapping metric, topological, semantic)
- Sensors modalities (camera, GPS, LED, electric sense, etc.).

Biorobotics

We address locomotion, perception and mechatronics aspects:

- Bio-inspired Locomotion: dynamic modeling of fish swimming, terrestrial locomotion (snake, Inchworm, etc), insect-like hovering flight and soft robotics;
- Bio-inspired Perception: modeling of electric sense of fish, sensorimotor feedback loop for navigation, X-agent navigation in water (ANGELS FP7 ICT FET: ANGuilliform fish-like robot with ELectric Sense).;
- Mechatronics: design and making of an eel-like robot, swimming modular robots, electric sensors and associated experimental benches.

The Robotics Team has three methodological research topics:

Modeling, Identification, Control

- Modeling of manipulator robots and locomotor systems
- Identification of dynamic parameters of robots
- Computed torque control law and/or sensor based control
- Control of multi-arms robots, robots on mobile platforms, underactuated systems.

Design

- Robust design of serial and parallel mechanisms
- Conceptual design of mechanisms (Type-synthesis and evaluation)
- Singularity analysis of lower-mobility parallel mechanisms
- Design of variable actuated parallel mechanisms.

Interaction and perception

- Localization using cameras or bio-inspired sensors
- Mapping, SLAM
- Environment reconstruction
- Haptic interface
- Man-machine interaction.

Keywords
Design
Control
Modeling
Identification
Industrial robotics
Biorobotics
Humanoid robotics
Mobile robotics
Parallel robots

Engineering Institute of Coimbra (ISEC)

RoboCorp

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Coimbra

Website
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robocorp@isec.pt

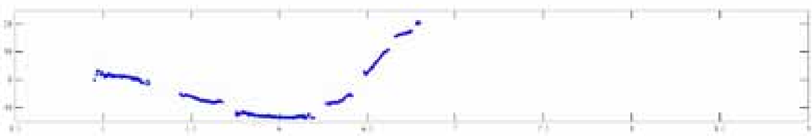
RoboCorp at the Engineering Institute of Coimbra (ISEC), is a multidisciplinary group with researchers from several scientific fields, being currently directed by the President of ISEC, Ph.D. Nuno Ferreira.

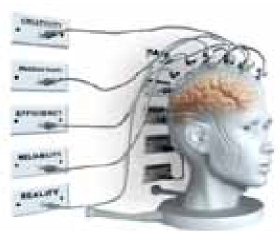
The Engineering Institute of Coimbra has established several partnerships with companies and industrial units in order to provide solutions for their problems.
This concept of "technology push" has allowed many B.Sc. and M.Sc. students to have a higher number of contact hours in the fields of robotics, automation, control systems, computer vision, biomimetics and sports engineering.

The overall goal of RoboCorp includes, firstly, the need to build skilled manpower necessary for strong scientific research and secondly, handling worthwhile projects that can be developed and implemented in national and international industrial units, opening new windows of opportunity and synergies.

POLITÉCNICO DE COIMBRA

isec
Instituto Superior de Engenharia de Coimbra





Apart from outsourcing services, RoboCorp also undertakes research projects on topics in the field of robotics and automation ranging from mobile and industrial robotics to computer vision and sports engineering.

Current research emphasizes on:

- Developing intelligent sensing, planning and control methods for robotic and manufacturing systems
- Machine vision, image understanding and pattern recognition in industrial applications
- Design, development and testing of sports equipment and mathematical tools.

In short, RoboCorp wants to contribute as a scientific and educational privileged vehicle. More than just a reference, it is RoboCorp's mission to embody science while Thinking Beyond Engineering.

Keywords
Outsourcing services
Technology push
Applied research
Automation
Robotics
Sports engineering

ENSTA ParisTech

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Keywords
Manipulation planning
Reinforcement learning
Human-robot interaction
Long-term learning and adaptation
Human modelling

The "Robotics and Computer Vision" group is working on mobile robot navigation, mapping, perception, embedded vision, motor control and human-robot interaction, with a focus on applying machine learning in real-world applications.

We are working mainly on applications in assistive and service robotics, humanoid robotics, intelligent vehicles and security.

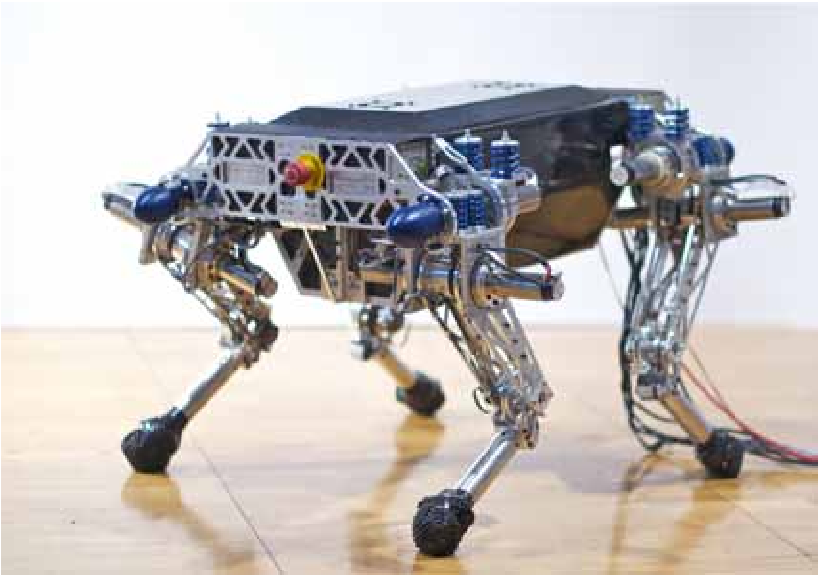
Several members of our team are also part of the INRIA/ENSTA ParisTech FLOWERS team which is focusing on developmental robotics, with the goal of applying learning algorithms to robots in strong interactions with humans.

Developmental robotics
Intelligent vehicles
Assistive robotics
Object detection
Image processing and models
Motion analysis
Embedded vision
Semantic navigation

ENSTA ParisTech

ETH Zürich (Swiss Federal Institute of Technology)

Department of Mechanical and Process Engineering (D-MAVT)
Autonomous Systems Lab (ASL)



Location
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The Autonomous Systems Lab was founded in 1996 at EPFL Lausanne and it has been part of the Institute of Robotics and Intelligent Systems (IRIS) at ETH Zurich since 2006. It is led by Prof. Roland Siegwart.

Our mission and dedication is to create robots and intelligent systems that are able to autonomously operate in complex and diverse environments. We are interested in the mechatronic design and control of systems that autonomously adapt to different situations and cope with our uncertain and dynamic daily environment.

We are fascinated by novel robot concepts that are best adapted for acting on the ground, in the air and in the water. We are furthermore keen to give them the intelligence to autonomously navigate in challenging environments. This includes novel methods and tools for perception, abstraction, mapping and path planning.

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Keywords
Mobile robots
Autonomous navigation
Micro aerial vehicles
Legged locomotion
3D perception
Sensor fusion
Robot vision

ETH Zürich (Swiss Federal Institute of Technology)

Faculty of Architecture
Institute of Technology in Architecture
Architecture and Digital Fabrication

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Zurich

Website
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The Professorship for Architecture and Digital Fabrication is a pioneer in the field of digital design and fabrication in architecture, founding the world's first architectural robotic research facility in 2005 at ETH Zurich.
Their investigations have radically extended the possibilities of architectonics, creating 'digital materiality' — a design process whereby architecture is precisely informed through to the level of material, thus enabling a greater and more sophisticated expression of sensuality.

Through the integrated research and teaching activities the professorship has acquired pioneering expertise in the interplay of digital and material processes. The inter-disciplinary discoveries were demonstrated in numerous award-winning designs that utilise profoundly innovative construction methods.

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

The research focuses on additive digital fabrication techniques used to build non-standard architectural components at full scale. Simply put, additive fabrication can be described as a three-dimensional printing process.

By positioning material precisely where it is required, it is enabled to interweave functional and aesthetic qualities into a structure, thus to "inform" architecture through to the level of material.

The aim is to develop criteria for novel constructive material aggregations which can be applied to architecture and that are intrinsic to digital fabrication, ranging from 1:1 prototypical installations to the design of robotically fabricated high-rises.

Keywords
Digital design and fabrication
Full-scale robotic fabrication
Constructive computational programming
Additive architectural aggregations
Non-standard material systems

Institute of Technology in Architecture
Faculty of Architecture / ETH Zurich

European Space Agency (ESA)

ESA Telerobotics & Haptics Laboratory

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Website
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The ESA Telerobotics & Haptics Laboratory is an engineering research laboratory of the European Space Agency. We aim to create value through fundamental research and engineering developments in the domains of robotics, telerobotics, mechatronics, human-robot systems and haptic devices. Our work is best characterized by theoretical research paired with mechatronic system optimization. We research and develop advanced mechatronic devices, control algorithms and related software for teleoperation and haptic systems mainly for space applications. We study and research how to optimize related technologies for efficient interaction with varying human operators and target robotic systems. It is our vision that this 'human centric approach' will enable truly intuitive control interfaces and telerobotics systems of the future.

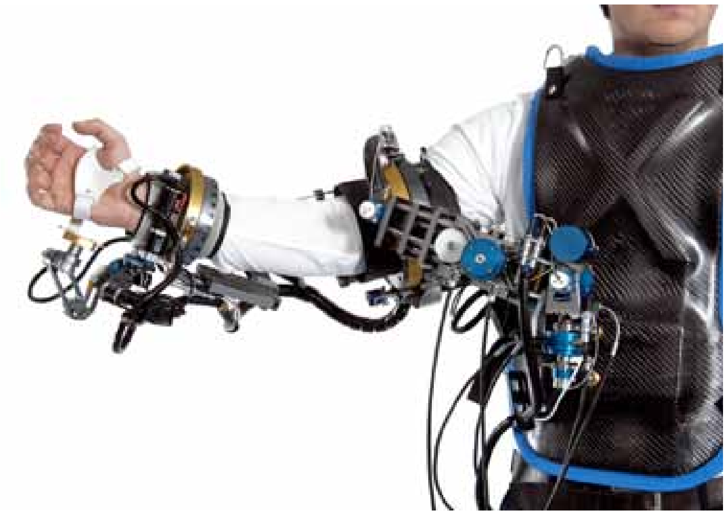
Our laboratory is geared towards custom developing end-to-end systems, in order to learn how to continuously improve and optimize bilateral control systems and their individual components. All research in the laboratory is centred on the concept of 'human centric design'. In practice this means, all systems are optimized for human operator usage.

esa

Control as well as mechatronics solutions are targeted towards the optimal support of human functionality, anatomy and motor control capabilities in remote execution tasks. In addition, improving robustness and quality of related mechatronics systems is a key scope of our prototypes and systems.

"It is of high strategic importance to foster cross-transfer technologies between space and terrestrial markets".

It is the goal of the Telerobotics & Haptics Laboratory to develop advanced technologies for enabling future space missions and to maintain a strong engineering and fundamental research competence within ESA and its partners in the European and International Space sector. Moreover, the Laboratory has strong links to non-space related activities with academia and industry.



Key research areas

- Haptic devices
- Telerobotics systems
- Human-robot interaction
- Advanced mechatronics
- Robotics interoperation
- 3D vision
- Augmented reality
- Control frameworks
- Real-time target platforms
- Impedance control
- Manipulation
- Bilateral control
- Force control
- Haptics.

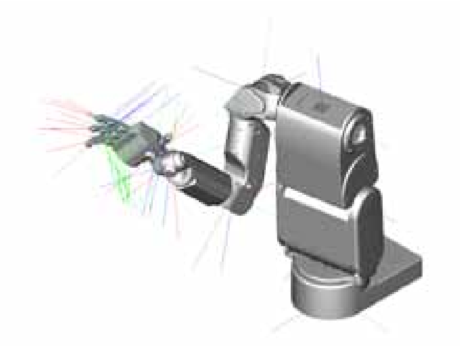
Keywords

Exoskeletons
Telerobotics
Haptics

esa

fortiss

Cyber-Physical Systems
Virtual Engineering & Robotics



Location
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Website

Contact
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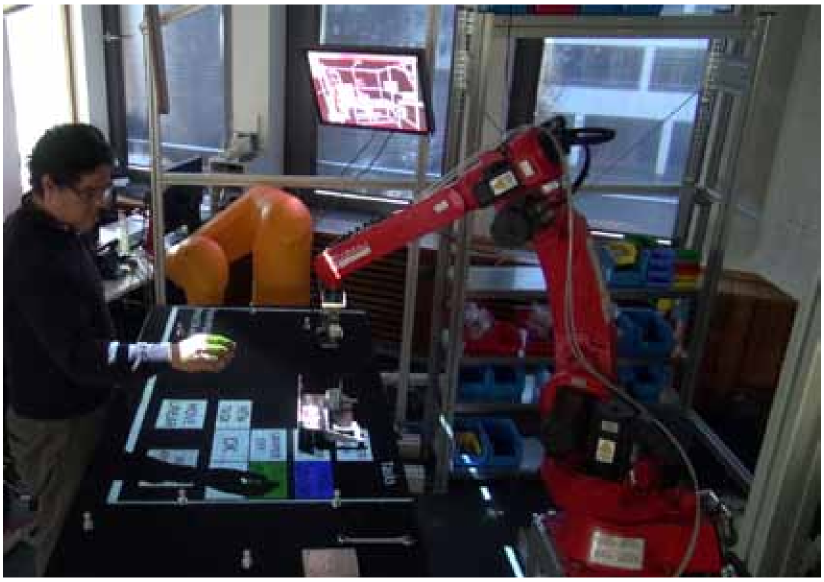
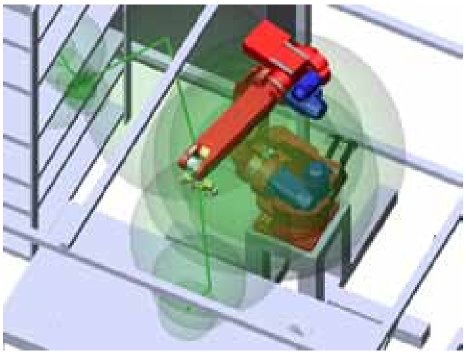
fortiss is a non-profit research and development organization founded in 2009. Building on the distinguished research and development tradition of the Technische Universität München, fortiss carries out R&D and technology transfer for software-intensive systems and services. In this role fortiss acts as a technological think tank, bridging the gap between fundamental research in academia and its fruitful implementation in an industrially and commercially feasible context.

Part of our robotics research is aimed at new and intuitive programming paradigms for industrial robots. Especially small and medium-sized enterprises (SMEs) with small lot sizes and constantly changing product cycles are reluctant to consider automation using robots due to the complexity and the need for skilled technicians. We investigate concepts for human-robot interaction using new input and output devices as well as the fusion of several of these modalities in order to provide interfaces suitable for a domain expert without robotics knowledge. Another focus is the advancement of interaction and dialog managers in order to be able give the user the ability to communicate with the system about objects, actions, and processes rather than writing program code.





Social aspects of the interaction between humans and robots are another focus of our research. While a robot is able to correctly fulfill its task without keeping the social needs of a human in mind, complying with social norms can often increase the acceptance and performance of a robot system. Here, we conduct user studies to investigate and evaluate various aspects of social human-robot interaction: usage of interaction modalities, handover scenarios, head movement and other non-verbal gestures, or dialog with natural language generation. This also includes observation and annotation of human-human interaction, as well as comparison of different interaction strategies.

As a software institute, we also look into how the development workflow of these demanding projects can be improved. This typically involves heterogeneous systems with tight real-time requirements for controllers, implementation of low-level control algorithms, up to high-level perception and reasoning components. We contribute to the research and education community with open source projects such as the Robotics Library.

Keywords
Industrial robotics
Social human-robot interaction
Intuitive programming
Multimodal input & output
Knowledge representation
Task planning
Motion planning
Software engineering

fortiss

Fraunhofer Institute for Intelligent Analysis and Information Systems (IAIS)

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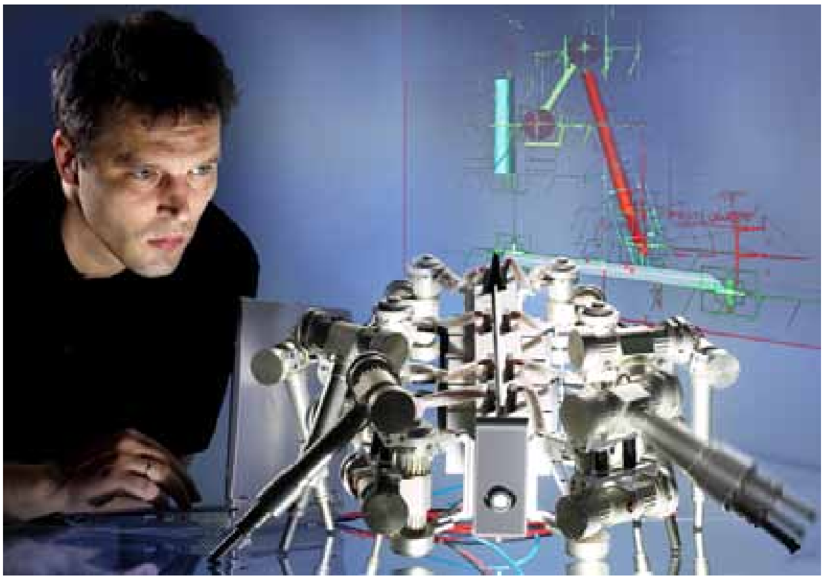
Fraunhofer IAIS is an institute of the Fraunhofer-Gesellschaft, Europe's largest provider of research and development services in the field of information and communication technology. Fraunhofer IAIS has about 260 employees, including a research staff of about 160. Fraunhofer IAIS develops tailor-made IT solutions for the analysis, access and targeted use of large data quantities, new media technologies and solutions for innovative business and security processes.

Its main business areas include Marketing, Market Research & Media Analysis, Business Planning & Controlling, Digital Media Asset Management, Process Intelligence, Preventive Security, and Spaces for High-Tech Experience.
In these areas, Fraunhofer IAIS performs basic and pre-market research leading to application-oriented concepts and individual solutions for industrial, scientific, and governmental clients. Fraunhofer IAIS is closely cooperating with universities from its home region, particularly with the University of Bonn and the University for Applied Sciences Bonn-Rhein-Sieg in Sankt Augustin.

Fraunhofer
IAIS

Fraunhofer IAIS is working for many years in the research areas adaptive robotics and cognitive robotics. Different types of autonomous robots have been developed, e.g. for applications in sewage tunnels, difficult terrain, underwater or in the air. What these robots have in common is the ability to cope with interruptions in communication links, component failures, and changes in workload, resources, and mission requirements. Being equipped with a multitude of external and internal sensors, they can perceive their environment and their own system status on a multimodal basis and perform a robust, targeted behavior even in changing and unpredictable environments.



Project examples

- In the FP7 project First-MM, Fraunhofer IAIS investigated statistical relational inference and learning for manipulation tasks.
  http://www.iais.fraunhofer.de/index.php?id=5273&L=1
- In the FP7 project NIFTi, IAIS develops a system that enables robots to communicate with rescue workers by natural language. The robots - in the air and on the ground - interact independently with each other and provide the rescuers pre-filtered, relevant information.
  http://www.iais.fraunhofer.de/index.php?id=5241&L=1
- Fraunhofer IAIS also investigates control methods for autonomous under water vehicles (AUVs). For this, a simulation »AUV-Framework« has been developed.
  http://www.iais.fraunhofer.de/index.php?id=5247&L=1

Keywords

Cognitive robotics
Machine learning
Pattern recognition
3D perception
Volksbot

Fraunhofer
IAIS

Fraunhofer Institute for Manufacturing Engineering and Automation (IPA)

Department Robot and Assistive Systems

Robotic home assistant Care-O-bot 3

Location
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Stuttgart

Website
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Fraunhofer IPA is one of the largest research institutes within the Fraunhofer-Gesellschaft which again is the largest applied research organization in Europe.
Finding solutions to organizational and technological challenges in all areas of industrial and non-industrial automation is the key focus of the research and development work carried out at Fraunhofer IPA.
The activities conducted by the Robotic Systems Department encompass all areas connected with robot deployment and automatable production processes, as well as the development of robotic systems and their key components. Many of Fraunhofer IPA's technologies and solutions have already been approved in daily use applications.

In service robotics, advanced software libraries have e.g. been developed for real-time 3D environment perception as well as for mobile robot navigation and manipulation in dynamic everyday environments.

Fraunhofer
IPA

Industrial mobile manipulator rob@work 3

Teaching an industrial robot by demonstration

Fraunhofer IPA is also well known for the development of highly sophisticated hardware platforms, such as the robotic home assistant Care-O-bot®, the industrial mobile manipulation platform rob@work or their three entertainment robots, which, for more than 15 years, have been running freely among visitors of the Museum für Kommunikation in Berlin.

In industrial robotics, Fraunhofer IPA develops new applications and solutions in the areas of fast and intuitive programming, material flow, machining with robots, safe human robot cooperation and many other areas. The services offered begin with consulting and problem solving, cover the fast and efficient set up of proof-of-concept robot cells and end with the realization in the customers work shop.

Keywords
Service robotics
Assistive robotics
Mobile manipulators
Industrial robotics
Manufacturing
Health care
Navigation
Manipulation
6D object recognition
3D environment reconstruction
Human-robot interaction
Process control and monitoring
System integration
Simulation
Safety
Wire kinematics
Lightweight arms
Grippers and assembly tools
Drive modules

Fraunhofer
IPA

Fraunhofer Institute for Factory Operation and Automation (IFF)

Top: Assistant Robot ANNiE
Right: Service Robot for sewer inspection

Location
Germany
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The Fraunhofer Institute for Factory Operation and Automation IFF is a research institute in the Fraunhofer-Gesellschaft, the largest applied research organization in Europe. The Fraunhofer IFF researches and develops innovative and custom solutions in the fields of robotics and automation, logistics, process and plant engineering and digital engineering.

The Robotics Business Unit specializes in the development of new systems and technologies for human-robot interaction, assistive robotics, safe collaborative robot systems and service robots for inspection, cleaning and maintenance.

Safe Collaborative Robot Systems
High safety standards must be met whenever humans and robots work collaboratively in a shared space. The development of new safety technologies and components for safe human-robot collaboration is one of the principle foci of research at the Fraunhofer IFF. Our research includes tactile sensing, safe manipulators, workspace monitoring and collision measurement.

Fraunhofer
IFF

Left:
Robot with tactile sensor system

Top: Human-Robot interaction with safe area monitoring
Left: Trunk-like robot arm BROMMI

Assistive Robots
Research on assistive robotics at the Fraunhofer IFF concentrates on the perception of the environment, intuitive and multimodal interaction with humans, autonomous navigation, safety, cognitive capabilities, and autonomous decision making.

Service Robots
Service robots work fully automatically and can perform work that is hazardous, monotonous or unreasonable for humans. The Fraunhofer IFF is developing worldwide one-of-a-kind systems such as inspection robots for high precision damage detection and cleaning of sewer lines and other infrastructures such as power plants as well as facade cleaning robots.

Keywords
Human-robot interaction
Safe human-robot collaboration
3D perception
Cognitive robotics
Software architecture
Tactile sensing
Assistive robotics
Service robots
Inspection robots

Fraunhofer
IFF

Friedrich-Wilhelm-Bessel-Institute Research Company (FWBI)

Robotics for Risky Interventions

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The Friedrich-Wilhelm-Bessel-Institute Research Company (FWBI) is a non-profit registered association (gGmbH) located in Bremen (Germany) since 1997.
The FWBI unites professors from the University of Bremen aiming for applied research projects in cooperation with other research facilities (universities) and industrial partners.

The industrial partners are recruited mainly from small and medium sized enterprises, using grants from national or international funding organizations. In addition to applied research projects, FWBI is specialized in the transfer of scientific results to industry.

FWBI

Disaster management aims to reduce, or avoid potential damage from hazards, assure prompt and appropriate assistance to victims of disaster, and achieve rapid and effective recovery. The main prerequisite of effective management of a hazard situation is a fast and clear verification of possible contamination.

The research area "Robotics for Risky Interventions" at the Friedrich-Wilhelm-Bessel-Institute Research Company arises from cooperation and joint research with the Institute of Automation (IAT), University of Bremen. The results of fundamental robot control research at the IAT have been transferred to the industry within research projects funded within the program "Industrial Joint Research" of the German Federal Ministry of Economics and Technology.

Research project "Reconnaissance Robot (RecoRob)" addresses several issues of the investigation robotics, in particular autonomous sample handling. The RecoRob system consists of a mobile platform with the 7DOF robot arm and various sensors, e.g. dome, stereo and thermo cameras mounted on a pan-tilt-head unit. An independent software framework developed at the IAT is applied to enable autonomous sample handling and adaptive task execution. To avoid cross contamination during sampling procedure an innovative container concept was developed within the project.

Keywords
Reconnaissance robot
Sample handling
Task planning
Dexterous manipulation
Software architecture

FWBI

Friedrich-Wilhelm-Bessel-Institute Research Company (FWBI)

Soft-Robotics Group

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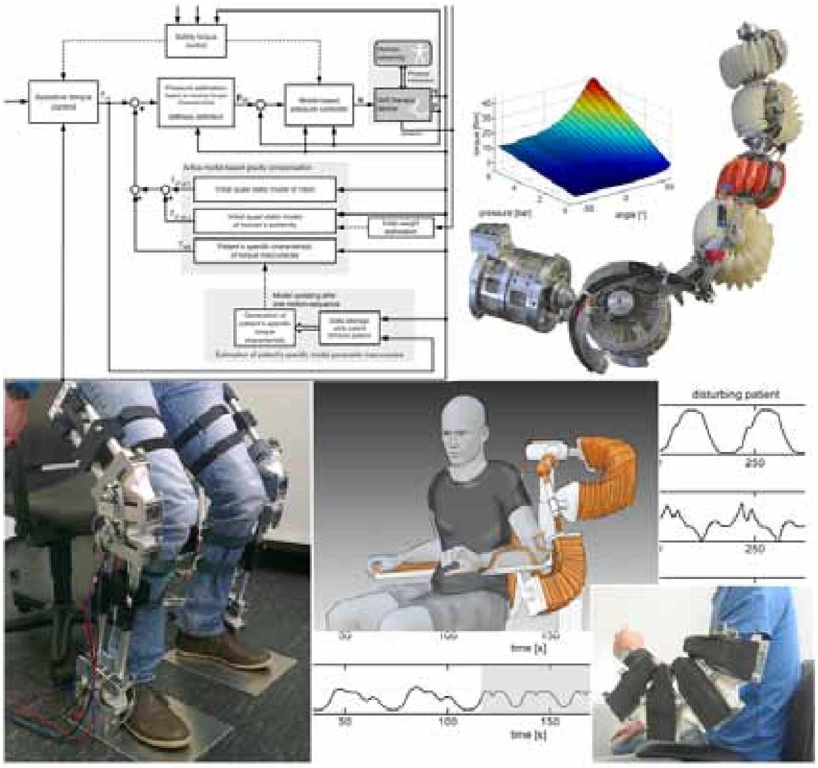
The research activities of the FWBI Soft-Robotics Group are focused on development and control of robotic devices that work in immediate proximity or in direct contact with humans. The development is mainly based on a specific type of soft fluidic actuators – actuators with rotary elastic chambers (REC-actuators). The combination of these lightweight, natural compliant actuators with proper control strategies allows to provide safe interaction between humans and robots.

Main topics of research

- Soft actuators design
- Advanced pressure control algorithms
- Modelling & control of soft actuators & robots
- Human-robot interaction control strategies
- Detection of human-robot interaction
- Man-machine interface with audiovisual feedback.

FWBI

Since 2006 several modifications of partially patent pending actuators with different forms of elastic chambers - pleated (pRECs), buckled (bRECs), coiled (cRECs) and newly with skewed elastic elements (sREC) - were designed, manufactured, tested and implemented into robotic arms and rehabilitation devices.
Integrated in revolute joints directly (i.e. without additional transmissions) REC-actuators enable modular design of multi articulated robotic structures and therefore more efficient and simpler robot constructions.



Keywords
Soft actuators
Modelling and control
Human-robot interaction
Robot-aided therapy

Different control strategies have been developed and tested with soft robotic devices, including nonlinear pressure controllers, robust and adaptive position control concepts with updated gravity compensation, adaptive impedance- and admittance control for safe human-robot interaction.
Robot-aided therapy for neurological as well as for orthopedic rehabilitation is an important field of application of soft actuators. Several compact and cost-effective assistive acting motion therapy devices are being developed and tested; the training device for knee/hip is now under clinical trials. Assistive controller takes into account effort, ability and behavior of patients, so that a patient can interact with the therapy device and is only assisted as much as needed. The long-term goal is to imitate the treatment technologies of physiotherapists.

German Aerospace Center (DLR)

Institute of Robotics and Mechatronics (RMC)

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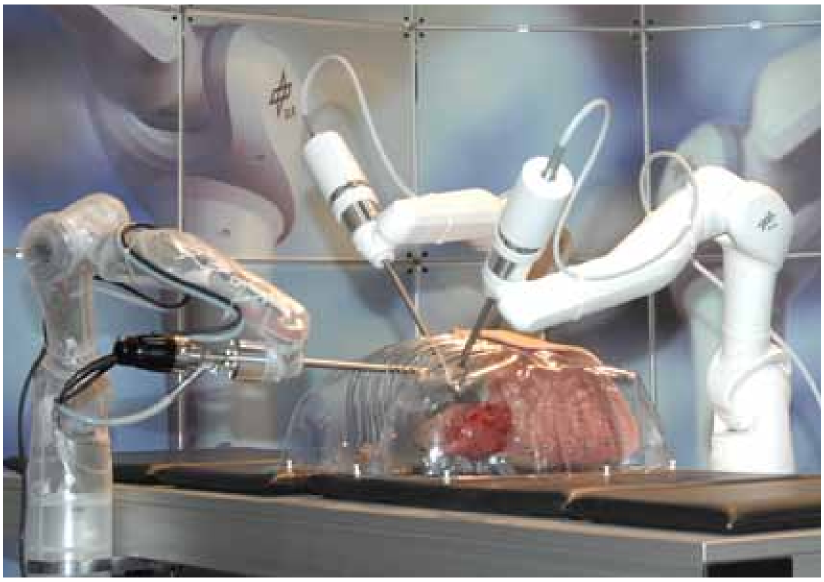
DLR is Germany's national research center for aeronautics and space. Its extensive research and development work in space aeronautics, transportation, energy, defence and security research is integrated into national and international cooperative ventures. As Germany's Space Agency, the German federal government has given DLR responsibility for the forward planning and implementation of the German space programme as well as international representation of Germany's interests.
The broad technological base of the Robotics and Mechatronics Centre (RMC) located at Oberpfaffenhofen and Berlin is mechatronics which is the highest possible integration of mechanics / optics, electronics and computer science (software) to create „intelligent mechanisms" culminating in robots that interact intelligently with their environment. Consequently the work of the institute is focused on interdisciplinary design, optimization and realistic simulation activities and also on the implementation of complex mechatronic systems and the appropriate man-machine interfaces.
The center is regarded internationally as the leading institution for applied robotics research focused on robotics in space (ESA Reference Lab).

DLR

One of the key goals is the development of mobile and / or roving robonauts moving on planetary surfaces in support of the astronauts at work in space (robotic servicing and exploration). The development of DLR's lightweight robot and the multi-fingered hands are the results of this approach and helped DLR's „soft robotics" concept to a breakthrough as a new important method for realizing human/robot interactions. The two-arm mobile JUSTIN robot became a trademark of DLR's robotics research.



The center specializes in the field of exploration with the development of planetary rovers in particular with the design and implementation of the first European Mars rover "ExoMars".

Traditionally the technology transfer to terrestrial applications has high priority at the center. Examples are the use of DLR's lightweight robot as a production assistant in the automobile industry and the development of a novel surgical robot according to telepresence concepts. The center is also developing new approaches for the modeling, simulation and development of mechatronic systems and concepts for aircraft technology (such as „flying robots"), the automobile industry as well as for advancing electro-vehicle mobility (ROboMObil).

Keywords
Service robotics
Soft robotics
Surgical robotics

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Mobile Systems Laboratory

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In the Mobile Systems Laboratory at the Harz University of Applied Sciences, research covers the fields of artificial intelligence, multi-robot systems, as well as image and knowledge processing.

In the beginning in 2003, the focus was on deductive specification and analysis of multi-agent systems for the RoboCup, based on hierarchical state machines and hybrid automata (HHA). As hardware, robots of type Sony Aibo were used. The corresponding team named Harzer Rollers participated in the annual German Open RoboCup competitions and won the third prize in Hannover in 2008.

Since 2009 flying robots with four or eight propellers, i.e. multicopters, were used in research and also education. For this, the models are designed to fly autonomously and also accomplish tasks in a team. The problem of semantic object recognition and multi-sensor platforms are addressed in this context.

HOCHSCHULE harz University of Applied Sciences

The group has experiences with funded projects involving partners from industry. The research efforts so far have been funded by the German Research Foundation and the German Federal Ministry for Economics and Technology.
Furthermore, Prof. Stolzenburg is member of the European Network for the Advancement of Artificial Cognitive Systems, Interaction and Robotics (EUCog) and the European Robotics Research Network (EURON).

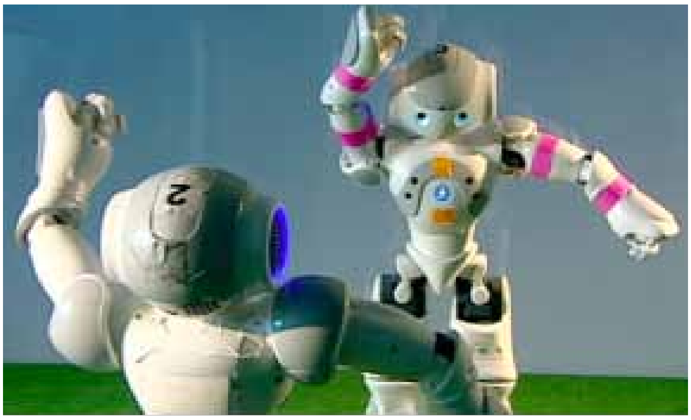
Research and development activities:
- Artificial intelligence
- Multi-agent technologies
- Mobile robots
- Robot team behavior modelling
- Knowledge processing and reasoning
- Computer vision.

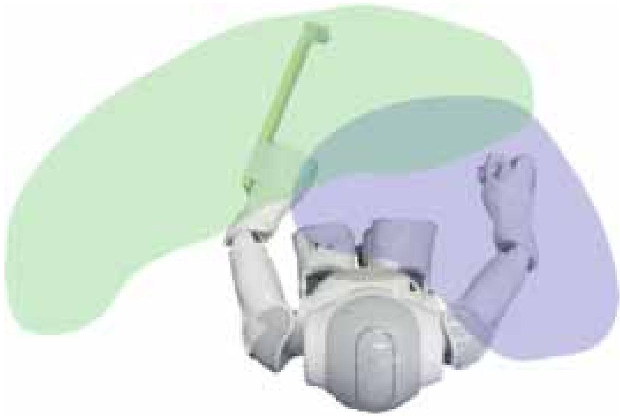
Keywords
Multicopter
Object recognition
Mobile robot team coordination

HOCHSCHULE harz
University of Applied Sciences

Humboldt University Berlin

Faculty of Mathematics and Natural Sciences II
Department of Computer Science
Cognitive Robotics





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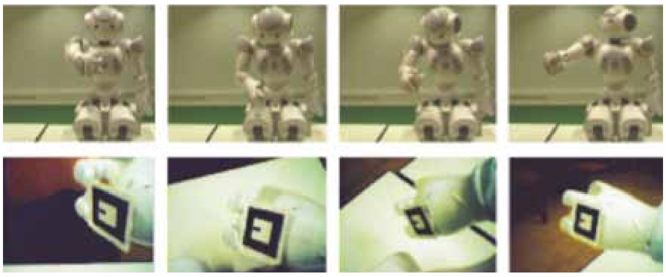
The Research Group „Cognitive Robotics" works on extracting principles of intelligent behavior in natural systems and transferring them onto artificial systems. Embodiment plays a major role since intelligence can only develop through the interaction of an agent with its environment. Through such actions, an autonomous agent can directly influence its sensory perception.

Research areas and topics:
- Cognitive robotics
- Biorobotics
- Developmental robotics.

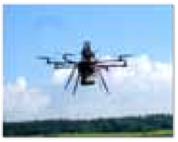
Sensorimotor Interaction in Humanoid Robots

We are interested in the development of skills through sensorimotor interaction. Specific topics are imitation learning, exploration learning, internal models and simulation, gesture-based interaction. The experiments are performed on the humanoid robot platform Nao from Aldebaran. *http://introbotics.eu*.



Autonomous flying robots

In cooperation with agricultural scientists, we are working on a flying robot that autonomously samples aerial images and creates suggestions for area-specific crop fertilization. *http://agricopter.de*.

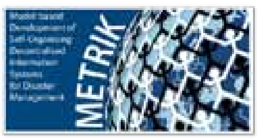


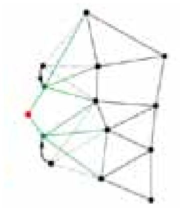
Bio-inspired Navigation Strategies

We take inspiration from biological autonomous flying objects and transfer the insights onto artificial autonomous systems such as this multicopter. Methods involve visual homing strategies and optical flow.

Mobile Sensor Nodes

We enhance sensor networks with mobile nodes using robotics and embodied AI approaches and swarm robotics. *http://gk-metrik.de*.

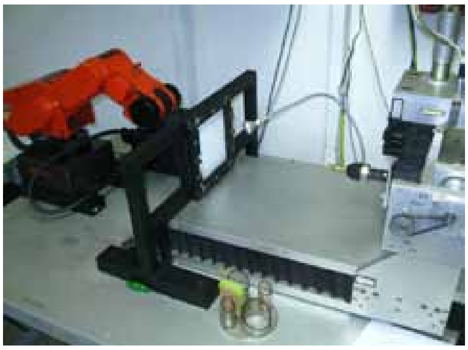




Keywords
Joint attention
Behavior recognition
Sensorimotor interaction & learning
Spatial cognition and navigation
Computational modelling of cognitive processes

Hungarian Academy of Sciences

Computer and Automation Research Institute
Computer Integrated Manufacturing Research Laboratory (CIM Lab)



Set-up with small robot and milling machine

Several years of R&D co-operation with Hungarian and foreign industries, SMEs, universities and research institutes (in Korea, Japan, Mexico, Italy, Germany, etc) directed us towards joint European research projects with prestigious academic and industrial partners.

R&D Fields: keeping the "traditional" design and control tasks of manufacturing automation, and turning towards intelligent manufacturing applications, virtual/extended enterprises and www network applications. Research in design, simulation, scheduling, real-time control, evaluation and quality control of robots, flexible manufacturing cells (FMC) and systems (FMS). Focus: handling the management, design and operation of manufacturing systems together in an integrated way. Results are verified at industrial sites, are then published in journals and in conference proceedings and in several non-public research reports.

In the summer of 2011 a new robot laboratory started to work in our Institute under leadership of CIMlab to make automation research more attractive and demonstrative, giving interesting, research tasks to some young researchers.

Some basic, joint characteristics of our R&D projects

- Object-oriented design methodologies and software reuse were applied in CORBA environment for the modelling and simulation system and in the CNC control system for the OSACA EU project. Virtual enterprises are typical in our EU projects with the acronyms: PLENT, FLUENT and WHALES. In the EU 5th Framework project of WHALES, the goal is the web-based management of complex, high volume, expensive projects of big, powerful, distributed, complex enterprises. The REDEST project dealt with management of requirement gathering and analysis, while the BIDMED project solved the computer assisted management of co-operative bidding in the medical sector. By joining the XPERTS EU project we had a chance to deal with intelligent/knowledge based machine tool design. E-BEP and E-MULT are targeting life-cycle management issues in car disassembly, reuse and recycling.
- Being members in the EU networks of ICIMS-NOE, AMETMAS-NOE, SIM-SERV, CODESNET and NEURON, we cooperate with 35-40 research and industrial firms in robotics, simulation and virtual/real enterprises on their design and management issues.
- Our recent SEE and FP7 projects are about clouds, robotized living tissue production, 3D measurements, SME assistance and clever games, among others.

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Website
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- In the projects with Paks Nuclear Power Plant (Hungary) the knowledge server technology was used to assist the substation operators and engineers by designing and implementing multi-function Decision Support Systems.
- Our digital movie film-restoration and saving system was a great success.

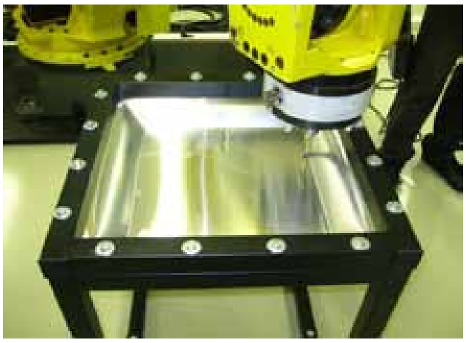
The setup of the new laboratory and R&D Experiments with robots

Recently we have two robots (an old small one and the new-born big one) and a small 2.5D milling machine. The small robot is a Mitsubishi RM-501 with a circular work envelope of 445 mm maximum horizontal reach and a maximum payload of 1.2 kg, while the 2.5D milling machine is of type Rieckhoff, with a working space of 400x250x50 mm. These two equipment have been in use in another room of CIMlab since more than 10 years. The big robot is a FANUC S-430iF with the following main Robot Specifications data: Axes: 6, Payload: 130 kg, H-Reach: 2488 mm, Repeatability: ±0.5 mm, Controller: FANUC R-J3.

FANUC S-430iF robot, lights-camera box and Rubik's Cube

Three experiments are running on the three tools of the lab:

- Incremental Sheet Forming (ISF) of polymer sheets with heating the sheet from one side (small robot) and forming it with an appropriate tool from the other side (milling machine). Optical and electromechanical measurements for sheet thinning and thermal behavior are started. Synchronised and adaptive control experiments are running, too
- Incremental Sheet Forming (ISF) of metal sheets with the FANUC robot using a spherical edge tool and the specific frame to hold the sheet. We measure torques and forces and sheet data.
- Controlling the robot and the optical box to solve the magic cube (Rubik's) by learning it and then by turning it to its requested positions/colors with the FANUC robot. This experiment allows us to demonstrate the speeds and different movements of the robot on one hand, and interesting mathematical and movement algorithms are tested concerning the magic cube's solution..



ISF experiment with the FANUC S-430iF robot

All equipment and control are modelled and realized via the VirCA (Virtual Collaboration Arena) software frame, a product of our institute to demonstrate 3D behavior and real and virtual activities at the same time.

Some future plans

- We plan to realize and test a recently submitted EU patent application (EU 11462004.0 – 2302 - DEVICE FOR TWO SIDED INCREMENTAL SHEET FORMING) and a new sheet holder frame adjustable to be able to work with different sheet sizes.
- We plan an optical robot control to recognize and find and move known objects with the FANUC robot.
- Serious industrial experiments are planned for assembly, disassembly, part sorting and perhaps for point and line welding as well. These experiments will be done together with industrial SME partners who eagerly wait for the first possibilities.

Keywords
Co-operating robots
Intelligent control
Incremental sheet forming
Rubic's (magic) cube

Ilmenau University of Technology

Faculty of Computer Science and Automation
Neuroinformatics and Cognitive Robotics Lab (NEUROB)

Home robot companion TWEETY (MetraLabs SCITOS G3) in interaction with elderly in their home environment

Location
Germany
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Research topics

The research of the lab aims at the development of behavior-oriented machine intelligence based on bio-inspired information processing and learning techniques. One main focus is the evolution and organization of navigation and interaction behaviors in actively learning multi-modal human-robot systems.

From methodological view, the following topics are of particular interest:

- Neural and probabilistic techniques for robot navigation and Human-Robot-Interaction (HRI)
- Real-time approaches to person detection, tracking and re-identification in real-world video- and laser data streams
- Non-verbal human-machine communication by gestures and facial expression
- Information-theoretic and reinforcement learning for problem decomposition, evolution and coordination of behaviors in cognitive systems.

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Application areas

- Interactive mobile assistance and guidance robots for public environments (Shopping centers, airports, museums, authorities, etc.)
- User-adaptive social robots for home assistance in context of demographic change
- Intelligent and adaptive video surveillance systems
- Actively learning and self-optimizing control for large-scale industrial combustion processes.

Left: Shopping robot TOOMAS (MetraLabs SCITOS A5) during a guidance tour in a home depot of the TOOM Baumarkt

Center: Companion robot CORA (MetraLabs SCITOS A5) during interaction in a home environment

Right: Home robot companion TWEETY (MetraLabs SCITOS G3)

Special equipment

- 5 mobile, interactive service robots (MetraLabs SCITOS A5) equipped with multimodal sensors (color and depth cameras, laser-scanner, sonar)
- 1 mobile, interactive companion robot for home assistance (MetraLabs SCITOS G3)
- 1 mobile interaction robot PERSES (B21)
- 1 outdoor robot MILVA
- 2 experimental robots HOROS (Pioneer II) equipped with multimodal sensors.

Keywords

Cognitive robotics
Assistive robotics
Service robotics
Human-robot interaction
Robot navigation
Robot companions

Reference Projects

FP7 EU-Project CompanionAble (2008-12)

- FP7 EU/BMBF-Project ALIAS (AdaptabLe AmbIent Living Assistant, 2010-13)
- BMBF-Project APFel (Analysis of person movements at airports, 2010-13)
- Research Group SERROGA (SERvice Robotics for Health Assistance, 2012-15).

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Industrial Research Institute for Automation and Measurements (PIAP)

Location
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Warsaw

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http://www.piap.pl/en

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Industrial Research Institute for Automation and Measurements PIAP based in Warsaw, Poland is a research and development institute. It was established in 1965 and since it has prepared and implemented new technologies including automation systems, specialist measuring equipment and robotic applications for various branches of industry.

Nearly fifty years of close cooperation with industry sector have brought a large number of designs and significant implementations. In that time PIAP specialists solved many complex technological challenges mainly in the subject intelligent systems of industrial automation and robotics, modern mechatronic systems, specialist measuring and inspection equipment, systems for visual inspection as well as they created applications for various communication technologies.

For over a decade PIAP is the only producer of high quality mobile robots and robotic devices for counter-terrorism use in Poland. In 2000, PIAP's first mobile robot INSPECTOR was delivered to the local Police forces. End users' positive opinions about the product and their precious advises encouraged PIAP's construction engineers to carry on investigations and implement further projects.

Next machines created in PIAP's laboratories were: EXPERT, PIAP SCOUT, TRM® and IBIS robots as well as EXPLORER device. This is a family of highly technologically advanced products, constructed especially for counter-terrorist missions in all environments and for a wide range of tasks. PIAP's robots are by far the most widely used in Polish services responsible for security and defense (Police, Army, Border Guard, Government Protection Bureau), but they are also proving very popular among international users. So far, they have been deployed to Iraq, Saudi Arabia, Germany, Switzerland, Lithuania and Belarus. As the terrorism threat is growing and development of advanced terroristic techniques increased the demand for equipment supporting special forces missions.

To meet these requirements, PIAP's engineers constantly work on new intelligent devices and accessories which assist military and police officers in various difficult missions. Quality of our designs is appreciated not only by customers, but was also noticed by scientific circles and different organizations from whom we received a number of awards. The most important ones from the previous years include: Poland Now Emblem (in the 12th edition of the competition), Polish Product of the Future, nomination to Economic Award of the President of the Republic of Poland and medals at International Poznań Fair or Innovation Fair in Brussels.

We participate in international programmes including framework programmes of European Union. One of our recent achievement was to successfully end in April 2012 the TALOS project which developed a versatile, efficient, flexible and cost effective system for border protection. PIAP was the coordinator of this international research project which objective was to develop and field test the innovative concept of a mobile, autonomous system for protecting European land borders. The project was co-funded from EU 7th Framework Programme funds in Security priority. PIAP also organize Science and Technology Conference AUTOMATION and co-organize International Fair of Automation and Measurements AUTOMATICON.

Keywords
Automation
Robotization
Visual inspection
Measuring and inspection equipment
Mobile robots
Security engineering

Institute for Systems and Computer Engineering - Technology and Science INESC TEC

Robotics and Intelligent Systems Unit

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INESC-TEC is one of the largest research laboratories in Portugal strongly connected to several Universities in the north of Portugal.
The activity of INESC-TEC is conducted by 600 researchers, from which 200 hold a PhD degree. Its funding comes in almost equal parts from direct R&D contracts with industry, international activity, and national research projects and programs.

Under INESC TEC, 12 Units are active in research, technology transfer, knowledge valorization and launching of spin-off companies.

To address traversal problems the Robotics and Intelligent Systems Unit (ROBIS) unit interacts closely with other INESC-TEC Units, namely Telecommunications and Multimedia, Manufacturing Systems, Industrial Management, Information and Computer Graphics Systems, and Artificial Intelligence.
INESC-TEC ROBIS is focused on the design and implementation of innovative solutions within the areas of land, water, aerial and industrial robotics and intelligent systems.

INESCTEC
TECNOLOGIA E CIÊNCIA
LABORATÓRIO ASSOCIADO
COORDENADO POR
INESCPORTO

ROBIS
ROBÓTICA E SISTEMAS INTELIGENTES

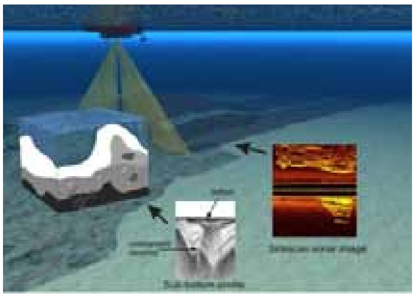
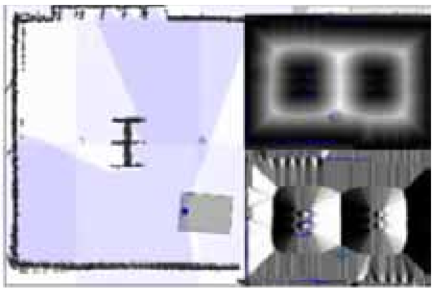
ROBIS 3 main strategic application scenarios include:

Security and defense
- Indoor and outdoor surveillance
- Search and rescue operations
- Border and harbor protection and minesweeping.

Environmental monitoring and mapping
- 3D precise mapping
- Underwater inspection
- Aquatic environment monitoring.

Industrial and service robotics
- Flexible manufacturing cells
- Automated logistics
- Easy programming.

To address these scenarios the **main research topics** are:
- Robot development
- Perception
- Navigation and control
- Cooperative robotics
- Human-robot cooperation
- Robotic manipulators
- New applications for automated guided vehicles
- Real-time artificial vision
- Environmental monitoring and mapping
- Adaptive sampling.


Keywords
Robot development
Perception
Navigation and control
Cooperative robotics
Human-robot cooperation
Robotic manipulators
New applications for automated guided vehicles
Real-time artificial vision
Environmental monitoring and mapping
Adaptive sampling

INESCTEC
TECNOLOGIA E CIÊNCIA
LABORATÓRIO ASSOCIADO
COORDENADO POR INESCPORTO

ROBIS
ROBÓTICA E SISTEMAS INTELIGENTES

Istanbul Technical University

Faculty of Computer and Informatics
Artificial Intelligence and Robotics Laboratory (AIR)

Location
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Istanbul

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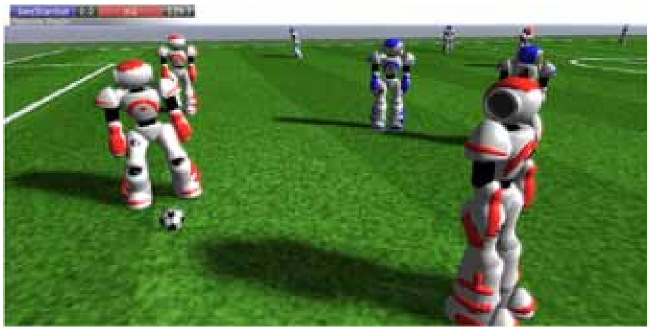
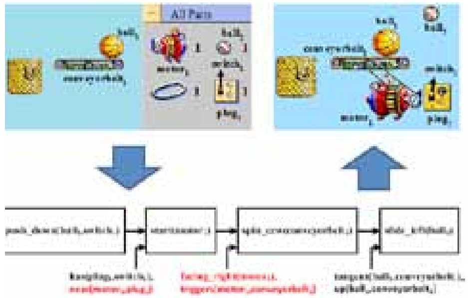
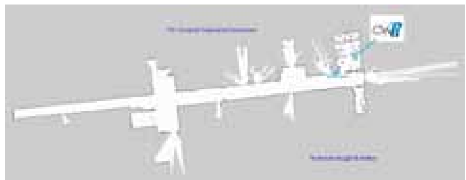
The main research focus of Artificial Intelligence and Robotics Laboratory (AIR Lab) is building intelligent systems by developing and applying artificial intelligence methods and algorithms since 2007. The laboratory is running several projects on intelligent robot/agent systems.

Three main research topics of AIR Lab
• Automated Reasoning and Planning for Autonomous Mobile Robots
• Learning in mobile robots and intelligent agents
• Cooperation in multirobot systems: beeStanbul RoboCup project.







In an ongoing project (funded by TUBITAK, the Scientific and Technological Research Council of Turkey), automated reasoning, planning and learning methods are investigated for autonomous mobile robots. A Pioneer 3DX robot with a 7-DOF arm is used as the experimental platform in the project. The robot interacts with objects by perceiving its environment with a Kinect sensor and acting by its arm. Advanced vision techniques have been used and developed for scene interpretation. The ultimate goal of the project is developing a fully autonomous mobile robot system that plans, handles failures and continually learns to better act on its environment.

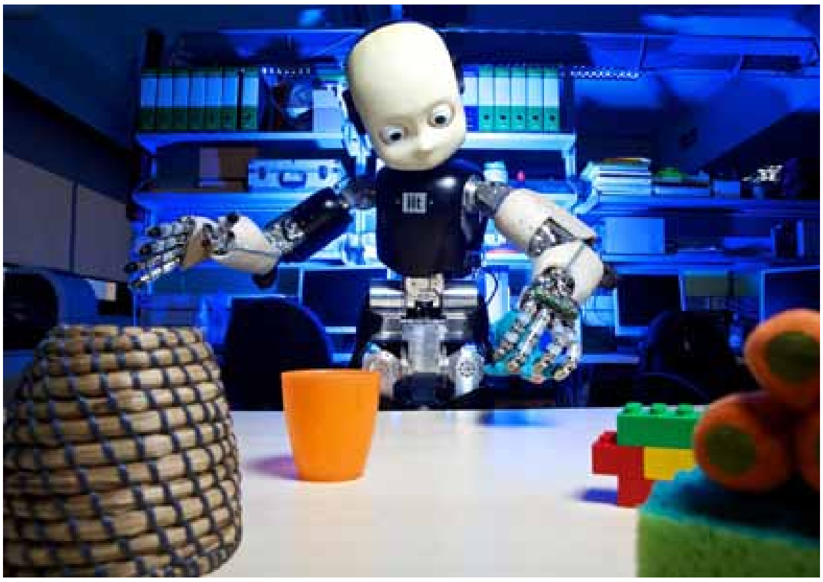
In another project, reasoning and learning methods are investigated for artificial agents. In particular, the focus is developing a method for learning interactions among different types of objects to devise new plans in the Incredible Machine Game environment. Learning is accomplished by observing a given sequence of events with their timestamps and using spatial information of the objects in the environment. A spatio-temporal learning approach is used which gives close results to that of a knowledge-based approach.

Earlier projects in the AIR lab were mainly on cooperative multirobot systems. The beeStanbul RoboCup project was initiated in 2009 to apply the experience, gained from earlier research on multirobot systems to competitive environments as well. RoboCup 3D Simulation League is one of the major leagues of RoboCup organization which is held by the RoboCup Federation. The league provides an environment for multiplayer soccer games of two competing teams of simulated autonomous humanoid agents. The beeStanbul project from AIR lab is the first initiative from Istanbul Technical University (ITU) to participate in RoboCup competitions. The main goal of the team is to contribute to the main objective of the RoboCup project by an efficient design of a software system to correctly model the behaviors of simulated Nao robots in a competitive environment. The designed software system serves as a basis to apply several reasoning, planning and learning methods.
The laboratory has advanced research facilities for both undergraduate and graduate studies. In general, several AI algorithms are being used and developed in AIR Lab to advance the robotics research.

Keywords
Cognitive robotics
Automated reasoning
Planning and learning for mobile robot systems
Multirobot systems

Istituto Italiano di Tecnologia (IIT)

Robotics, Brain and Cognitive Sciences



Location
Italy
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At the Department of Robotics, Brain and Cognitive Sciences of IIT, the central theme of the research activity is "Motor Cognition and Interaction" along three main streams:

1. Cognitive robotics with a focus on actions in close contact with humans
2. Human cognition with emphasis on manipulation related skills
3. Human-human and human-machine Interaction and Interfacing
4. These streams of research are characterized by an interdisciplinary, human-centric approach aimed at advancing knowledge in the area of artificial systems. This is addressed by performing targeted investigation of human motor and perceptual abilities and by implementing the abilities required to learn from experience and to interact naturally with humans in an autonomous humanoid robot (the iCub).

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RBCS research approach follows four guidelines:

1. Human-centric research addressing the level of complexity of the human being in understanding our (social) behavior and in advancing useful technologies. All the technological approaches are characterized by bio-compatibility and possibility of integration.
2. Sharing of science and engineering objectives by addressing topics of mutual interest to neuroscientist studying the human brain and body and engineers implementing artificial cognitive.
3. Studying robot actions in close contact and interaction with humans (including motor and sensory rehabilitation).
4. Focus on learning systems and development (not only action executing).

To pursue its interdisciplinary objectives RBCS research activity is organized around topics explicitly spanning across the three streams and is structured along the following main thrusts:

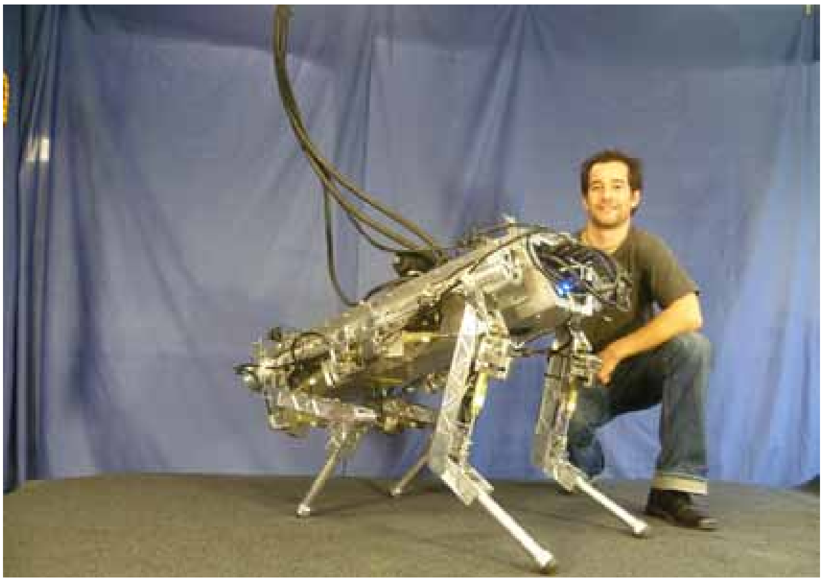
- Manual and postural actions: to study in humans and implement in the iCub the execution and understanding of goal-directed actions with specific reference to mono- and bi-manual exploration, manipulation and interaction. Reference sub-topics are: Computational motor control, variable compliance, sensorimotor learning, motor synergies and syntax, oculomotion and spatial attention, hand's design.
- Perception during action: to investigate how sensory information is exploited during actions to stress the unitary nature of perception and action in supporting each other during development, learning, motor execution and understanding. Reference sub-topics are: Perception of self and space, attention, perception of time, object's affordance, sensorimotor development, perceptual rehabilitation and sensory aids, computational principles and neuromorphic sensors technologies.

Keywords
Cognitive neuroscience
Humanoid robotics
Human-machine interaction
Neuro and motor rehabilitation
Brain-machine interface

ISTITUTO ITALIANO
DI TECNOLOGIA

Istituto Italiano di Tecnologia (IIT)

Advanced Robotics



Location
Italy
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The Italian Institute of Technology (IIT), based in Genova, is a Research Institute, founded in 2006, to deliver scientific excellence, technological innovation and advanced education in four key technological areas:

- Neuroscience
- Nanotechnology
- Drug discovery/development
- Robotics.

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Research activities in the Department of Advanced Robotics concentrate on an innovative, multidisciplinary approach to robotic design, cognition and control, and the development of novel robotic components and technologies.
The core philosophy is to merge the best engineering technologies and principles found in robots and mechatronics systems (speed, robustness, accuracy, and endurance) with biologically inspired traits (intelligence, adaptability, softness, safety, cognitive and physical flexibility and compliance).

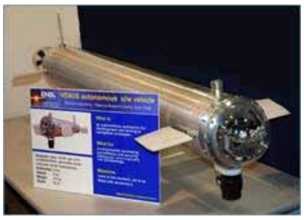
This synergetic combination will lead to advances in:
- Robotic mechanisms
- Materials and structures
- Actuation and energy/power systems
- Motion, locomotion and planning paradigms
- Interfaces and interaction technologies
- Advanced sensing and sensory systems
- Intelligence
- Control
- Learning.

Work within the Advanced Robotics Department is divided into five core areas:
- Humanoid Technologies, with a particular focus on compliant and VSA systems such as COMAN (Compliant huMANoid)
- Biomimetic technologies focusing on the Hydraulic Quadruped HyQ
- Biomedical technologies including rehabilitation and surgical robotics
- Learning technologies based around learning by imitation and reinforcement learning
- Haptic technologies covering dextrous manipulation, exoskeletons, and wearable haptics.

Keywords
Humanoids
Legged robots
Locomotion
Medical robots
Haptics
Learning systems

Italian National Agency for New Technologies, Energy and the Environment (ENEA)

Centro Ricerche Casaccia
Robotics Lab



Location
Italy
Rome

Website
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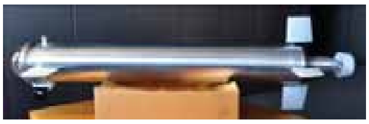
ENEA is the name for Italian National Agency for New Technologies, Energy and Sustainable Economic Development.

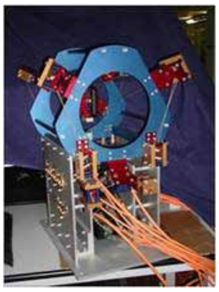
The Agency's main research issues are identified as follows:

- Energy efficiency
- Renewable energy sources
- Climate and the environment
- Safety and health
- New technologies
- Electric system research.

The Agency's multidisciplinary competences and great expertise in managing complex research projects are put at the disposal of the country system.

The Robotics Program...
...came to be created, over several years, in part as result of long-term projects and some for specific strategic choices.





The Group dedicated to robotics...
...derives from a previous group of "control systems" mainly aimed at human-machine interface. After the group has expanded and extended its activity first in environments hostile to the permanence of the man (space 1990, Antarctica 1992) and then applications to support national industry (technology transfer), concentrating to aspects of land and sea mobility and then extending these skills to the aspects of robot cooperation.

The current robotics guidelines on which the Laboratory is concentrating its activities include:

- Underwater robotics (marine technologies, navigation, enhanced controls)
- Robotics earth (navigation, enhanced controls)
- Environmental perception (sensor technology, data fusion)
- Multiagent robotic systems.

Keywords
Mobile robotics
Autonomous underwater vehicle (AUV)
Unmanned aerial vehicle (UAV)
Swarm
Swarm intelligence
Human-robot interface
Human-swarm interface
Teleoperation
Robotic surveillance

Jaume I University

School of Technology and Experimental Sciences
Department of Computer Science and Engineering
Robotic Intelligence Lab

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The Robotic Intelligence Laboratory at Universitat Jaume I (UJI) was established in 1991. Its mission is to conduct research in the science and applications of robotic intelligence, understood as embodied intelligence in robotic systems that behave in the real world.

Our original focus was on cognitive manipulation by means of sensorimotor coordination of robotic arms, hands and perceptual systems, such as our participation in projects FP7 EYESHOTS (Heterogeneous 3-D Perception Across Visual Fragments) and FP7 GRASP (Emergence of Cognitive Grasping through Emulation, Introspection, and Surprise).

Also, in the last years collective intelligence is also an interest, such as in FP6 GUARDIANS (Group of Unmanned Assistant Robots Deployed In Aggregative Navigation supported by Scent detection) in which we participated with a team of 8 mobile robots.

GENERALITAT VALENCIANA

UNIVERSITAT JAUME•I

We work on robotics science based on computational models inspired by neuroscience and psychology, supported by sound engineering principles, which result in successful application-oriented projects, with some of our perceptual manipulation systems having had a significant impact such as the UJI Librarian Robot, the UJI On-line Robot, the UJI Service Robot or, more recently, the UJI Humanoid Robot Torso. We are aware of the need of good experimental methods in robotics research, as well as performance evaluation and benchmarking of robotic systems; we have co-organized over 12 workshops on these topics in the major robotics conferences.
The RobIn Lab is a PROMETEO Research Group of Excellence funded by the Generalitat Valenciana, and a founding contractual member of EURON, the European Robotics Research Network since 2001. The lab is also well known in Europe for the organization of 12 consecutive summer schools: the International UJI Robotics School (IURS 2001-12) initially co-funded by EURON, as well as by award-winning authored books such as „Robot Physical Interaction through the combination of Vision, Tactile and Force Feedback“ or „Robust Motion Detection in Real-Life Scenarios“, both published by Springer in 2012.

The team has a long experience in many research areas such as:
- Spatial cognition and motion planning
- Active learning from perception and experience in manipulation and grasping
- Visuomotor coordination with robot hands and PTV heads
- Visually-guided grasping
- Task-oriented grasping and vision-force coordination
- Integrated architectures for vision-force-tactile control
- Tactile perception for manipulation
- Perceptual grounding
- Cognitive models for manipulation and vision for manipulation
- Benchmarks and performance evaluation in robotics
- Internet robotics
- User studies on human-robot interaction
- Robot vision for surveillance and human-robot interaction
- Neuroscience-inspired approaches to robot manipulation
- Active vision with robot heads
- Visual servoing
- Models in neuroscience and child development for advanced robotic architectures.

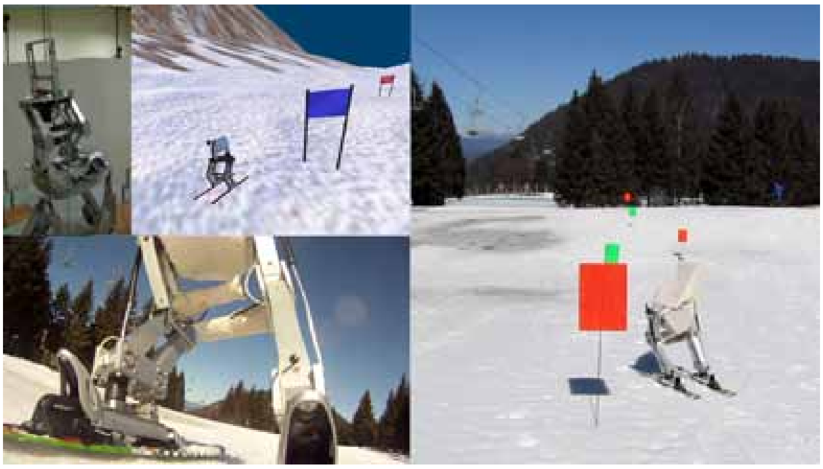
And more specifically in the following industry-oriented areas:
- Handling industry solutions based on advanced manipulation, machine vision, force control and haptic sensing
- Supervision and monitoring of large facilities by teams of mobile robots
- Installation of teleoperated robotic systems via internet
- Mobile robot teams for intervention in hostile environments
- Inventory and localization of books in libraries with robot teams
- Development of computer simulators for industrial and service robots
- Teams of humanoid robots for entertainment and educational activities.

Keywords
Manipulation with dexterous hands
Cooperation in autonomous mobile teams
Multisensor integration
Autonomous mental development
Humanoid robots
Robot PTV heads
Physical interaction
Robust motion detection
Service robots
Internet and on-line robots
Visual servoing
Robot vision
Human-robot interaction
Vision, force, tactile control
Benchmarks and performance evaluation
Neuroscience and robotics
Developmental robotics
Active learning

Robotic
Intelligence Lab

Jozef Stefan Institute

Department of Automation, Biocybernetics and Robotics



Skiing robot demonstrating low level reflexive stability control and navigation around gates using vision (robot on simulator and skiing around gates).

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Slovenia
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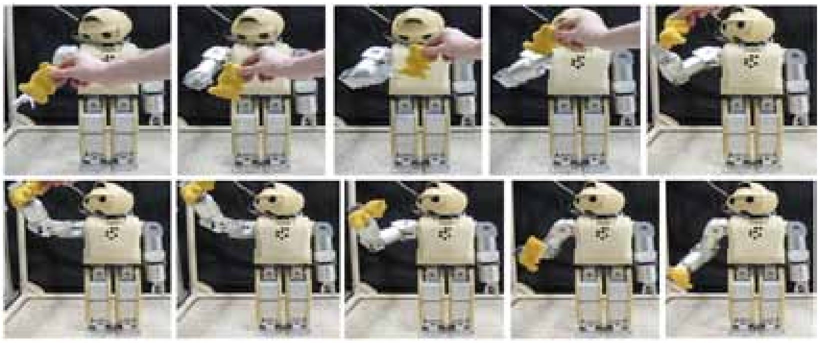
The Jožef Stefan Institute is the leading Slovenian scientific research institute, covering a broad spectrum of basic and applied research.
The subjects concern production and control technologies, communication and computer technologies, knowledge technologies, biotechnologies, new materials, environmental technologies, nanotechnologies, and nuclear engineering.

Department of Automation, Biocybernetics and Robotics is an interdisciplinary group of researchers specializing in electrical, mechanical and biomechanical engineering, computer sciences and applied mathematics with the research focus in the fields of automatics, robotics (including intelligent control, humanoids, cognitive robotics, and robot vision), biocybernetics, kinesiology, ergonomics and environmental physiology.

The common theme in all our research endeavours is optimizing „behavior of man and machine“, accounting for the interaction with the environment. By combining engineering sciences and life sciences, we have been able to make significant contributions to the development of new methods for sensorimotor learning by imitation and coaching, a planetary habitat simulation facility, humanoid vision systems, models of human body that serve as a basis for the design of anthropomorphic systems, etc.



HOAP-3 detects the object and keeps tracking it. Once the object stops moving, the robot can grasp it and move the arm back to its starting position.

The department has three groups with overlapping research foci: Automation and intelligent robot control, Humanoid and Cognitive Robotics, and Environmental physiology and ergonomics.

The research orientation within **Automation and intelligent robot control** is primarily in the development of advanced control strategies for robot systems working in unstructured environments, low level reflexive control, stability, bio-inspired control systems, robot motion synthesis through human sensorimotor learning, full-body optimal human motor control, cooperating robot systems and automation of industrial processes.

The main goal of **Laboratory of Humanoid and Cognitive Robotics (HCR)** is the development of robots intended for helping people in their natural environments, such as for example their homes. This requires the development of robotic systems, which can autonomously act in unstructured, human-centered environments. The research foci of HCR are: human motion capture and transfer onto robotic mechanisms, learning by imitation, robotic learning by autonomous exploration (reinforcement learning), humanoid robot vision, and classification and interpretation of human actions.

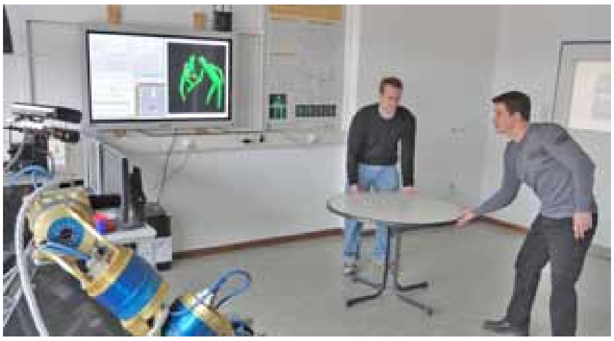
Keywords
Advanced robot control
Motion generation
Humanoid robotics
Cognitive robotics
Robot vision
Intelligent learning systems
Modelling and simulation of robot systems
Automation and industrial robotics

Automation
Biocybernetics
Robotics

Karlsruhe Institute of Technology (KIT)

Institute for Anthropomatics (IFA)
Humanoids and Intelligence Systems Lab (HIS)



Location
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The Humanoids and Intelligence Systems Lab explores machine learning, planning and perception for autonomous systems, with a focus on humanoid service robots, cognitive automobiles and computer-assisted surgery. Key areas of research are Programming by Demonstration (PbD) of autonomous service as well as industrial robots, situation awareness and probabilistic decision making for both service robots as well as automobiles and cognitive support for minimally invasive surgery.

Interactive Learning
In the research group “Interactive Learning” we focus our research on the representation and acquisition of knowledge enabling a robotic system to act autonomously in human-centered and industrial environments. Current activities include:
- Interactive robot programming with focus on autonomous manipulation planning and probabilistic decision making
- Interactive Scene Understanding and Object Modeling.

In our lab, multiple service robots with advanced manipulation and perception capabilities are available: Armar, Albert and Adero. Due to strong (cont.)

Karlsruhe Institute of Technology

(cont.) collaboration with the research center for information technology (FZI) in Karlsruhe the applicability of the developed methods to industrial robotics is shown using state-of-the-art robotic systems, e.g. KUKA LWA with Omnibot or Schunk Powerball Arms.

Programming by Demonstration

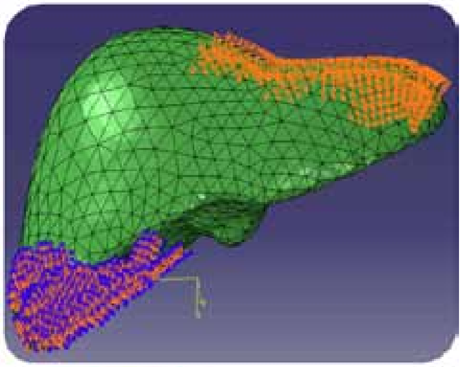
Service robots have to be flexible to operate autonomously in human centered environments with a large variety of tasks and objects as well as a restricted workspace. The basis are sophisticated models of the missions, tasks, scenes and objects, which enable the robot to decide the next action to take, plan a manipulation task in a goal-directed way and gather information about the environment using onboard-sensor systems. Manual definition is cost-intensive and requires expert knowledge. In Programming by Demonstration, we observe and interact with a human teacher to generate these models efficiently. We generate precise, textured 3D object models in an interactive process using a high-precision laser scanner in combination with a stereo camera system (available online: *http://i61p109.ira.uka.de/ObjectModelsWebUI*). In recent work, planning models for manipulation tasks are generated automatically using a dedicated sensor environment to observe forces, fingertip, hand and object motions during the demonstration of a manipulation task. The planning models form the basis to learn complex mission structures, represented as probabilistic decision making models, using onboard-sensors to observe and interact with multiple human teachers.

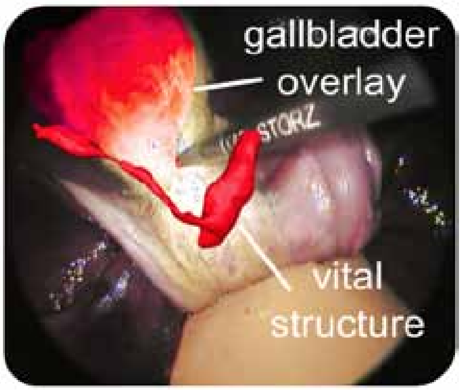
Computer-assisted Surgery

Minimally invasive surgery has gained significantly in importance over the last decade due to the numerous advantages on patient-side. The special operation technique reduces the operative trauma with the benefit of a faster recovery and a shortened hospitalization. It is a highly complex medical discipline with additional difficulties for the surgeon. The surgeon has to adapt special operation-techniques and deal with difficulties like the complex hand-eye coordination and restricted mobility. To alleviate these constraints, we propose to enhance the surgeon's capabilities by providing a context-aware assistance using augmented reality (AR) techniques. Clinical AR systems assist the surgeon by visualizing virtual objects in the surgical site. Most of the systems are used only for a short period of time because the visualization is restricted to planning data due to the lack of intraoperative sensor data about the current state of the intervention. In order to generate a context-aware assistance it is necessary to recognize the current state of the intervention using intraoperative sensor data and a model of the surgical intervention. According to this current state, a visualization is generated assisting the surgeon to perform the ongoing task, e.g. to warn the surgeon in a dangerous situation or to provide relevant planning information. The visualization of preoperative planning data requires an intraoperative soft-tissue registration. The intraoperative model is acquired by a 3D analysis of the endoscopic images and registered with the preoperative model of the intervention. Furthermore, a biomechanical model is used to compensate for soft-tissue deformations. The biomechanical model encapsulate a-priori knowledge about the mechanical properties of the tissue.

Keywords

Programming by demonstration
Interactive learning
Object modeling
Scene understanding
Probabilistic learning
Probabilistic situation awareness
Probabilistic decision making
Autonomous service robots
Humanoid robots
Flexible industrial robots
Cognitive automobiles
Minimally invasive surgery
Endoscopic image processing
Augmented reality
Biomechanical modeling
Situation interpretation
Context-aware visualization





Karlsruhe Institute of Technology

Lancaster University

InfoLab21
School of Computing and Communications
Intelligent Systems

Location
United Kingdom
Lancaster

Website
http://www.infolab21.lancs.ac.uk/research/intelligent_systems.php

Contact
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InfoLab21 is one of the largest and most significant ICT research establishments worldwide and holds Lancaster University's School of Computing and Communications.

Research is organized around 5 major themes:

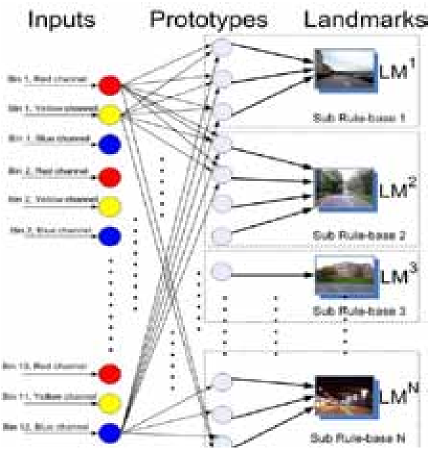
- Communications and networking
- Computer systems
- Intelligent systems
- Software engineering
- Human-computer interaction.

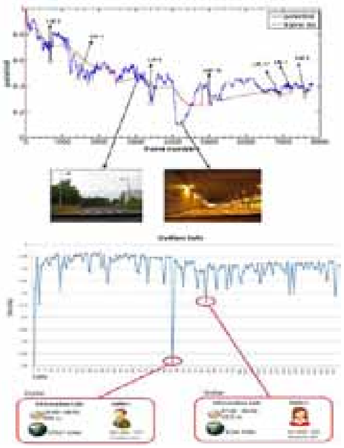
The Intelligent Systems Research Group was established based on the solid track record in the research, development and applications of computationally intelligent, adaptive, self-learning, and autonomous systems.

LANCASTER UNIVERSITY

School of Computing and Communications

Computational Intelligence, which includes (but is not limited to) fuzzy logic, artificial neural networks, evolutionary algorithms, machine learning, pattern recognition and advanced signal, image and video processing is nowadays one of the pillars of the modern computer science and is recognized by organ is at ions such as IEEE, IET, BCS, ACM.





Its pioneering research covers:

- Evolving intelligent systems
- Evolving self-learning classifiers
- Evolving fuzzy rule-based and neuro-fuzzy systems
- Recursive density estimation
- Anomaly and fault detection
- Self-calibrating intelligent sensors
- Density-based simplified fuzzy systems
- Autonomous video analytics
- Evolving clustering
- Self-learning controllers
- Activity and context recognition
- Evolving user behavior modelling
- Evolving social networks analysis
- Location and localization-related algorithms
- Statistical signal processing
- Bayesian methods
- Particle filters
- Markov Chain Monte Carlo methods
- Sensor data fusion and tracking
- Intelligent transportation systems.

Keywords
Evolving intelligent systems
Evolving fuzzy rule-based and neuro-fuzzy systems
Evolving self-learning classifiers
Recursive density estimation
Anomaly and fault detection
Self-calibrating intelligent sensors
Density-based simplified fuzzy systems
Autonomous video analytics
Evolving clustering
Self-learning controllers
Activity and context recognition
Evolving user behavior modelling
Evolving social networks analysis

InfoLab21

ENTELSENSYS LTD.

Lappeenranta University of Technology

Faculty of Technology
Laboratory of Intelligent Machines
Mechatronics Research Group

Location
Finland
Lappeenranta

Website
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The Laboratory of Intelligent Machines at Lappeenranta University of Technology (LUT) is one of the leading Finnish education and research institutes specializing in the design, simulation and control of mechatronic systems such as unmanned mobile working machines and heavy duty robots.

Modern machines include mechanics, electronics and information technology, which interact and create a coupled dynamic entity. The machines are either automated or operated by a person through a user interface.

The Laboratory of Intelligent Machines conducts research recognized at an international level on the design, simulation and control of such machines.

The laboratory has developed a key parallel robotic system for the assembly of ITER (International Thermonuclear Experimental Reactor) vacuum vessel and one of the most advanced fully interactive virtual environments for investigating HMI in mobile machinery.

Keywords
Heavy duty robots
Parallel robots
Haptics
Virtual environment
Simulators
Human-machine interface

Open your mind. LUT.
Lappeenranta University of Technology

Lund University

Faculty of Engineering (LTH) RobotLab for Productive Robotics

Location
Sweden
Lund

Website
http://www.robot.lth.se

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Research goals

- Create solutions that make robots productive also for smaller players in industry and development, based on scientific advancements in sensing, control, actuation, interaction, mechatronics and software architectures.
- Bridge the gap between service robotics and industrial robotics, by enhanced system integration techniques, by more generic sensor-based motion control, by adapting reasoning and knowledge representation to industrial contexts, and by novel combination of existing approaches in research and industry.
- Build generic semantic components within natural language processing, with focus on scalability for large corpora aiming at robots with maintained knowledge from millions of documents.
- Find new principles for how to efficiently build robots/systems with human-friendly interaction for defining robot tasks and the implied computing.
- Show how to organize open robot control systems, built around industrially available robots, and support experimental verification of these principles and well as open control for new applications.

Technical areas

Semantics is the study of meaning, and within computer science it is closely related to Artificial Intelligence (AI) and Natural Language Processing (NLP). We also apply semantic techniques in robotics and automation, to facilitate high-level interfacing and to better support human-robot interaction. Combining semantic technologies with solutions for industrial automation, into what can be called semantic systems, also connects to the area of feedback control. That wide spectrum of topics, ranging from mechatronics and control software to the semantic web technologies and natural language dialogs, forms the field of Robotics and Semantic Systems (RSS) at the department of Computer Science (*http://rss.cs.lth.se*).

Within the department of Automatic Control (*http://www.control.lth.se*) the algorithmic development and analysis of adaptive control schemes has a strong tradition. Recent theoretical research include passivity-based control, friction estimation and compensation, sensor fusion (in particular force and vision), motion planning for under-actuated manipulators and optimization of (real-time) trajectory generation for constrained motions.

The departments of Automatic Control and Computer Science host together the RobotLab that has unique experimental facilities concerning advanced control of industrial manipulators. The robots range from traditional serial robots extended with fast sensor interfaces, to the dual-arm robot FRIDA (ABB) for high-performance force-assisted assembly and safe workspace sharing, to a new family of parallel kinematic manipulators (so-called Gantry-Tau robots).

The research group was awarded the 1st prize of the EURON Technology Transfer Award in 2005, received the 3rd prize in 2008 and „the best automation paper" at ICRA 2012.

A variety of collaborations with other departments within Lund University is instrumental for the inter-disciplinary character of robotics research. The collaborations with other research institution and with industry are extensive.

Keywords
Industrial robots
Sensor fusion
Motion control
Mobile manipulation
Semantics
Knowledge representation
Embedded software
System integration principles

LUND UNIVERSITY

Marche Polytechnic University

Faculty of Engineering
Department of Industrial Engineering
Machine Mechanics Lab

Location
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Ancona

Website
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The research area of the Machine Mechanics lab is focused on design of machines and mechanical systems, robotics, mechatronics and multibody dynamics. The lab is also an active member of national and European research programs.
The Machine Mechanics lab is equipped with some industrial robots used to develop innovative and flexible technological operations, such as incremental forming and friction stir welding. By exploiting the new opportunities offered by artificial vision, visual servo controls have been developed in order to enhance the performance of robots in quality test operations, assembly tasks and Cartesian path following.
Main skills of the lab are kinematic and dynamic analysis and synthesis of mechanical systems, as well as design, prototypation and testing of automated machines. Such activities are supported by the use of multibody and FEM software for dynamic simulations and structural analysis and optimization. Two innovative lower mobility parallel kinematic machines, for pure translational and pure rotational motions respectively, have been designed and prototyped. The lab is also specialized in vehicle dynamics, handling and stability analysis and in the design of vehicle mechanical components.

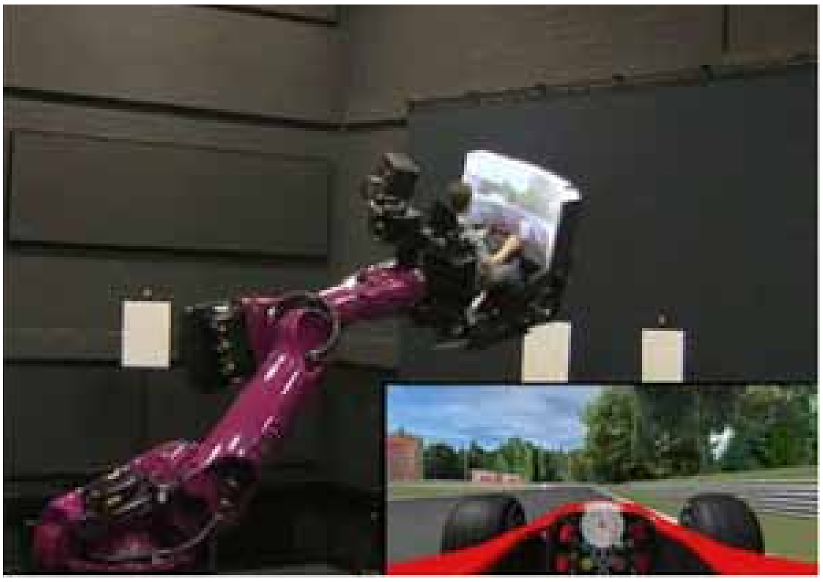
A recent research topic of the MM lab is the design of mini devices used for special applications such as the manipulation of small measurement or biomedical instruments. At present the lab is working on the design of a mini orientation platform integrated in a mini assembly cell which will be developed in cooperation with 3 other important research centres.
The use of novel software for the simulation of automatic production cells gives useful assessments for the process optimization and for the production planning.

Main topics are the design of the cell layout, the evaluation of production times, the study of the material flow between the cell components and the definition of the control laws to be deployed to the machines.
The research group develops its scientific activities in association with the following Italian Societies: „Italian Group of Mechanics for Machines and Mechanical Systems" (Gruppo italiano di Meccanica Applicata: GMA), „Italian Society of Robotics and Automation" (Associazione di Robotica ed Automazione, SIRI), „Italian Association of Theoretical and Applied Mechanics" (Associazione Italiana di Meccanica Teorica ed Applicata, AIMETA).
It is highlighted the participation in the European integrated project „Leadership for European Apparel Production From Research along Original Guidelines" (LEAPFROG) and in the Italian research projects PRIN2003 („Design and prototyping of application-oriented mini-PKM: miniPAR"), PRIN2005 („Mini-robotic devices for advanced technology applications) and PRIN2009 („MM&A Micro Manipulation and Assembly") funded by the Italian Ministry of Research and Education and by the participating universities.

Keywords
Parallel kinematics machines
Advanced industrial robotics
Minirobotics

Max Planck Institute for Biological Cybernetics

Department of Human Perception, Cognition and Action
Human Robot Interaction Group



The aim of the Human-Robot Interaction group is to study novel ways to interface humans with robots, i.e., autonomous machines that are able to sense the environment, reason about it, and take actions to perform some tasks.

These efforts are guided by the accepted vision that in the future humans and robots will seamlessly cooperate in shared or remote spaces, thus becoming an integral part of our daily life. For instance, robots are expected to relieve us from monotonous and physically demanding work in industrial settings, or help humans in dealing with complex/dangerous tasks, thus augmenting their capabilities.

Location
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MAX-PLANCK-GESELLSCHAFT

Max-Planck-Institut
für biologische Kybernetik

This research group tries to address these challenges from an engineering/ computer science point of view.
Our focus in mainly on (1.) how to empower robots with the needed autonomy in order to facilitate the interaction with the human side for accomplishing some shared task, and (2.) how to allow a human user to effectively be in control of a robot(s) while performing a task.

Main research areas

- Vestibular Channel (MPI CyberMotion Simulator)
- Human/multi-robot interaction (Swarm teleoperation)
- Self-Localization and navigation (Vision and RFIDs).

We rely on the tools of robotics, systems and control theory, computer vision, and psychophysics. A good example that illustrates our philosophy is probably given by the telepresence/telerobotics scenarios: exploit remote robot(s) as an extension, or even an augmentation, of the humans' senses and actions.

This roughly means that

- The robot(s) should be able to autonomously reason about their remote environment, i.e., to possess a significant level of autonomy in order to perform local tasks and take decisions
- The human user should be able to dispatch his/her actions to the remote site, and to receive a suitable sensory feedback for an appropriate (remote) situational awareness
- A flexible level of control/coupling between human user and robot(s) should be possible: from a tight direct control for, e.g., remote manipulation tasks, to a more abstract supervisory control for, e.g., remote navigation tasks.

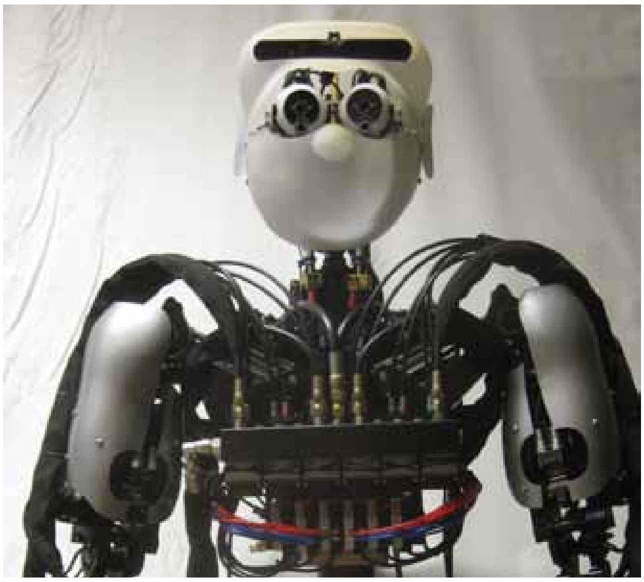
Keywords
Human-robot interaction
Aerial robotics
Multirobots

MAX-PLANCK-GESELLSCHAFT

Max-Planck-Institut
für biologische Kybernetik

Max Planck Institute for Intelligent Systems

Departments Autonomous Motion, Empirical Inference, Perceiving Systems



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Dr. Michael Black
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Autonomous Motion (Stefan Schaal)
The Autonomous Motion Department has its focus on research in intelligent systems that can move, perceive, and learn from experiences. We are interested in understanding, how autonomous movement systems can bootstrap themselves into competent behavior by starting from a relatively simple set of algorithms and pre-structuring, and then learning from interacting with the environment.

Research areas
Using instructions from a teacher to get started can add useful prior information. Performing trial and error learning to improve movement skills and perceptual skills is another domain of our research. We are interested in investigating such perception-action-learning loops in biological systems and robotic systems, which can range in scale from nano systems (cells, nanorobots) to macro systems (humans, and humanoid robots).

MAX-PLANCK-GESELLSCHAFT

Empirical Inference (Bernhard Schölkopf)

New learning processes are developed in the "Empirical Inference" department which can detect structures in experimental data. These include, for example, algorithms for pattern recognition, regression, density estimates, novelty detection and feature selection.

Research areas

- Statistical learning theory
- Causal and probabilistic inference
- Vision and image processing
- Pattern recognition
- Robot learning
- Machine learning in neuroscience
- Bioinformatics.

Keywords
Autonomous motion
Machine learning
Machine seeing

Perceiving Systems (Michael J. Black)

We seek mathematical and computational models that formalize the principles of perception. We combine insights from neuroscience with statistical models, machine learning, and computer graphics to derive new computer vision algorithms that, one day, may enable computers to understand the visual world of surfaces, materials, light and movement.

Research areas

- Robust estimation of optical flow
- Motion estimation over long sequences
- Layered models of motion
- Segmentation of scenes in motion
- Detection of occlusion and disocclusion
- Inference of structure and material
- Data sets for quantitative evaluation of optical flow
- Learning models of image motion
- Biological models of motion perception.

MAX-PLANCK-GESELLSCHAFT

Middle East Technical University

Faculty of Engineering
Department of Computer Engineering
KOVAN Research Lab

Location
Turkey
Ankara

Website
http://kovan.ceng.metu.edu.tr

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Assoc. Prof. Erol Sahin
erol@metu.edu.tr

KOVAN Research Lab. is a center for state-of-the- art autonomous robotics research under Department of Computer Engineering, Middle East Technical University (METU).

Three tracks of research are active:
- Cognitive robotics
- Swarm robotics
- Computer vision.

Our research on cognitive robotics was funded through FP6 and FP7 projects as well as national projects. Our work on this track focused on using machine learning methods in robots. In recognition of our studies, we were given a free 53-DOF iCub humanoid platform to carry out our research.

kovan researchlab

METU

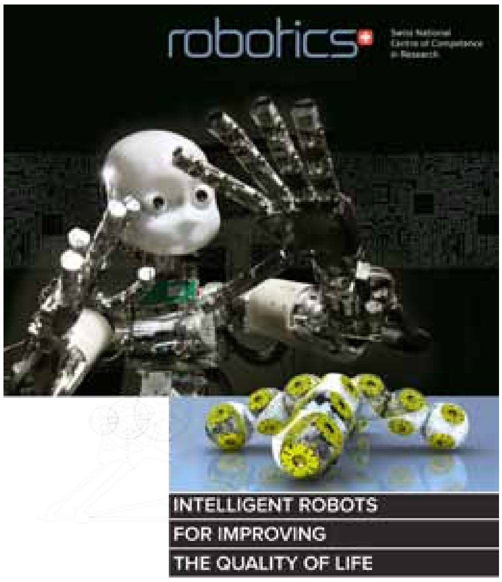
Our research on swarm robotics focused on the development and implementation of distributed and scalable coordination algorithms, such as self-organized flocking, for mobile robots.
Recently we have also started to work with mini unmanned aerial vehicles to develop similar coordination strategies.

In Vision track, we are actively participating in projects that develop artificial vision systems that can adapt to the environment to improve perceptual capabilities.

Keywords
Cognitive robotics
Service robotics
Affordances
Planning
Swarm robotics
Mobile robotics
Robot vision
Cognitive vision

National Centre of Competence in Research (NCCR)

NCCR Robotics



Location
Switzerland
Lausanne

Website
http://www.nccr-robotics.ch

Contact
Thomas Estier
thomas.estier@epfl.ch

NCCR Robotics is a nation-wide centre launched by the Swiss National Science Foundation. This centre gathers internationally renowned leading experts from 26 research groups from cutting-edge Swiss research institutions. We envision robots merging with humans, homes, and environment into an ecosystem aimed at improving the quality of life.

We focus our research on:

1. **Wearable robotics for assistance, rehabilitation, and training.** We aim at developing the next generation of exoskeletons, which will be soft, modular and lightweight robots capable of adapting and interfacing to a variety of users.
2. **Active environment for improved safety and comfort.** We aim at developing an ecosystem of mobile robots and robotic furniture capable of cooperation and communication to support a variety of user's needs.
3. **Rescue Robotics for monitoring and catastrophe mitigation.** We aim at developing an ecosystem of heterogeneous robots with extreme agility on the ground and in the air and capable of interacting with human users.

robotics Swiss National Centre of Competence in Research

FNSNF SWISS NATIONAL SCIENCE FOUNDATION

The uniqueness of our approach resides in four principles and technologies that all proposed solutions share: Adaptation and learning > Physical and neural interfaces > Softness and growth > Modular, reconfigurable, and swarming.

ASSESSMENT OF YOUR NEEDS
1

Our Tech Transfer Officer will meet you to understand your objectives, challenges and constraints. He will also present and outline the competences within the NCCR Robotics that match your activities.
This meeting, which is absolutely free of charge, will take place in your company and would take between 2 to 3 hours.

LAB VISITS & ROUND TABLE
2

We will then carefully identify the right labs within the NCCR Robotics that have the right competences to match your needs and organize one or more lab tours for your company. A meeting will follow the visits to draft together with senior researchers the actual opportunities of collaboration.
The lab tours and the meeting take usually half a day and are again free of charge.

COLLABORATION PROJECTS
3

Depending on your needs, we offer a framework of complementary collaboration tools:

Pioneer project
Pioneer projects are small collaborative projects that last typically 3 to 6 months and involve one senior researcher. Depending on the needs and on the timing, one or more master students can join these projects.
There are two distinct goals for a Pioneer Project: either offering a solution to your current specific challenge or paving the road of longer term collaboration by assessing potential solutions and offering a proof of concept for the most promising one.
The cost of such a project is typically CHF 20k to 50 k and can include an option right for a future license in a specific domain of application.

NCCR ROBOTICS

OUR AREAS OF ROBOTICS	OUR CORE COMPETENCES
• NANOROBOTICS	• SENSING & ACTUATION
• PROSTHETIC ROBOTICS	• IMAGE PROCESSING
• ASSISTIVE DEVICES	• MACHINE LEARNING AND CONTROL
• ROBOTIC LOCOMOTION	• NAVIGATION
• ROBOTIC MANIPULATION	• HAPTICS
• FLYING ROBOTS	• BRAIN-COMPUTER INTERFACES
• HUMAN-CENTERED ROBOTICS	• HUMAN-MACHINE INTERACTION
• BIOMIMETIC ROBOTICS	• DISTRIBUTED SYSTEMS
• SWARM ROBOTICS	
• SOCIAL ROBOTICS	
• SOFT ROBOTICS	

Your benefits

- A "one stop-shop" to collaborate with the leading laboratories in human centered robotics
- Access to cutting edge prototyping facilities
- Access to government funding for collaborative research (CTI projects & NCCR Tech Transfer Projects)
- Access to skilled future collaborators with strong expertise in human centered robotics.

Keywords
Nanorobotics
Prosthetic robotics
Assistive devices
Robotic locomotion
Robotic manipulation
Flying robots
Human-centered robotics
Biomimetic robotics
Swarm robotics
Social robotics
Soft robotics
Sensing and actuation
Image processing
Machine learning and control
Navigation
Haptics
Brain-computer interfaces
Human-machine interaction
Distributed systems

EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
ETH Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zurich
Universität Zürich
USI SUPSI IDSIA Istituto Dalle Molle di studi sull'intelligenza artificiale

National Technical University of Athens

School of Mechanical Engineering
Control Systems Laboratory

Location
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http://site.csl.mech.ntua.gr

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Research in Control Systems Lab mainly focuses on robotics, control and mechatronics problems lying in the exciting intersection of mechanical / aerospace, electrical and computer engineering fields. In order to realistically address those types of problems we, mostly but not exclusively, adopt control theoretic concepts and utilize or develop analytic approaches coming from both the continuous and discrete domains. More specifically our current research interests are in the area of nonlinear control and real time embedded control systems in sensor based motion planning and control of multi-agent robotic systems: Manipulators and vehicles (mobile, underwater and aerial).
Although robotics and autonomous systems are the main applications domains, further interests include:

- Air traffic management
- Production inspection and automation.

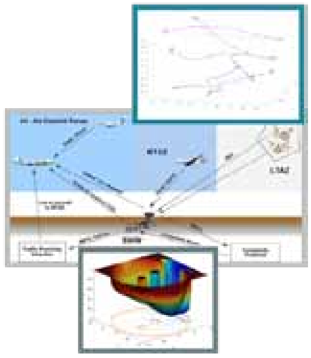
Our research directions, outlined above, have been and are currently sponsored by a number of national and international sources, mostly in the form of collaborative projects. So far, we have been granted 29 research contracts adding up to 3.0 M€.

The **Neurorobotics** group focuses on teleoperation, manipulation and control with anthropomorphic robotic arm hand systems. The motion and the myoelectric activations (sEMG) of the human arm and hand are captured, through the use of appropriate equipment, and are used in order to design both bio-inspired and biomimetic control laws. Semi-autonomous (EMG-based) and autonomous grasping and manipulation, are current research directions.

The **Aerial robotics** group focuses on control of UAV's (e.g. single or multiple RC helicopters) for surveillance reasons. Aerial vehicles operate in complex and uncertain environments under external disturbances (wind, air density and currents). Thus, the development of feedback control schemes is required for efficient and reliable performance in real-time applications.

The **Mobile robotics** group, focuses on endowing a moving mobile robot with the capability of distinguishing between static background and dynamic foreground without the need for accurate localization, of tracking either walking people, or other moving objects, as well as to develop methods augmenting the overall environmental perception through cooperation between multiple robots.

Multi-agent systems group focuses on navigation and collision avoidance algorithms, with air traffic control as a key application. We develop algorithms that can offer guaranteed performance and ensure flight safety in a future ATC environment. So far, navigation functions have been adapted for the decentralized control of non-holonomic agents in 3D space, while a combination with Model Predictive Control (MPC) has been developed in order to account for the limited actuation capacity and the constraints imposed on a real aircraft.



Underwater robotics group focuses on navigation and control of semi-autonomous ROV (Remotely Operated Vehicle) and AUV (Autonomous Underwater Vehicle). Underwater vehicles operate in complex and uncertain environments partially due to the highly nonlinear hydrodynamics and external disturbances (waves, currents and cable effects). Thus, the development of feedback control schemes, accompanied with online estimation algorithms of the dynamic environment is required for efficient and reliable performance in real-time applications. Real world applications involve ship hull inspection, water-jet cleaning, seabed mapping, navigation in an unknown environment and underwater manipulation.

Keywords
Multi-agent systems
Neuro-robotics
Underwater robotics
Aerial robotics
Mobile robotics

Örebro University

Centre for Applied Autonomous Sensor Systems (AASS)

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Website
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Contact
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AASS - Intelligent robots for industry, environment and society

The Center for Applied Autonomous Sensor Systems (AASS) was founded in 1996 and since then it successfully represents the technology dimension of the strategic-research profile of Örebro University, Örebro, Sweden. AASS today employs 21 researchers and 27 PhD students with a wide range of complementary competencies in robotics and artificial intelligence. AASS is the national leader in field robotics and robotics for the elderly. It is internationally recognized for its research in mobile robot olfaction and has a well-established presence in Europe where we currently are a partner in ten European projects.

80% of AASS research is externally funded by the European Commission and major Swedish funding bodies such as The Swedish Research Council, The Knowledge Foundation, as well as private Swedish companies and public authorities. We are founding members of Robotdalen – a 10-year and 20 million euro innovation effort in robotics funded by the Swedish innovation agency VINNOVA.

ÖREBRO
UNIVERSITET

We perform multidisciplinary research on autonomous systems with a focus on their perceptual (e.g., 3D perception in unconstrained dynamic environments, olfactory perception) and cognitive capabilities (e.g., knowledge representation and reasoning) and their integration. The study of these two central scientific issues provides the scientific basis for the development and application of real autonomous systems. Our main application areas are field robotics, robotic technologies for the elderly and environmental monitoring.

Current projects that best illustrate our work are (for more detail see *www.oru.se/aass*):

Field robotics. Together with major industrial companies (Atlas Copco, Volvo CE, Kollmorgen, and Linde Material Handling) and end users such as Stora Enso and NCC Roads we develop autonomous functionalities for forklift trucks, wheel loaders and mining LHD trucks.

Rich 3D perception. We develop algorithms to create and maintain consistent world models from 3D data augmented with additional information (e.g., color, reflectivity, temperature, semantic information, etc.). In particular, we address compact representations, scan registration, change detection and loop closing. Applications include unloading of containers (together with Berthold Vollers GmbH and Qubiqa A/S) and perception for safe navigation in field robotics.

Olfactory perception. We study open gas-sampling principles and techniques. Combining this type of artificial olfaction and mobile robotics, we are developing the foundations for mobile-robot olfaction and apply it to environmental inspection and monitoring. Application domains include gas sensor networks and mobile robots for surveillance of landfill sites, monitoring of air pollution and gas leak detection and localization. We also study the principles of cognitive electronic olfaction via the fusion of numerical data and symbolic knowledge and its uses in the recognition of environmental pollutants, smart homes and medical applications (e.g., bacteria recognition).

Keywords
3D robot vision
Mapping, localization and safe navigation
Planning and scheduling
Mobile and cognitive olfaction
Autonomous professional vehicles
Robotics for independent living
Environmental inspection/monitoring

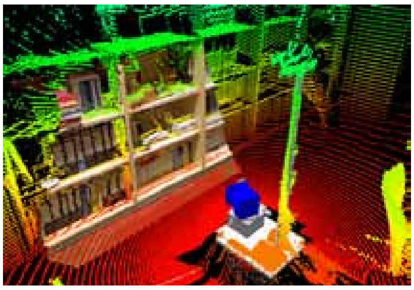
Robotic technologies for the elderly. We study the use of robotic technologies to address the needs of the ageing population and to provide it with increased independence and quality of life. We participate in the EU projects Robot-Era (*www.robot-era.eu*), Giraff-Plus (*www.giraffplus.eu*), and AAL ExCITE (*www.excite-project.eu*). These projects all involve the close cooperation of academia, industry, public bodies and end users. The last two projects are coordinated by AASS.

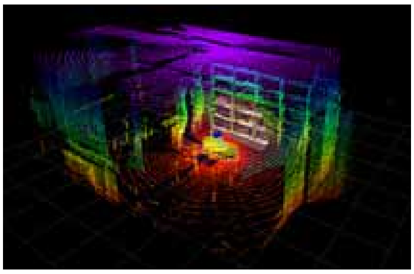
Cognitive robotics. We are one of the world leading groups in the use of artificial intelligence techniques in robotics. We focus in particular on the study of planning, knowledge representation and symbol grounding applied to robotics. We explore these techniques both on isolated robot systems, as in the EU projects GeRT (*www.gert-project.eu*) and RACE (*www.project-race.eu*); and on robots embedded in a smart environment, as in the EU project RUBICON (*www.fp7rubicon.eu*).

ÖREBRO UNIVERSITET

Osnabrück University

Institute of Computer Science
Knowledge-Based Systems Research Group





Location
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Website
http://www.inf.uos.de/kbs

Contact
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Research of the Knowledge-Based Systems (KBS) group focuses on methods and algorithms for controlling embedded agents to acquire, reason in, and maintain symbolic knowledge about the world to achieve purposeful and goal-directed behavior in the current context, and do so by computation on-line and on-board the agents. We call Embedded Knowledge-Based Systems (EKBSs) the resulting control systems. Autonomous robots are typical agents considered here, but pure software agents are of interest, too. At least some of the respective knowledge must be symbolic in order to be inspectable and communicable. Regarding environment sensing, the focus is on 3D sensor data, such as point clouds, and on methods and algorithms for efficient handling and semantic interpretation.

We consider applications of the group's research topics in various areas. Service robots are an obvious choice. In addition, we are transferring our robotics-motivated results into more mundane application settings, such as machines in agriculture and logistics, and handling 3D data in production.

UNIVERSITÄT OSNABRÜCK

RACE - Robustness by Autonomous Competence Enhancement (2011-2014)
The overall aim of this project is to develop an artificial cognitive system, embodied by a service robot, able to build a high-level understanding of the world it acts in by storing and exploiting appropriate memories of its experiences. Experiences will be recorded internally at multiple levels: high-level descriptions in terms of goals, tasks and behaviors as well as constituting sub-tasks, and finally sensory and actuator skills at the lowest level. In this way, experiences provide a detailed account of how the robot has achieved past goals or how it has failed, and what sensory events have accompanied the activities.
Funding: EU, FP7-ICT, Cognitive Systems and Robotics
http://project-race.eu

MERMAID - Methods for Map-Based Reasoning (2010-2012)
The goal of the project is to experimentally transfer on-line sensor data interpretation and embedded knowledge-based systems methods to problems of ambient intelligence, smart environments and context awareness.
Funding: BMBF (German Federal Ministry of Research)
http://www.inf.uos.de/kbs/mermaid.html

LISA - An autonomous mobile robot as assistant system in a life-science environment (2006-2009)
The project goal was to develop a mobile assistance robot for every-day use in life-science enterprise labs for interacting with lab staff and executing mundane transport and mounting tasks autonomously. To be acceptable for human staff members, a robot assistant sharing the work space with the humans and interacting with them needs flexible reaction, intuitive communication, and operational safety. These aspects were central to the research in the project.
Funding: BMBF (German Federal Ministry of Research)
http://www.lisa-roboter.de

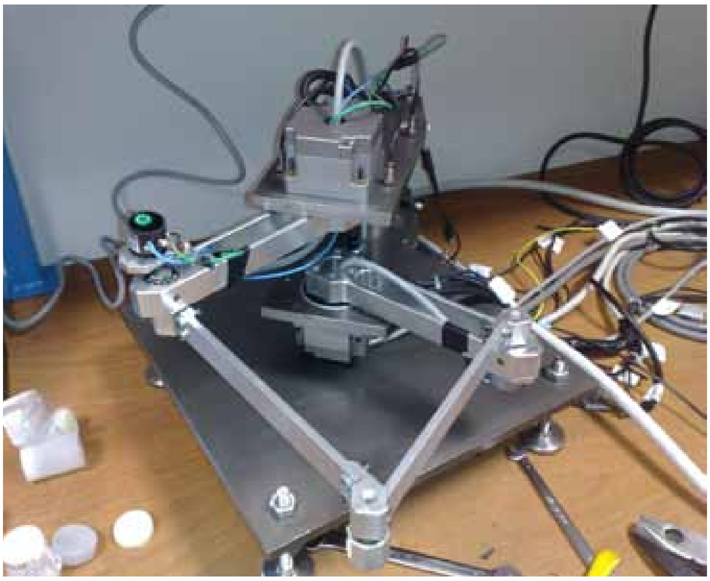
MACS - An autonomous mobile robot exploiting the concept of affordances for interacting with objects in dynamic environments (2004-2007)
The main objective of the MACS project was to explore and exploit the concept of affordances for the design and implementation of autonomous mobile robots acting goal-directedly in a dynamic environment. The claim was to develop affordance-based control as a method for robotics. Technically speaking, a prototypical affordance-based architecture has been developed and implemented on a mobile robot, KURT3D. For providing simple manipulation capabilities, KURT3D was equipped with a magnetic gripper crane arm.
Funding: EU: FP6-IST, Cognitive Systems and Robotics
http://www.macs-eu.org

The KBS group is closely connected with the Osnabrück branch of DFKI's Bremen-based Robotics Innovation Center (RIC). Its research topic is plan-based robot control. It is headed by Joachim Hertzberg, too.

Keywords
Artificial intelligence
Embedded knowledge-based systems
Cyber-physical systems
Cognitive technical systems
Autonomous mobile robots
Sensor data interpretation
Semantic mapping
Action planning
Plan-based robot control

Politecnico di Milano

Robotics@POLIMI



Location
Italy
Milan

Website
http://robotics.polimi.it

Robotics is one of the core research lines @POLIMI since 1972, when the Politecnico di Milano Artificial Intelligence and Robotics Lab (PM-AIR Lab) was established.

Since then, the multi-disciplinary activity in robotics has been developed @Polimi in different Departments giving birth to several focused labs.

Robotics@POLIMI is a joint initiative aimed at creating synergies among those laboratories, and to provide a common access point to the Robotics research at Politecnico di Milano.

Contact AIRLab
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Andrea Bonarini
bonarini@elet.polimi.it

Artificial Intelligence and Robotics Laboratory (AIRLab)

- Autonomous robots
- Bio-inspired robots
- Edutainment robotics
- Mobile robots and intelligent vehicles
- Robotic perception and computer vision
- Robotic rehabilitation.

POLITECNICO
DI MILANO

Mechatronics and Robotics Laboratory for Innovation (MERLIN)

- Industrial Robotics Mechatronics
- Mobile Robots and Intelligent Vehicles.

The Virtual Prototyping Lab (VPLab)

One of the laboratories of the KAEMaRT Group (Knowledge Aided Engineering, Manufacturing and Related Technologies)

- Haptics.

Mechatronics and Smart Structures Lab (M&SSLab)

The Mechatronics and Smart Structures Lab (M&SSLab) focuses on mechatronics applications ranging from domestic to industrial robotics. Particular emphasis is given to the integrated design of smart systems that couple micro-sensors, energy harvesting devices, miniaturized actuators and innovative control architectures. Thus, the approach needs to be multidisciplinary: combining a thorough understanding of the system, a deep knowledge of edge-cutting sensor and actuator technologies and a comprehensive experience of state-of-the-art control algorithms allows to design ground breaking devices and systems. For what concerns robotics, high precision redundant architectures (closed loop parallel kinematic chains as well as cooperating robots) have been analyzed, designed and tested together with „soft" systems, combining active, adaptive, self-optimizing, portable plug-and-produce components with advanced sensing and actuating functionalities, in which the deformability of both joints and links is used for improving HRI (human-robot interaction) at the cost of more complex control algorithms for compensating vibrations and positioning errors. Autonomous navigation of robotic platforms using both commercial and newly designed sensors with intelligent fail-safe algorithms as well as vision based system for human-robot cooperation in industrial environments are also core research topics at M&SSlab.

Neuroengineering and Medical Robotics Laboratory (NearLab)

NearLab is part of the Bioengineering Department of Politecnico di Milano and includes two sections, NeuroEngineering Section (NES) and the Medical Robotics Section (MRS). The NeuroEngineering Section aims at developing biomimetic neuroprostheses, bioartificial interfaces, motor control modelling. The Medical Robotics Section is mainly devoted to biomechanics and computer assisted and robotic surgery.

- Robotic rehabilitation
- Surgical robots.

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Keywords
Autonomous robots
Bio-inspired robots
Edutainment robotics
Industrial robotics
Mechatronics
Mobile robots
Intelligent vehicles
Robotic perception
Computer vision
Robotic rehabilitation
Surgical robots
Haptics

POLITECNICO
DI MILANO

Politecnico di Torino

Department of Control and Computer Engineering (DAUIN)
Robotics Research Group

Location
Italy
Torino

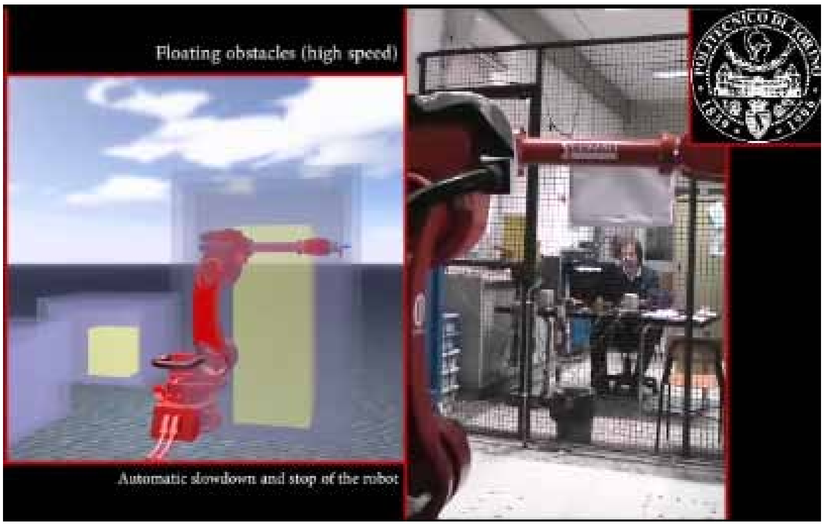
Website
www.polito.it/labrob

Contact
Prof. Basilio Bona
basilio.bona@polito.it

Prof. Marina Indri
marina.indri@polito.it

Main research areas
- Industrial robotics
- Mobile robotics.

Mobile robotics
- Autonomous navigation and planning
- Cooperative robotics
- Multi-robot localization
- Active SLAM and exploration
- Visual SLAM
- Cooperative mapping
- Planetary rover navigation
- ROS based applications
- Logistic applications.



Industrial Robotics

- Motion planning, inverse kinematics and collision avoidance for industrial manipulators
- Virtual robotic cells for motion planning and monitoring
- Real-time controller design for robotics applications
- Friction modeling and compensation
- Vision for industrial control
- Dynamic parameters identification
- Force and impact control of robotic arms
- HW/SW Architectures for rapid prototyping of digital controllers.

Keywords
Mobile robotics
Industrial robotics
Mechatronics
Intelligent vehicles
Robotic perception
Computer vision

POLITECNICO
DI TORINO

Polytechnic Institute of Castelo Branco

School of Technology
Electrotechnical and Industrial Engineering Scientific Unit
Robotics and Intelligent Equipment Laboratory

Location
Portugal
Castelo Branco

Website
http://www.est.ipcb.pt/laboratorios/robotica

Contact
Prof. Paulo Gonçalves
paulo.goncalves@ipcb.pt

The Robotics and Intelligent Equipment Lab (LREI@IPCB) focus on research for industrial and service robots, oriented to solve real world problems for industry and society.

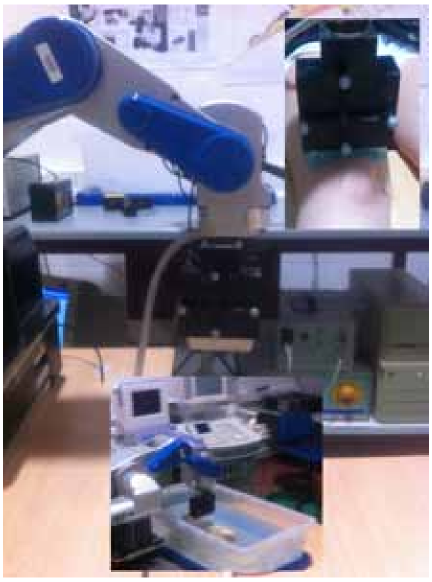
Manipulators and mobile robots are/were used in active and past projects, and also in our educational programs on robotics, vision and computational Intelligence. Our research is also oriented to technological innovations and equipment development.

The LREI@IPCB offers a wide range of courses at undergraduate level and also for industry professionals, in the fields of automation, control, robotics and acoustics.

Instituto Politécnico de Castelo Branco
Escola Superior de Tecnologia

Main activities

- Automatic control
- Computational intelligence
- Computer vision and image processing
- Industrial automation
- Robotics, manipulation and mobile (indoor).



LREI@IPCB is currently involved in interdisciplinary research projects (FP7 and Portuguese Science Foundation funded) focused in actual demands of the industry and society, including:

- Surgical robotics, applied to orthopedic surgery, mainly in the development on precise navigation systems for robots, based in ultrasound images of bones.
- Development of robot companions for the elderly, capable to interact and monitor life patterns.
- A special research activity is to build easy to deploy intelligent robots, into peoples homes. Smart robots capable to rapidly recognize the environment, navigate, and perform tasks.
- Mobile robot competitions, for indoor autonomous driving, at national level with increasing success.
- Construction, visualization and analysis of 3D object models, for real-time industrial and medical applications.

Keywords
Industrial robotics
Surgical robotics
Robot companions
Automatic visual inspection
Medical imaging

Instituto Politécnico de Castelo Branco
Escola Superior de Tecnologia

Polytechnic University of Catalonia / Spanish Council for Scientific Research

Institut de Robòtica i Informàtica Industrial

Location
Spain
Barcelona

Website
http://www.iri.upc.edu

Contact
Prof. Alberto Sanfeliu
sanfeliu@iri.upc.edu

The Institut de Robòtica i Informàtica Industrial is a joint research center of the Polytechnic University of Catalonia (UPC) and the Spanish Council for Scientific Research (CSIC). It was created in November 1995 and its current premises are located in the Faculty of Mathematics and Statistics building in the South Campus of UPC in Barcelona.

The Institute promotes fundamental research in robotics and applied informatics, cooperates with the community in industrial technological projects, and offers scientific education through graduate courses.

The Institute presence in European research is strong, producing significant contributions in human oriented robotics. At the national level, currently performs basic and applied research on outdoor mobile robotics and computer vision, position analysis and motion planning, fuel cell systems and management of water distribution networks.

UNIVERSITAT POLITÈCNICA
DE CATALUNYA
BARCELONATECH

IRI's research activities are funded primarily by grants from the EU FP7 Research Program and by competitive funds from the Spanish Ministry of Economy and Competitiveness through the DPI program. Other sources that support our research include projects funded by the Government of Catalonia, by our hosting institutions (CSIC and UPC), and through technology transfer contracts.
The Institute's research activities are organized in four research lines. Three of them tackle various aspects of robotics research, including indoor and outdoor human-centered human-safe robotics systems, and the design and construction of novel parallel mechanisms. Efforts in the fourth line are aimed at research on energy efficiency, in fuel cells research, and on the management of energy systems.

Our activity finds applications in several fields through collaboration with our technological partners, including from instance, computer vision and robotics solutions to everyday problems, and energy routing for the electric industry.
Moreover, the Institute has several technological facilities that offer their services to the surrounding industrial community.

The Institute hosts six laboratories that provide hands on support to the various research activities. Four of these laboratories are devoted to build and test robotics systems of all kinds, including indoor challenging robotics applications, novel parallel mechanisms, and outdoor mobile robotic systems.
The other two laboratories help the research activities in automatic control for energy management and fuel cells research. Complementary services also include a mechatronics workshop.

Keywords
Urban robots
Mobile robotics
Intelligent systems
Kinematics
Robot design
Perception
Manipulation
Fuel cell
Water network management

Institut de Robòtica i Informàtica Industr

CSIC

Polytechnic University of Catalonia

Institute of Industrial and Control Engineering (IOC)

Location
Spain
Barcelona

Website
http://www.ioc.upc.edu

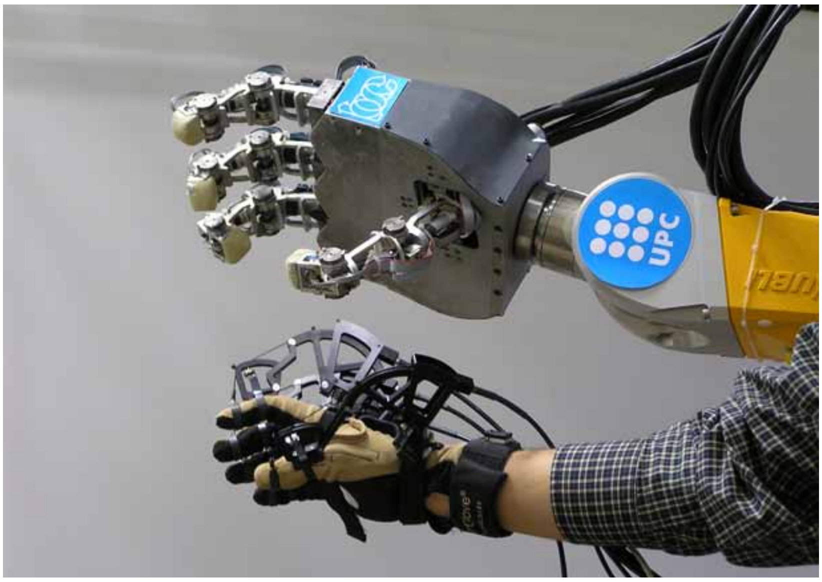
Contact
Prof. Raúl Suárez Feijóo
raul.suarez@upc.edu

The IOC is a university research institute of the Polytechnic University of Catalonia (UPC). As a university institute, its functions are research and technology transfer, as well as the teaching of postgraduate courses.

The fields of activity of the IOC, which continues the work done by the Instituto de Cibernética for more than twenty-five years, are automatics, robotics, automatics, artificial intelligence, computer science and industrial engineering, with a special emphasis on the analysis, the design, the management and the control of logistic and goods and services production systems and on the methods and the techniques appropriate to solve these problems and on the fields of science and technique related to them as well.

Institut d'Organització i Control de Sistemes Industrials (IOC)
UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

The IOC has teaching and research staff from several departments of the UPC, which provides the institute with a multidisciplinary character, and administrative and technical staff which support the institute activities. Also, there are undergraduate and postgraduate students which are completing their education, whether it be a graduate dissertation or a doctoral thesis.

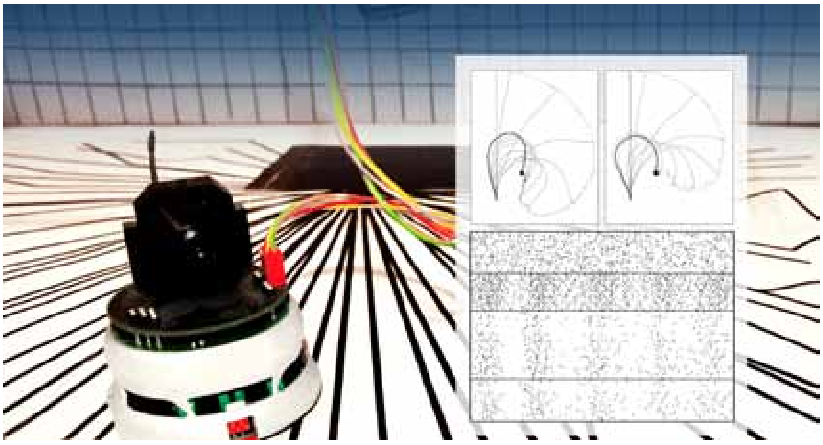


The institute has a robotics laboratory; a control and electronics laboratory; a remote control laboratory; a logistics laboratory; a computer network equipped with servers, workplaces, PC's and software; and a specialized library comprising about six thousand volumes and numerous journals.

The activities of the Institute include research subsidized with public funds, both European and national projects; agreements with companies; formation of researchers and participation in official masters, doctorate and masters from the UPC Foundation. The IOC fosters the relationship with both Spanish and foreign research centres in order to promote the connection in related research areas and encourages the international exchange of research experiences.

Keywords
Robotics
Control
Logistics
Teleoperation
Robotic manipulation

Romanian Institute of Science and Technology



Location
Romania
Cluj-Napoca

Website
http://www.coneural.org

Contact
Dr. Răzvan V. Florian
florian@rist.ro

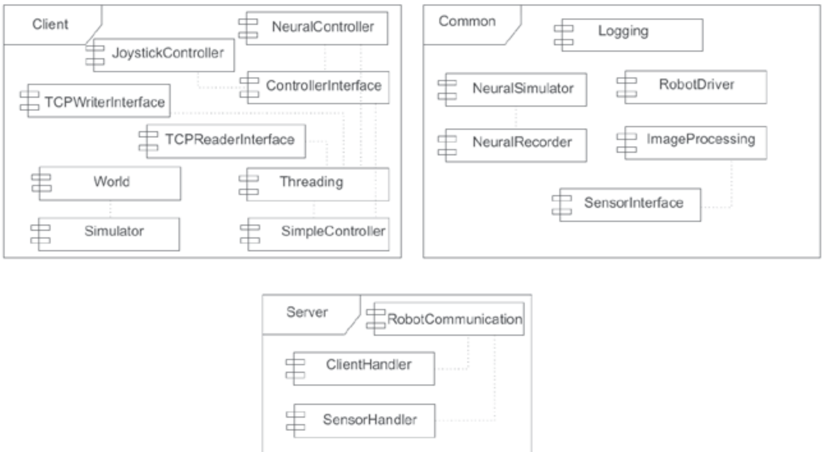
The Romanian Institute of Science and Technology (RIST) is a non-governmental research institute, founded in 2009.

RIST currently performs research on computational, theoretical and experimental neuroscience, complex systems, biologically-inspired robotics, artificial intelligence and dynamical systems.

The research interests of RIST's scientists include:

- Developing robotic controllers using spiking neural networks, in order to explore computational models of the brain
- Robotic applications of probabilistic learning
- Autonomous cognitive development of robots interacting with their environment.

Romanian Institute
of Science and Technology



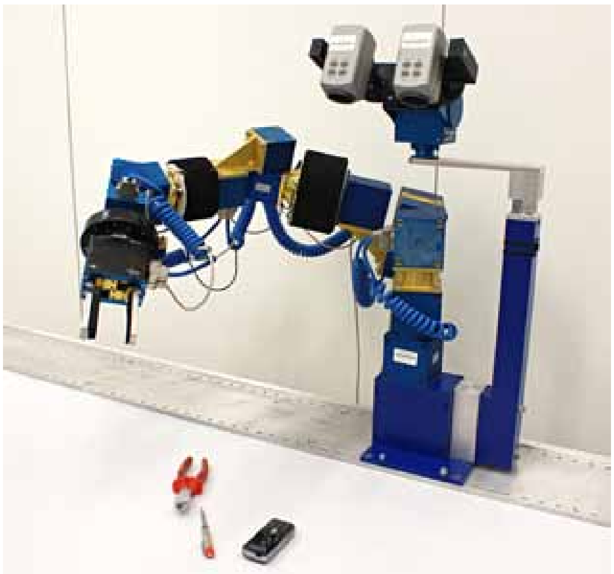
RIST's scientists have developed several new new learning rules for spiking neurons, for both supervised and reinforcement learning, some of them having biological relevance.

RIST's scientists have also developed Robby, an open robotic framework which enables an efficient and easy distributed control of different devices, such as Khepera or E-puck, by spiking neural networks. The framework provides both the abstractization layer for robot communication and the logic to support the development and simulation of large-scale spiking neural controllers. It is written in C++ and adheres to the POSIX standards. It is available at *https://github.com/robby-project/robby*.

Keywords
Spiking neural controllers
Autonomous cognitive development

Ruhr University Bochum

Autonomous Robotics Group



Location
Germany
Bochum

Website
http://www.ini.rub.de/research/groups/ar

Contact
Prof. Gregor Schöner
gregor.schoener@ini.rub.de

The Autonomous Robotics Group is part of the Institute for Neural computation, which investigates how fundamental problems of information processing are solved by organisms and their nervous systems. Artificial autonomous systems are confronted with these same problems.

Our global goal is to understand the organizational principles through which nervous systems solve these problems and to form these principles into new solutions to problems of information processing in technical systems. We do this around the exemplary areas of artificial action (autonomous robotics), artificial perception (computer vision) and artificial cognition. Industrial applications are pursued in real time vision, face recognition, and medical engineering.

Our methods come primarily from the mathematical theory of neural networks, the theory of stochastic dynamical systems, and the theory of machine learning.

Our research in autonomous robotics is organized around the problems posed by robotic assistants, that is, partially autonomous robot systems that interact with human operators with whom they share a natural environment.

RUHR
UNIVERSITÄT
BOCHUM
RUB

Robotic assistants need an array of sensor systems and powerful perceptual algorithms so that they may acquire enough information about the scene to interpret user commands and autonomously perform actions such as orienting toward objects, retrieving them, possibly manipulating them and handing them over to the human operator.

Based on analogies with how nervous systems generate motor behavior and simple forms of cognition, we use attractor dynamics and their instabilities at three levels to generate movement trajectories, to generate goal-directed sequences of behaviors, and to derive task-relevant perceptual representations that support goal-directed behavior.

Our Hardware

The Autonomous Robotics Group Lab is equipped with two non-mobile anthropomorphic robotic assistant, several wheeled robots and a NAO humanoid robot. The anthropomorphic robots consists of an arm with seven degrees of freedom, several force/torque sensors and stereo camera heads.

Keywords
Cognitive robotics
Autonomous robots
Neural dynamics
Human-robot interaction

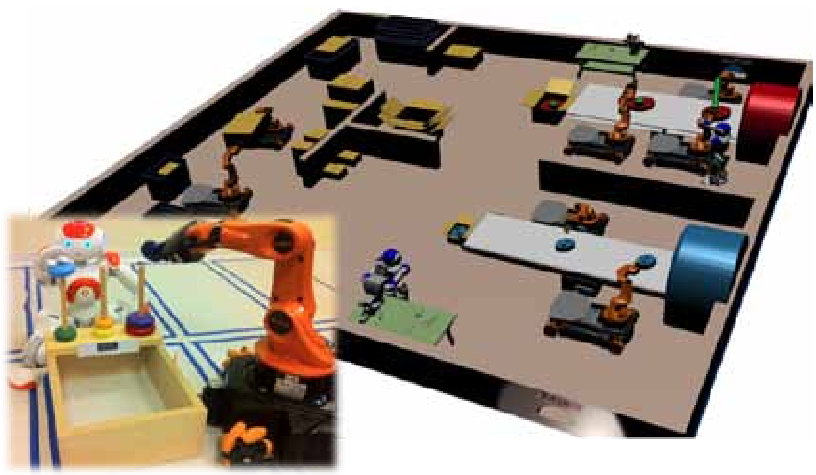
Our Software

In the Autonomous Robotics group ï»¿we developed CEDAR, a C++ library that bundles our knowledge and ideology of autonomous robotics with an emphasis on cognition, embodiment, and dynamics. CEDAR is the result of an ongoing effort to implement and integrate a collection of powerful tools that had been developed over many years. Linking up perception and motor control of a robot and putting some cognitive processing in between should not be constrained by programming issues, but should only be a question of applied concepts. CEDAR provides a tool aimed at facilitating the connection of modules to create robotic architectures. You can focus on „what" to connect, keeping the effort of „how" to connect it as low as possible.

INSTITUT
FÜR
NEUROINFORMATIK

Sabancı University

Faculty of Engineering and Natural Sciences
Computer Science and Engineering
Cognitive Robotics Laboratory



Location
Turkey
Istanbul

Website
http://cogrobo.sabanciuniv.edu

Contact
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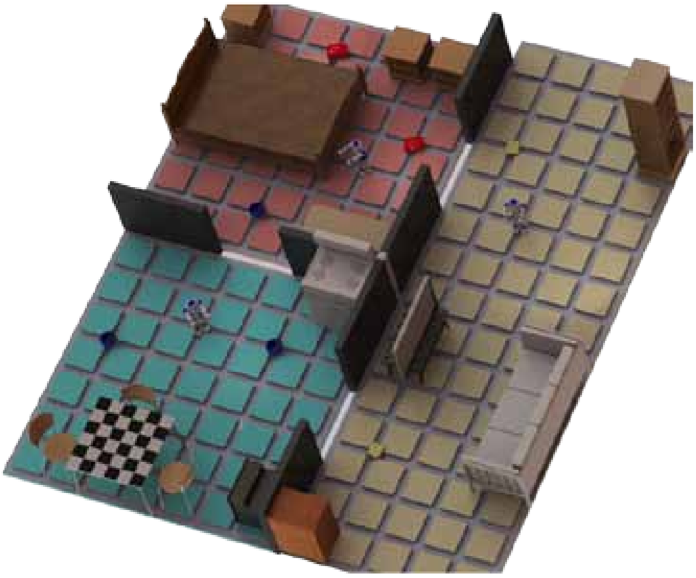
Asst. Prof. Volkan Patoğlu
vpatoglu@sabanciuniv.edu

Cognitive Robotics Laboratory at Sabancı University is concerned with endowing robotic or software agents with higher level cognitive functions that involve reasoning, for example, about goals, perception, actions, the mental states of other agents, collaborative task execution, etc.

Our research has mainly been on bridging the gap between high-level reasoning and low-level control, involving both theoretical and hands-on components. Along these lines, we have been working on several robotic applications, including manipulation planning, service robotics, cognitive factories, multi-path planning and rehabilitation robotics.

Our research team consists of researchers from computer science and mechatronics engineering and has emerged from collaborations between Knowledge Representation and Reasoning Group and Human-Machine Interaction Laboratory.



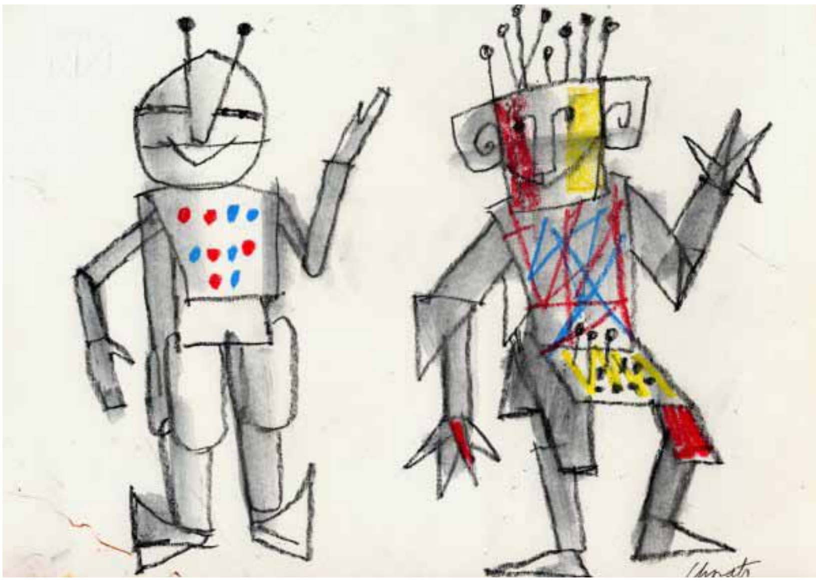
Due the interdisciplinary and synergistic nature of this research area, we study various topics, including

- Architectures for robot control
- Kinematic and dynamic modeling of robots,
- Robot design
- World maps and localization
- Object recognition
- Manipulation and path planning
- Physical human-robot interaction (pHRI)
- AI planning
- Multi-path planning
- Sensing and monitoring
- Diagnosis
- Robotic learning
- Representation and reasoning formalisms and algorithms
- Methods for coupling high-level reasoning with low-level control.

Keywords
AI planning and diagnosis
Execution monitoring
Robotic manipulation
Cognitive factories
Service robotics
Multi robot systems
Rehabilitation robotics

CogRobo

School of Robotics (Scuola di Robotica)



Location
Italy
Genova

Website
http://www.scuoladirobotica.eu/en

Contact
Fiorella Operto
info@scuoladirobotica.it

Scuola di Robotica (School of Robotics) is a non profit cultural association whose aim is to promote the knowledge of the science of Robotics among students, teachers and the general public.
It provides for the widest practicable and appropriate dissemination of information concerning the results of the R&D in the field of robotics and of the complementary disciplines, artificial intelligence, neuroscience, philosophy, psychology, and roboethics.

The mission of Scuola di Robotica is to develop a chain of transmission between research laboratories, education, industry and society at large, because without an effective translation between the language of science and those of other disciplines, communication of science is incomplete.

Scuola di Robotica

Scuola di Robotica investigates the ethical dimension of robotics in collaboration with scholars of several disciplines (Humanities). When robotics will be applied to society in numbers and volumes bigger than today, it will trigger widespread social and economic change, for which public and private policy must now prepared.

Keywords
Educational robotics
Roboethics
Robotics and society

Scuola di Robotica organizes: conferences, classes for teacher and students, video conferences, documentaries, publications and events, based on the pedagogical principle of live science, structured to bring teachers and students close to the edge of scientific research in the field of ICT and robotics. It promoted the birth of Roboethics: *www.roboethics.org.*

Scuola di Robotica is Certified National Training Society, a member of the European Robotics Platform, of the European Centre for Women and Technology (ECWT), National centre of the project "Roberta, Girls Discover Robots", and partner of the First Lego League Italia.

Scuola di Robotica

Scuola Superiore di Studi Universitari e Perfezionamento Sant‘Anna

The Biorobotics Institute

Location
Italy
Pontedera (Pisa)

Website
http://www.bioroboticsinstitute.it

Contact
Prof. Paolo Dario (Director)
paolo.dario@sssup.it
Prof. Maria Chiara Carrozza
chiara.carrozza@sssup.it

The BioRobotics Institute explores the possibility to reach an inexhaustible springboard for the creation of applications that are useful for man. This is achieved through engineering, mechatronics and robotics as well as advanced smart systems inspired by the living world. The BioRobotics Institute is focused on interdisciplinarity by exploiting knowledge and technologies from various fields of engineering (mechanical, electronic, computer science, chemistry, materials, energy), and also transdisciplinarity, thanks to strong interactions with natural and social sciences.

The institute‘s expertise covers the following main areas:

- Future and emerging biorobotics
- Humanoid robotics
- Neuro-robotics
- Surgical robotics
- Soft robotics
- Neural engineering
- Creative design
- Biomedical signal processing.

The primary research sector of the Biorobotics Institute of the Scuola Superiore Sant'Anna is biorobotics, which represents an emerging area of science and technology, linking specific methodologies of robotics and bioengineering. It can be applied to different fields of engineering, base sciences and applied sciences (particularly life sciences, including biology, medicine, neuroscience, and bio/nanotechnology), social sciences (economics and law), and humanities (philosophy, psychology, ethics).

Biorobotics aims to deepen scientific knowledge on biological systems through engineering methods and instruments consisting of mechatronic and robotic platforms. Biorobotics exploits such knowledge to develop innovative technologies and methodologies for the design and manufacturing of bio-inspired machines and systems (at macro, micro and nano scale) characterized by advanced performance (e.g. animaloid and humanoid robots). A further key objective is to design, develop and validate technological devices for biomedical applications, especially for minimally invasive surgery and robot-assisted rehabilitation.

The BioRobotics Institute is located at Polo Sant'Anna Valdera, in Pontedera, a town close to Pisa. This is a research park, with a surface of 6,300 square metres, 2 "clean rooms" class 1.000 – 10.000, 2 CAD-laboratories for electronic and mechanical design, 1 high precision mechanical workshop with advanced support facilities that allow to develop and fabricate all the components of the prototypes, 4 classrooms, 25 offices, 20 beds available in guest rooms, 250m^2 of meeting rooms and teaching lab for educational activities.

Keywords
Bioengineering
Biomedical robotics
Biomechatronics
Service robotics
Marine robotics
Biomedical signal processing
Ambient assisted living
Biomechatronic hands
Neuro-developmental bioengineering
Robotics and society

THE BIOROBOTICS INSTITUTE
Scuola Superiore Sant'Anna

Second University of Naples

Department of Industrial and Information Engineering (DII)
Automatic Control Laboratory (ACL)

Location
Italy
Aversa (CE)

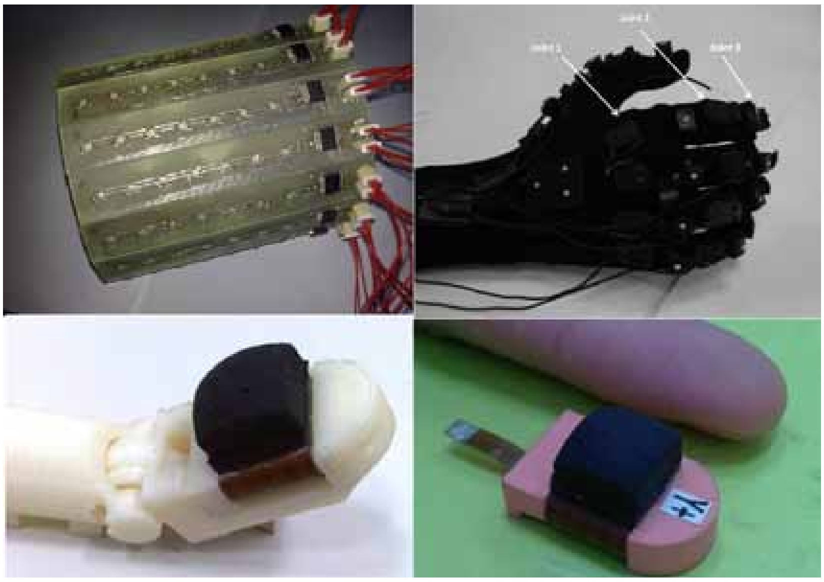
Website
http://www.dii.unina2.it/acl

Contact
Prof. Giuseppe De Maria
giuseppe.demaria@unina2.it

The Automatic Control Laboratory of the Second University of Naples carries out several research activities from automatic control systems in aeronautics and transportation systems to robotics and automation.
The research is conducted both at methodological and technological levels. Methodological research is focused on modelling and control of complex systems, with special emphasis on flexible structures and robotic manipulators. Technological research is performed in the area of mechatronic systems, with a special emphasis on innovative sensor and smart actuators development for application in active noise and vibration control and service robotics. The research has been developed within projects funded by both National and European RTD programs since the Fifth Framework Programme.

The group is connected with the PRISMA Lab (*http://www.prisma.unina.it*)

SUN
SECONDA UNIVERSITÀ DEGLI STUDI DI NAPOLI



Main research topics

Observation of human manipulation for automatic programming of robots

- Active control of noise and vibrations
- Development of sensors for advanced robotic systems
- Supervisory control and multiphysics simulation of aeronautical electronic equipment
- Mobile manipulation.

Keywords

Industrial robotics
Service robotics
Mechatronics
Sensor fusion
Active control of vibrations
Robust control

Main laboratory facilities

- 1 Kuka Youbot
- 1 CNC 3-axis machine
- 1 Vicon 360 motion capture system with five cameras
- 3 dSPACE rapid prototyping real-time control systems.

See *http://www.dii.unina2.it/acl/multimedia.html* for videos of our experimental activities.

SUN
Seconda Università degli Studi di Napoli
DIPARTIMENTO di INGEGNERIA dell'INFORMAZIONE
PRISMA Lab

Sheffield Hallam University

Material & Engineering Research Institute (MERI)
Centre for Automation and Robotics Research (CARR)

Location
United Kingdom
Sheffield

Website
http://www.shu.ac.uk/research/meri/who-we-are?centreid=10

Contact
Prof. Jacques Penders
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The Centre for Automation and Robotics Research (CARR) is a focal point where diverse robotics and automation projects are developed alongside each other. CARR creates a repository of practical solutions and knowledge, but at the same time can provide a source of inspiration for future developments. We welcome and support any robotics application, be it in art, health and wellbeing or industrial automation. CARR is a founding member of the Sheffield Centre for Robotics (SCentRo) (*http://www.scentro.ac.uk*) in which Sheffield Hallam University collaborates with the University of Sheffield. CARR consists of the Mobile Machines and Vision Laboratories (MMVL), the Systems Modeling and Integration Group (SMI), the SMI focuses on Automation and Logistics.

The expertise within the MMVL group includes artificial intelligence, computer vision, embedded systems engineering, electronic design, interaction design, mathematical modeling, robotics and swarm robotics. The group has a track record in robotics for search and rescue and works together with South Yorkshire Fire and Rescue.

Sheffield
Hallam University

SHARPENS YOUR THINKING

The main theme of our research is on the connection of artificial perception and physical action. Perception requires extensive processing and interpreting of data generated by sensors. We employ a wide range of sensors and sensing techniques including various types of cameras (Normal light, IR, Thermal), Laser and Ultrasound devices and also chemical sensors produced in-house. Actions are typically performed by robots and multi robot systems, ranging from medium sized mobile robots to mini, micro and also nano robots. The robots and sensors are to be applied in ordinary environments and human machine interactions play an important role.




Current projects

The REINS project aims to build a human- robot team, the technology could help fire-fighters to navigate in low visibility and eventually may provide a robotic guide that mimics aspects of the guidance provided by dogs for visually-impaired people. The project is building robotic reins to enable the human to feel the robot's movements and signals.

Previous projects of MMVL include The GUARDIANS – Group of Unmanned Assistant Robots Deployed in Aggressive Navigation by Scent- (*http://www.shu.ac.uk/research/meri/research/guardians-project*), which are a swarm of autonomous robots applied to navigate and search an urban ground. For instance, in a situation such as industrial warehouse in smoke, robots can provide vital assistance to humans who run the danger of being intoxicated, become disoriented and get lost.

The VIEW-FINDER (*http://www.shu.ac.uk/research/meri/research/viewfinder*) project built an autonomous robotic system to establish ground safety in the event of a fire. This system should help to gather data (visual and chemical) to assist fire rescue personnel. The Viewfinder robots use chemical sensors and video cameras to map safe locations for the crew to access in partially destroyed industrial sites, after events such as explosions.

Keywords
Urban search and rescue
In-the-field human-robot interaction
Sensors and autonomous systems
Swarm and collective robotics

scentro

Slovak University of Technology

Faculty of Electrical Engineering and Information Technology
Institute of Control and Industrial Informatics (ICII)
Department of Robotics and Artificial Intelligence

Location
Slovakia
Bratislava

Website
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Contact
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Department of Robotics and Artificial Intelligence is primarily engaged in research on industrial robotics, mobile robotics, mobile manipulators and service robotics.

Main topics in our research are:
- Modeling of robotic systems
- Manipulation
- Variable structure control
- Telecontrol
- Intelligent and autonomous control
- SLAM and navigation
- RGBD mapping
- Optimization of control methods
- Resonance free moving in mechatronic actor systems
- etc.

URPI
Institute of Control and Industrial Informatics
Faculty of Electrical Engineering and Information Technology
Slovak University of Technology in Bratislava

The Department is well equipped:

- Mobile manipulator MRKV01
- Mobile robot Black Metal
- Multi-agent system created from iRobot Create platforms
- Several robotic manipulators (Mitsubishi, OJ-10, in future ABB)
- Special vision systems (thermo camera, HDR camera, Kinect, stereo vision)
- Several laser range finders
- Geodetic GPS Leica 1200
- Laser range finder for welding
- Walking robots (biped, hexapod)
- Bridge crane model
- Spykee robots
- etc.

The research team has extensive publishing activity and participation in grant projects (including international projects). Part of the research team is also 13 internal doctoral students.

Members of the team are members of international scientific committees (IFAC Technical Committee TC 4.3. Robotics, IEE The Institute of Electrical Engineers, Inc.), editorial board of journals (e.g. Journal of Intelligent and Robotic Systems (CC)) and they are involved in organizing conferences (Robotics in Education) and competitions on robotics (Istrobot, Robotour).

Members of the team regularly participate in competitions on robotics in which they, for example, achieved the second place in international competition called Robotour.

Keywords
Industrial robotics
Mobile robotics
Mobile manipulation
Service robotics

Swedish Royal Institute of Technology (KTH)

Centre for Autonomous Systems (CAS)

Location
Sweden
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Website
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Contact
Prof. Danica Kragic
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KTH is the leading technical university in Sweden with research in a broad range of topics ranging from natural sciences to all branches of technology.

The Centre for Autonomous Systems (CAS) is a research centre at KTH in Stockholm, Sweden inaugurated in 1996. CAS bridges three KTH schools, Computer Science and Communication, Electrical Engineering and Engineering Sciences. The centre performs research in collaborative and autonomous robot systems, and the researched spans the areas of robotics, computer vision, machine learning and control. CAS has also been highly active in research community efforts. The principal involvement was the founding and coordination of the European Robotics Network – EURON and coordination of several EU financed projects.

Our research provides novel functionalities and design principles for embedded, networked and assistive robots from a systems perspective, for their robust and versatile behavior in open-ended environments providing intelligent response in unforeseen situations, and enhancing human-machine interaction.

We contribute to scientific and industrial communities while also having a clear social dimension, providing technologies that increase life quality.

An important objective of several ongoing projects is the development of robotic systems for dual arm object manipulation based on visual, range and haptic information.

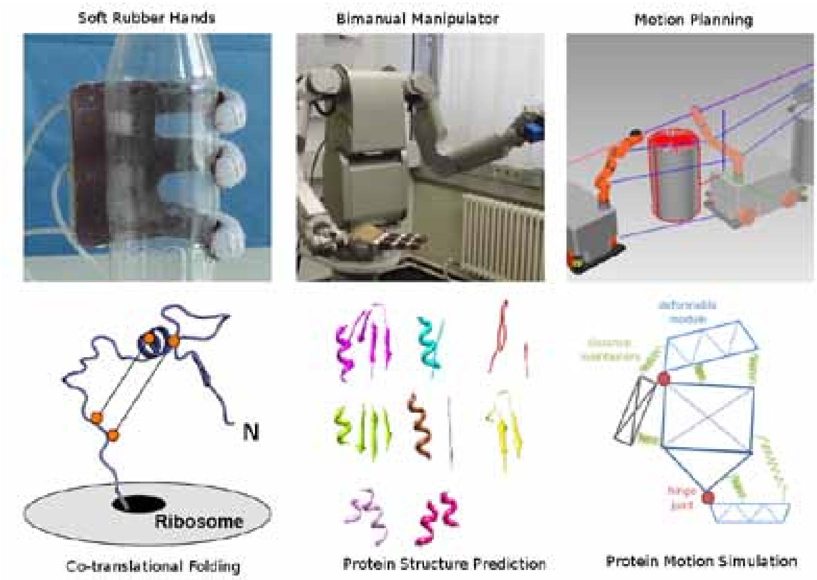
We address three research problems:
1. Task learning based on observation of human examples
2. A multi-agent control theoretic approach for dual arm manipulation
3. Sensors and system integration.

The projects are primarily interested in developing the basic theoretical frameworks for flexible and robust systems performing in realistic environments. To show the applicability of the methodologies, they are evaluated both individually and at a system level, in both domestic and industrial settings.

Keywords
Service robotics
Grasping
Manipulation
Spatial cognition and navigation
Computer vision
Machine learning

Technical University of Berlin

Faculty of Electrical Engineering and Computer Science
Department of Computer Engineering and Microelectronics
Robotics and Biology Laboratory



Location
Germany
Berlin

Website
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Contact
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Research activities in the Robotics and Biology Laboratory are concerned with the creation of robotic systems that autonomously achieve task generality in everyday environments and the advancement of computational structural biology by devising algorithms that incorporate insights and techniques from robotics, robot motion planning, machine learning, and AI.

Grasping. Using manufacturing techniques of soft robotics, we build pneumatically actuated hands made of rubber. We combine different materials to reach anisotropic elasticity and controllable stiffness. Conveniently, our rubber hands are inherently safe for interacting with humans, and cheap to produce. We want to create a compliant hand, where most control necessary for robust grasping is already performed by its mechanical structure. To exploit this property, we devise perceptual algorithms that detect suitable grasp affordances in unstructured environments.

Protein Motion Simulation. We use methods from structural engineering to calculate the deformability of a protein based on a simplified mechanical representation. This information serves as guidance for robotics-based sampling methods to simulate protein motion efficient and biologically accurate.

Manipulation. Interactive perception manipulates unknown objects in order to estimate their kinematic structure. We develop algorithms to track, infer, and recognize those structures. We use statistical relational learning to allow the agent to learn strategies for extracting the kinematic structure of objects as fast as possible, and reuse this knowledge for previously unseen objects.

Co-translational Folding. We aim to reduce the search space of the general protein structure prediction problem by identifying smaller subunits of the protein that fold independently.

Motion Generation. We devise motion planners, that use several sources of information to balance exploration and exploitation. Utility-guided sampling apply guided exploration by choosing samples with maximal expected utility. Disassembly planning uses the 3D-workspace connectivity to identify the regions of the configuration space where a detailed search is needed.

Protein Structure Prediction. We use several strategies to tackle the problem of high dimensionality: Our building blocks project tries to narrow down the search space by assembling protein structures from evolutionary conserved structural chunks. Further, we developed model-based search, which builds hypotheses about promising regions in the search space throughout the sampling. Our contact prediction project uses statistical methods to detect regions of sampled structures holding native-like contacts and utilizes that information in successive sampling rounds.

Loop Modeling. We employ operational space control techniques from robotics and search methods inspired from robotic motion planning to address the loop closure problem in protein structure prediction.

Keywords
Mobile manipulation
Interactive perception
Grasping
Soft robotics
Compliant manipulators
Motion generation
Protein structure prediction
Protein motion
Co-translational folding

Technical University of Braunschweig

Department of Computer Science
Institute for Robotics and Process Control (iRP)

Location
Germany
Braunschweig

Website
http://www.robotik-bs.de

Contact
Prof. Friedrich M. Wahl
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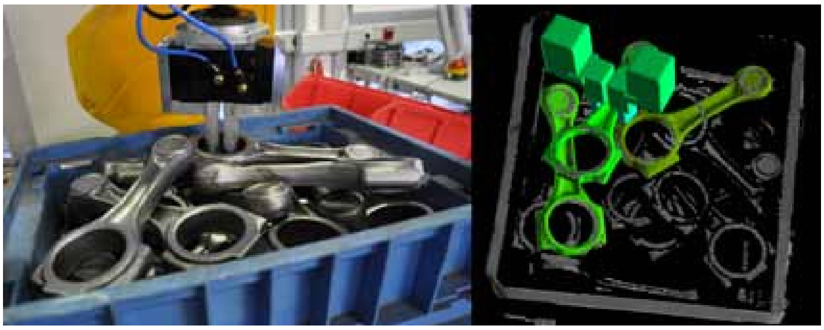
Since its foundation in 1986 the institute has been grown steadily due to the involvement in many industrial and academia funded projects. Today the institute has a well-equipped lab with several experimental robot work cells and therefore is a first class work environment for successful research and teaching. Researchers, technicians, and students are working in the following research areas:

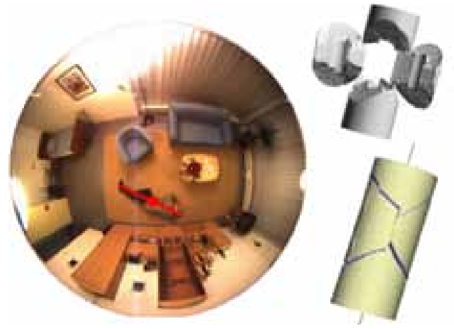
Industrial Robotics

- Human-robot cooperation in complex assembly tasks
- New robot programming paradigms and languages
- Versatile robot control architectures
- Sensor data fusion
- Sensor based (vision and force/torque) robotized manufacturing
- Automated assembly planning systems
- Alternative robot drive concepts
- Cooperation with many partners from industry and academia.

Technische Universität Braunschweig

iRP





Computer Vision

- From low level 2d image to 3d scene analysis methods
- Robot work cell monitoring and grasp planning
- Segmentation of medical images (X-ray, CT, MRT)
- Vision based driver assistance systems (automated parking)
- Fall detection of elderly people in their home environments
- Fragment matching algorithms (3d puzzle).

Medical Robotics

- Development of robotized surgical assistance systems
- Robot assisted reduction of long bone fractures
- Robotic and navigated correction of malalignments
- Robot guided endoscopy in nasal cavities
- Development of advanced surgical navigation procedures
- Cooperation with medical partners from all over Germany.

Mobile Robotics

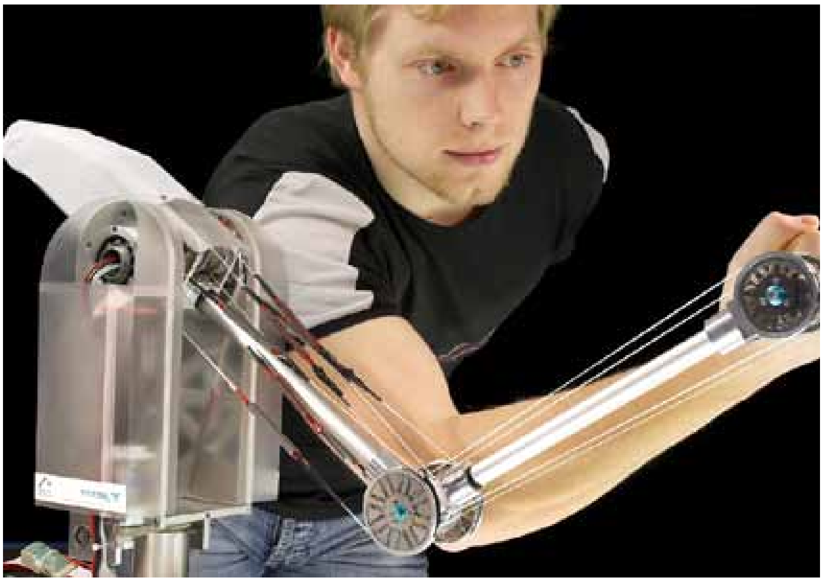
- Automated localization and mapping of mobile robots (SLAM)
- Probabilistic mobile robot navigation (collision avoidance)
- Vision based analysis of car environments
- Various successful projects with automobile manufacturers.

Keywords
Industrial robotics
Computer vision
Robot programming
Robot control
Medical robotics
Mobile robotics

Technische Universität Braunschweig

Technical University of Darmstadt

Department of Computer Science
Simulation, Systems Optimization and Robotics Group



Location
Germany
Darmstadt

Website
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Contact
Prof. Oskar von Stryk
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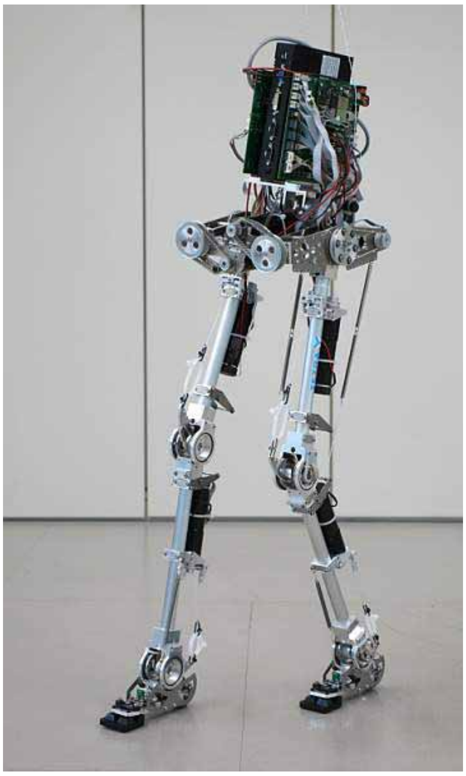
Our main focus in research and teaching is on simulation-based optimization and control and robotics.

For example, we investigate

- The efficient numerical optimal control of nonlinear dynamic processes (as motor vehicles, multi-joint robots and human motions) with continuous or hybrid discrete-continuous control and state variables
- The robust, simulation-based optimization with real-valued or mixed-integer nonlinear parameters (e.g., for CAE optimization of fluid flow or electromagnetic field simulations)
- Humanoid and four-legged robots
- Biologically inspired robots (BioRob, BioBiped)
- Cooperating teams of autonomous, mobile robots in dynamic or unstructured environments (e.g., Darmstadt Dribblers, Dribbling Dackels & Rescue Robot Team Hector).

TECHNISCHE
UNIVERSITÄT
DARMSTADT

Informatik



Keywords
Bio-inspired robots
Autonomous robot teams
Modelling, optimization and control of non-linear dynamical systems

TECHNISCHE
UNIVERSITÄT
DARMSTADT

Informatik

Technical University of Darmstadt

Institute of Sports Science
Chair in Sports Biomechanics
Lauflabor Locomotion Lab

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Germany

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Keywords
Human and animal locomotion
Sports biomechanics
Neuromechanics
Muscle
Gait templates

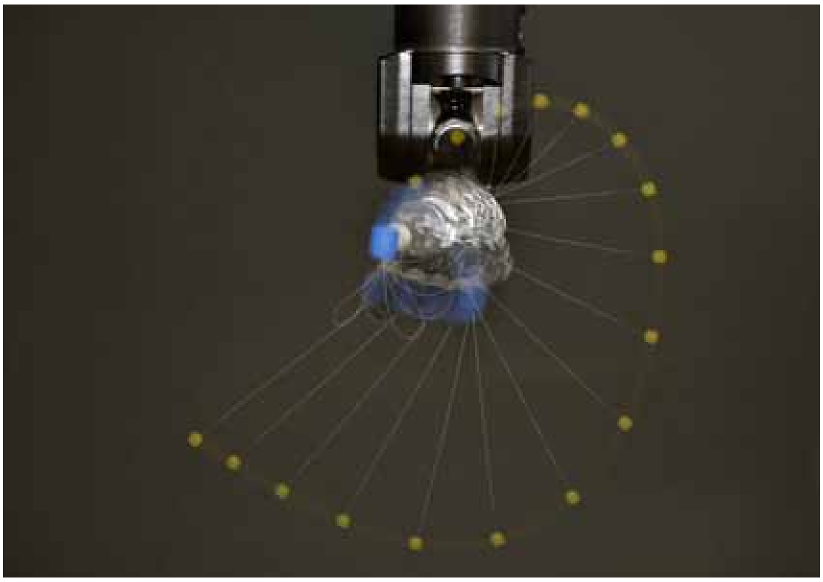
Our main focus in research is on developing models on human and animal locomotion at increasing levels of complexity and to transfer the identified concepts to robotic platforms for demonstration and validation.

With this interplay of different research methods (experiments, models, and robot platforms) we aim at advancing our understanding on how animals and humans move.

TECHNISCHE
UNIVERSITÄT
DARMSTADT

Technical University of Darmstadt

Department of Computer Science
Intelligent Autonomous Systems Lab



Location
Germany
Darmstadt

Website
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Our main focus in research and teaching lies on the development of machine learning approaches for robotics and biomimetic systems.
In this context, we investigate efficient automatic programming of robots with a mixture of imitation and self-improvement, develop novel learning algorithms for motor primitives, complex motor skills, and robot grasping, etc, as well as brain-robot interfaces.

Creating autonomous robots that can learn to assist humans in situations of daily life is a fascinating challenge for machine learning.
While this aim has been a long-standing vision of artificial intelligence and the cognitive sciences, we have yet to achieve the first step of creating robots that can learn to accomplish many different tasks triggered by environmental context or higher-level instruction.

Keywords
Robot learning
Autonomous robotics
Intelligent learning systems

TECHNISCHE
UNIVERSITÄT
DARMSTADT

Technical University of Košice

Faculty of Electrical Engineering and Informatics
Department of Cybernetics and Artificial Intelligence
Center for Intelligent Technologies

Location
Slovakia
Košice

Website
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Contact
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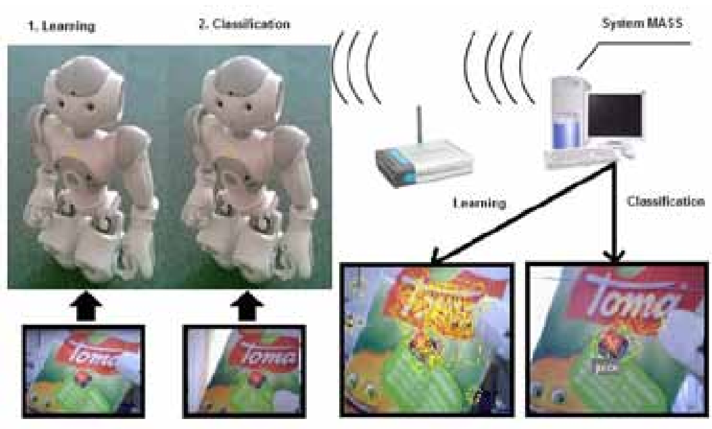
Center for Intelligent Technologies was established in 1995 and is a member of Center of Excellence and Competence Center for Knowledge based technology at TU Košice, Slovakia. The Center had/has a number of projects on a national and international level. We do a number of collaborations with Japanese universities and Korea.

The main focus in general is in promotion of new trends in information technology and also to support the applications of intelligent technologies in Slovakia. Evolving distributed framework for companion robotic systems is the main focus of the CIT in long term research. The testbed for this proof of concept engineering research is the NAO robotic humanoid platform. Interaction, teleoperation, learning by example, emotion technology, advance image processing, Robot internet interface to cyberspace and many other issues. We do focus on computational Intelligence tools including other related bio-inspired approaches.

In the future we are not linked to the platform but linked to the main aim to contribute to the creation of a worldwide software framework for Internet of Things e.g. robots. Ambient intelligence is the global direction including application of computational and artificial intelligence in robotics, smart spaces and houses.

We focus on the following topics:

- Remote smart monitoring diagnostic and additional sensory information
- Distributed artificial intelligence for knowledge sharing
- Framework for manual teleoperation with the learning ability
- Bridges for middleware platforms
- Emotional models
- Prediction systems for weather forecast support
- Accessories for humanoid robots
- Fuzzy systems, neural networks, evolutionary systems, brain-like image processing



- Joining the computational intelligence international research community and contribute to the development of computational intelligence in general.
- Organizing and supporting events about the research and promotion of these technologies which could contribute to support interest of young researchers, new ideas which contribute to the development of Artificial Intelligence in general.
- Promoting intelligent technologies among students of the Technical University of Kosice mainly in postgraduate and postdoctoral level.
- Teaching various subjects from a computational Intelligence domain or subjects supporting intelligent technologies in general.
- Promoting Intelligent technologies among research associates, academic community, industrial and non-industrial companies in Slovakia. Collaborating with these companies and provide them expertise services and pilot projects promoting intelligent technologies in their environment. Supporting spin-off and start-up in artificial intelligence domain as the essential domain of current and future IT.

Keywords
Intelligent systems
Intelligent robotics
Distributed intelligence
Emotion technology for HCI
Autonomy
Fuzzy
Neural networks
Evolutionary systems
Brain like technology
Bio-inspired technology

Center for Intelligent Technology is equipped with 16 NAO humanoid robots for research and educational purposes towards intelligent technologies. Annually the branch of AI finish aprx. 25 people in Bc. and MSc. PhD level is also very active - we do have 11 alumni in AI past 15 years in branch of AI.

Technical University of Košice

Faculty of Mechanical Engineering
Department of Production Systems and Robotics

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Slovakia
Košice

Website
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Contact
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The beginning of the robotics at the Faculty of Mechanical Engineering in Košice is dated to the year 1973 when the faculty bought the robot Versatran 500. At present, the Faculty of Mechanical Engineering is one of the leading departments in developing and teaching. Research in area in service robotics in the Department of Production System and Robotics gradually followed after the research of applications of industrial robots. The department provides teaching of robotics in several programs of bachelor, engineering and doctoral studies.

The department was especially successful in robot football in the category Mirosot, where we achieved valuable leading position in the international RoboCup competitions FIRA by development the third generation of small mobile robots.

Robotics Laboratory is equipped with:

- Robotic cell with two KUKA robots, on which we realize of research cooperation of robots for handling and technologic operations.
- Experimental workplace with robot OTC, where is verified and tested research of increasing intelligence - visual systems, sensors
- Workplace with the robot SDA 10 Motoman assigned for developing research in the field of intelligent assembly and cooperation with humans
- Robosoccer, management of research and cooperation of multi-agent systems
- Laboratory of service robotics for application and simulation of mobile platforms
- Application of robotic mechanics in rehabilitation.

Field of research activities

- Intelligent management of service robot
- Management of technical, environmental and human risks in permanent development of production and products in mechanical engineering
- Virtual Training Laboratory in Automated and Robotized Manufacturing Systems
- Research modules for intelligent robotic systems
- A comprehensive modular robotic system of middle category with more intelligence
- Principles of cooperation and multirobotic profiling systems
- E-learning of robotics with using of a virtual laboratory with a remote control real equipment based on Internet
- Research on improving the accuracy of machine tools using numerical simulations of the dynamics of the machining process
- Application of new types of studies working with reducers and actuators
- Design, installation and implementation of software for automatic tester piezoelectric sensors
- Development of four robots and software for robotic football.

Keywords
Multirobotic systems
Mobile robots
Multi-agent system (MAS)
Robosoccer
Intelligence

Technical University of Lisbon

Lisbon Technology Institute (IST)
Institute for Systems and Robotics

Location
Portugal
Lisbon

Website
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Contact
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ISR-Lisbon is located at the North tower of the Lisbon campus of IST (Lisbon Technology Institute) and is organized in six research groups/labs:

- Dynamical Systems and Ocean Robotics
- Computer and Robot Vision
- Signal and Image Processing
- Evolutionary Systems
- Intelligent Robots and Systems and Biomedical Engineering.

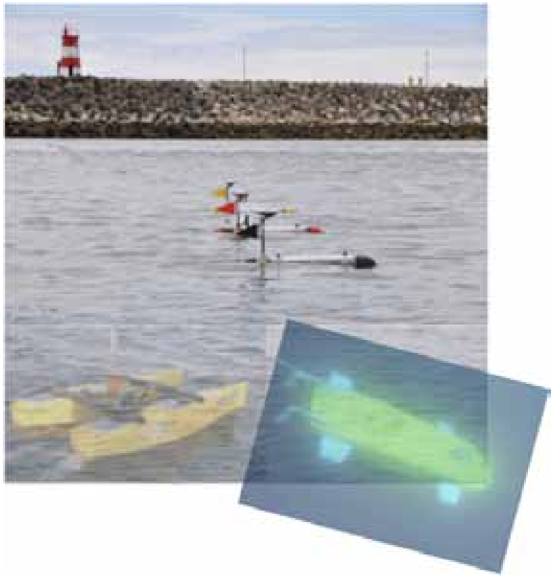
ISR-Lisbon gives special attention to international scientific research cooperation and to training and education initiatives through master, doctoral and post-doctoral programs.
Grants are available for foreign students and researchers who wish to enroll in these programs.

TÉCNICO LISBOA

PÓLO DO I.S.T

Ever since its foundation, and in close cooperation with IST, ISR-Lisbon has been committed to meeting the following main strategic objectives:

- Promoting scientific research and technological development in robotics, information processing and associated areas
- Promoting active intellectual collaboration among researchers with varied backgrounds and perspectives acquired in different kinds of science (e.g., experimental, computational and theoretical), different sectors (university, industry, governmental and regional administration) and different regions



- Providing education and research experience for graduate and undergraduate students, post-doctoral researchers, and industrial fellows, providing exposure to leading-edge research and introducing the students to large-scale collaborative research ventures
- Promoting the diffusion of scientific results through publications and by organizing seminars, conferences, exchange visiting programs and scientific meetings at a national or international setting
- Incrementing the scientific exchange among Portuguese universities and these and other foreign Universities and similar institutions, through the exchange of researchers and students, and the participation in joint ventures
- Promoting and support integrated graduate programs leading to Master and Doctor degrees
- Promoting the participation in research projects with national or international universities, R&D institutions and industrial companies.

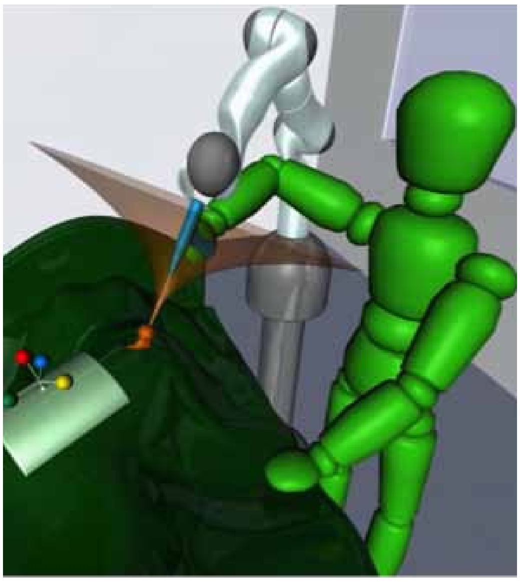
Keywords
Robotics
Computer vision
Signal processing

TÉCNICO LISBOA

PÓLO DO I.S.T

Technical University of Lisbon

Instituto Superior Técnico (IST)
Institute of Mechanical Engineering (IDMEC)
Centre of Intelligent Systems



Location
Portugal
Lisbon

Website
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Contact
Prof. José Sá da Costa
sadacosta@dem.ist.utl.pt

The activity of the Center of Intelligent Systems (CSI) aims the interplay of systems and control theory and engineering applications, having national and international orientation and seeking cooperation with other research institutes and industry.

The research and development of the CSI is divided into three complementary activities:
1. Fundamental research
2. Systems development and applications
3. Transfer of technology to industry.

The research activity at CSI fits on the broad area of systems and control engineering. In particular, the research activity aims the development of control theory and their applications to engineering systems towards the enhancement of performance, functionality, safety and reliability.

More precisely, the research topics are organized in three broad areas, namely Robotic Systems, Systems & Control and Complex Systems.

Complex Systems

- Distributed intelligent optimization of complex systems
- Distributed control based on cooperative behavior
- Fault tolerant control in networked control systems
- Data analysis using a combination of soft computing and statistical methods.

Robotic Systems

- Dynamics and control of rigid-flexible systems
- Active control of structures
- Physical human-robot interaction
- Exoskeletons
- Humanoid robots
- Mobile robots
- Flight control
- Machine vision.

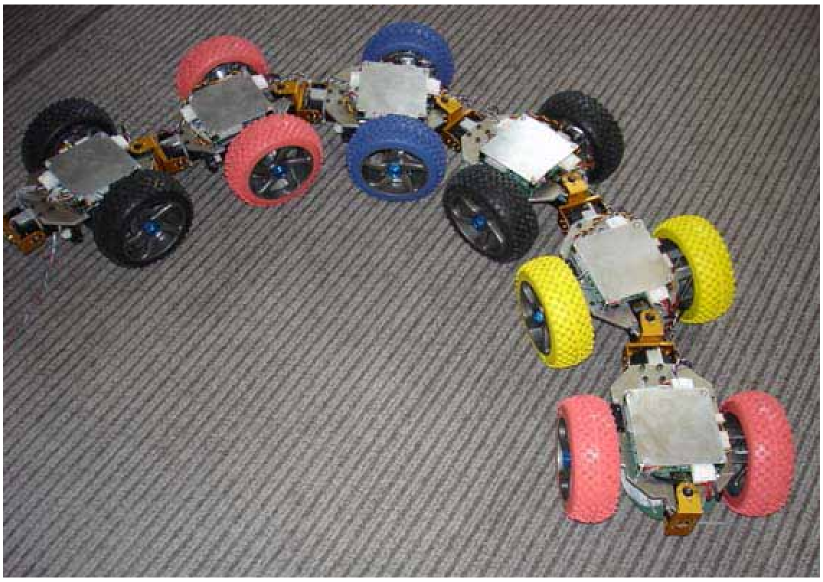
Systems & Control

- Systems and control in life sciences
- Hybrid systems
- Fractional systems
- Automation & systems integration
- Renewable energy systems
- Systems and control applications.

Keywords
Medical robotics
Biomechatronics
Medical imaging
Flight control

Technical University of Lodz

Faculty of Electrical, Electronic, Computer and Control Engineering
Institute of Automatic Control
Department of Robot Control



Location
Poland
Lodz

Website
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Contact
Prof. Edward Jezierski
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Department of Robot Control was established in 1991. Since the beginning, the scientific and research work is associated with control and construction of robots. We have promoted 6 doctorates, 2 habilitations and 2 persons obtained Professor title. Currently, the Department has 4 faculties and 3 PhD students.

The main directions of research in the Department of Robot Control are:
- Control of electric and pneumatic actuators for robots
- Use of visual information in the control of robots
- Design and control of mobile robots, and robots for special applications
- Advanced nonlinear control strategies
- Teleoperation and control of the systems over the network
- Impedance control.

Politechnika Łódzka

The Department of Robot Control offers the following curricula:
- Basics of robotics, control of robots
- Mobile robots, industrial automation and machine vision in robotics
- Embedded and real time systems.

The research recently carried out in the Department:
- Construction and control of the joints with many degrees of freedom
- Robot control based on visual information
- Position-force control of robot with pneumatic drives
- Jumping robots and hypermobile robots
- Impedance control for mobile manipulation
- Rehabilitation robots.

Keywords
Hypermobile robots
Impedance control of robots
Rehabilitation robots

Politechnika Łódzka

Technical University of Ostrava (VŠB)

Faculty of Mechanical Engineering
Department of Robotics

Location
Czech Republic
Ostrava

Website
http://robot.vsb.cz

Contact
Prof. Petr Novák
petr.novak@vsb.cz

The Department of Robotics was established in 1989 and the department has been focusing on the complex field of robotics - in education, research and science and expert services for practice. According to the current trends the department members concentrate also on the service robotics and robototechnics and on application of robots in non-machinery branches.

Orientation of science and research activities
The remarkable boom of mechanical engineering industry in the Moravian-Silesian region makes demands on specialists in the branches of service robotics, industrial robotics and mechatronics and their research and development capacities. Therefore there is a big call for absolvents of our specialization Robotics and also for cooperation with the team of department's employees and PhD students. This concerns not only automotive industry with huge numbers of industrial robots in use (for example Sungwoo-Hitech, Hyundai Nošovice, ABB robotics), but also development of service robots. The science and research orientation of the department is in correspondence with that.

Currently, the department deals with problems related to detection and emergency robots for rescuers, firemen and pyrotechnists. This research was supported by a grant from the Ministry of Industry and Trade of the Czech Republic and many of the prominent companies not only from the region participate on it, for example Strojírny Třinec a.s., Fite a.s. Ostrava, THT s.r.o. Polička, ÚJCHBO Příbram, Robotsystem s.r.o. Horní Suchá, Daniševský s.r.o. Polička, Moravský výzkum Brno.
Another project is related to light technology and is being solved for Visteon – Autopal. The department has its technical background in the Robotics Centre and also in the recently built Center of Advanced Innovation Technologies of VŠB, mechatronics division, on the university grounds.

Aim of research activities
- Construction and design of machines and work-cells
- Methodology of the machine design, methods and tools for the development and innovation of machines and technologies
- Optimization of parameters of machines
- Design and operation of robotized workshops, design of special periphery equipment and accessories
- Development of service robots based on the new concepts for new applications.
- Mechatronics – modelling and simulation of the behavior of machines including drives and control systems
- Computing of the kinematic and dynamic parameters of spatial mechanisms
- Positioning mechanisms, mobile robots
- Kinematics models of walking and anthropomorphic robots
- Machine vision
- Neural networks.

HARDY - Multipurpose service, emergency and rescue tracked robot (cooperation with Strojírny Třinec a.s., Fite a.s. Ostrava, Robotsystem s.r.o.).

Services
- Development, design and production of special machines (incl. control systems)
- Development of control systems based on industrial PCs
- Exact positioning systems using step motors, DC and AC motors
- Design and manufacturing of a prototype of an anthropomorphic gripper
- Projects of production systems with industrial robots
- Design of the special periphery, equipment and accessories.
- Consultancy and technical designs based on the structural, cost and functional analysis of products and processes
- Embedded control systems, control systems and electronics for ATEX.

ARES – mobile robot for collection of liquid, gas and solid samples, exploration and manipulation.

Technical equipment
- Robotics: 12 industrial robots including peripherals (ABB, Mitsubishi, Schunk, RTX, ...), Machine Vision, 5 service mobile robots
- Rapid Prototyping production system (Fortus 360 mcL)
- CAD and simulation software: Creo, MSC Adams, MathCAD, Matlab/Simulink
- GoldFire and TechOptimizer (Computer Aided Innovation)
- Control and visualization: SW InTouch, modular control systems (industrial PC cards), KEIL, MS Visual Studio, .NET Micro Framework
- Mechanical and machining workshop.

Keywords
Robotics
Mechatronics
Control
Rescue systems
Control systems

Department of Robotics
VŠB - Technical University of Ostrava, Faculty of Mechanical Engineering

Technische Universität München

Department of Computer Science
Robotics and Embedded Systems

Location
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Munich

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Contact
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Keywords
Human-robot interaction
Service robotics
Medical robotics
Cognitive robotics
Cyber-physical systems
Neurorobotics

Research areas

Human-robot interaction and service robotics
- Integration of speech, language, vision and action; programming service robots
- Development of new application scenarios for sensor-based service robots
- Robot systems for education

Medical robotics
- All aspects of manipulator and instrument control for complex surgical procedures, e.g. visualization of all types of patient data, haptic feedback for delicate handling, skill transfer, shared control, multi-manipulator cooperation

Cognitive robotics
- A comprehensive area of topics ranging from sensor models by the way of individual sensor processing entities (e.g. for high-speed face tracking) to high-level cognitive skills for navigation, adaptation, learning

Cyber-physical / Embedded systems
- Special emphasis on fault tolerance and high availability
- Special topics: design of very small redundant systems, associated software development models and tool chains.

Technische Universität München

The **MYOROBOTICS** project aims to improve the quality and reliability of the hardware involved and to make musculoskeletal robots readily available to researchers working in robotics and other domains (e.g. cognition, neuroscience), educators and the industry. The approach taken utilizes a modular design, involving components that can be easily interconnected in different ways to achieve required forms and functionality. These components will be mass-producible and reproducible (leveraging rapid prototyping techniques), improving cost-effectiveness and facilitating the transition to the market.

The **RoboEarth** project exploits a new approach towards endowing robots with advanced perception and action capabilities, thus enabling robots to carry out useful tasks autonomously in circumstances that were not planned for explicitly at design time. The core of the innovation proposed involves the development of a World Wide Web-style database: RoboEarth. RoboEarth allows robots to share any reusable knowledge independent from their hardware and configuration.

ECCEROBOT (Embodied Cognition in a Compliantly Engineered Robot). A new kind of robot is being developed by this project consortium – an anthropomimetic robot. Instead of just copying the outward form of a human, it copies the inner structures and mechanisms – bones, joints, muscles, and tendons – and thus has the potential for human-like action and interaction in the world.

OpenTL (Open Tracking Library). A general-purpose library for markerless tracking that provides a user-friendly high-level application programming interface (API) for the widest variety of methods and applications. It can handle multiple, simultaneous targets, visual modalities and sensors, making use of different Bayesian tracking schemes, representing object models of variable complexity, handling data association and fusion at different levels, and providing multi-threading and GPU-accelerated capabilities for real-time efficiency.

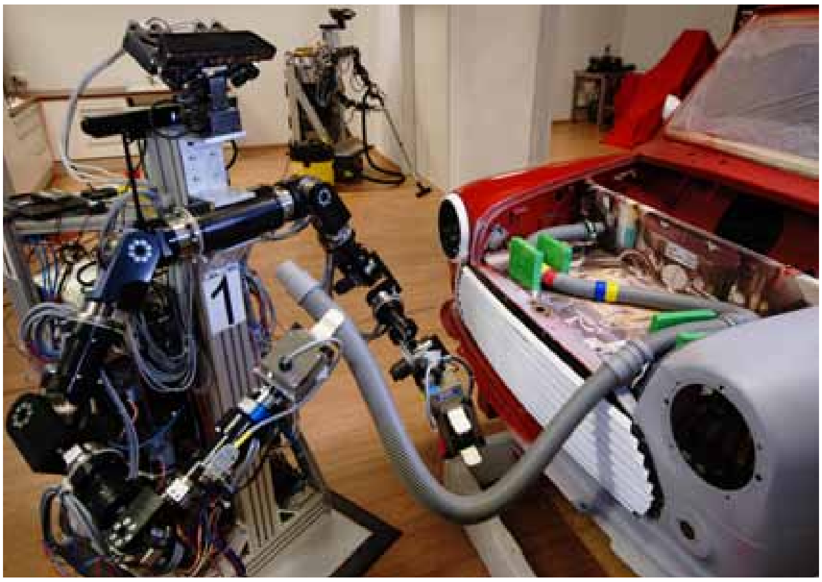
www.OpenTL.org

The **JAST (Joint-Action Science and Technology)** project aims to develop jointly-acting autonomous systems that communicate and work intelligently on mutual tasks in dynamic unstructured environments. A goal that is far-reaching beyond studying individual cognitive systems and that will expand the concept of „group" to „human plus artificial agent(s)". JAST will build cognitive systems that will be „socially aware", which will build trust and confidence in technology and finally, the ultimate tools that will result from the project will be applicable in industry and society.

ECHORD (European Clearing House for Open Robotics Development) is an EU-funded project within the Seventh Framework Program, aiming to strengthen the cooperation between scientific research and industry in European robotics. Via 51 small-scale projects ("experiments") ECHORD will bring about a large-scale introduction of robotic equipment into European research institutions. This is expected to result in both tangible and measurable outcomes in terms of the accelerated development of technologies, as well as the deployment of robotics technology into new scenarios for the direct application of research results.

Technische Universität München

Department of Electrical Engineering and Information Technology
Institute of Automatic Control Engineering
Industrial Automation Systems, Information-Oriented Control



Location
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Prof. Sandra Hirche
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The institute was founded in 1961 and thus is one of the oldest of its kind in Germany. Research and development at the institute is focused on novel control methods for complex nonlinear hybrid dynamical systems. Theoretical results are transferred into robotic and biomechatronic application fields. A major characteristic of most applications is a close interaction between human users and technical systems.

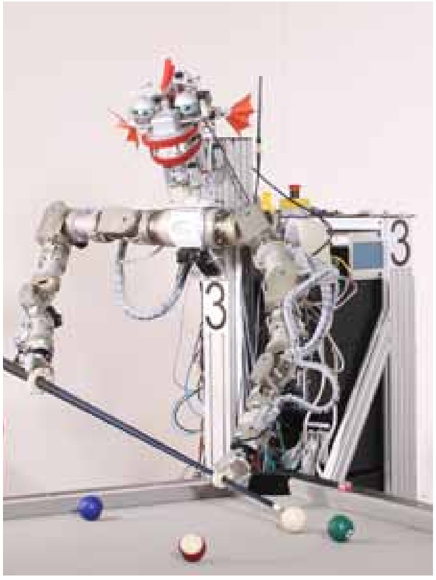
Based on fundamental research results, the institute focuses on applications in the following areas:

- High fidelity telepresence and teleaction
- Autonomous systems in human environments
- Dynamic human-robot interaction
- Multi-robot systems
- Biomimetic systems.

Technische Universität München

Fundamental Research. In fundamental control theory research, methods for the analysis and synthesis of complex, nonlinear and networked dynamic systems are investigated at the institute. The research portfolio includes methods for invariance control, optimal event-based and distributed control as well as reachability analysis and optimization of hybrid dynamic systems.

High Fidelity Telepresence and Teleaction. Telepresence and teleaction system provides the sensation of immersion into remote, inaccessible, or virtual environments to a human user. Moreover, the operator is enabled to manually interact with the remote environment. Important research challenges are the system design for multimodal immersion, the stabilization in the presence of communication/human/environment uncertainties as well as the human-centered system design and evaluation.



Autonomous Systems in Human Environments. Research in this field focuses on methods and technologies enabling autonomous robotic systems to act and interact in human-centered unstructured and dynamically changing environments. Particular focus is placed on understanding and interpreting the environment, navigating in densely populated areas, and retrieving missing information from passers-by through intuitive and human-inspired goal-directed interaction.

Dynamic Human-Robot Interaction. There is a strong need for seamless and intuitive human-robot interaction in personal and industrial robots in order to enable efficient and safe collaboration in joint work spaces. This research targets an integrated approach towards interaction in complex dynamically changing human-centered environments on various levels of abstraction. The main objective is to achieve fast and smooth coordination of joint action on human terms. The approach consists in a hierarchical framework to equip interactive robots with joint manipulation and action planning capabilities, means of representation of complex dynamic environments and human action, and communicative capabilities in order to account for human intentions and emotions.

Keywords
Control
Robotics
Mechatronics
Automation

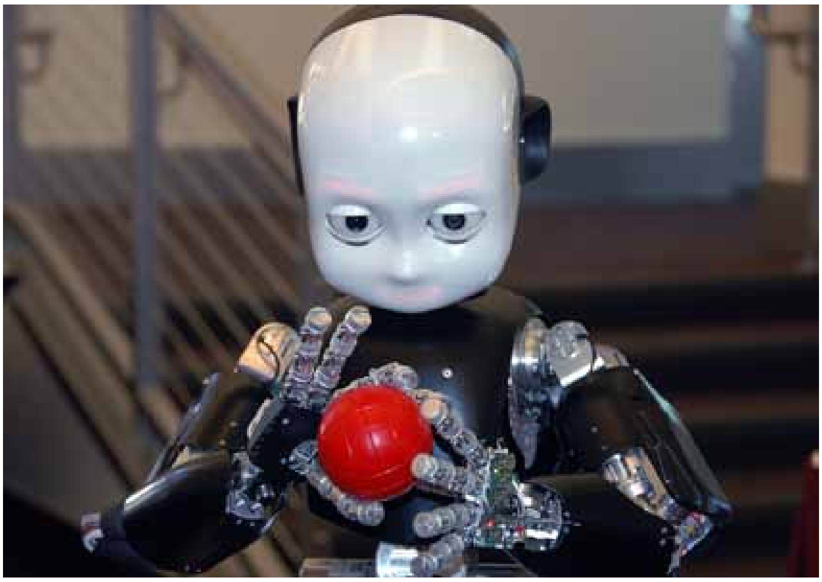
Multi-Robot Systems. One solution to design scalable and universal robot helpers are cooperative multi-robot systems, where the robotic systems support each other in order to achieve a common goal. In order to achieve a common goal, the involved robotic systems must be aware of each other, have shared goals, and actions of one robot contribute also to goals of other robots. Important research topics are cooperative/networked control for joint mobile manipulation and performance-optimal task allocation strategies.

Bio-Mimetic Systems. For many challenges in robotics, exemplary solutions can already be found in nature. The research in biomimetic systems is aimed at transferring functionalities of biological to technical systems, to either tackle specific problems or explore new possible fields of application. Of particular interest at the institute are bio-inspired mechatronic systems and information processing methods.

Technische Universität München

Technische Universität München

Department of Electrical Engineering and Information Technology
Institute for Cognitive Systems



Location
Germany
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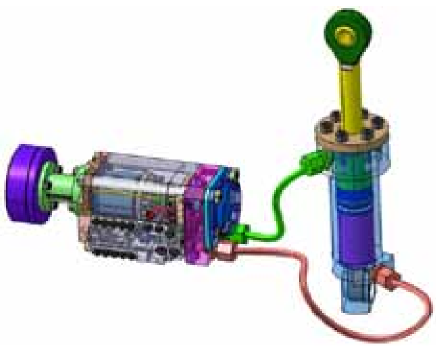
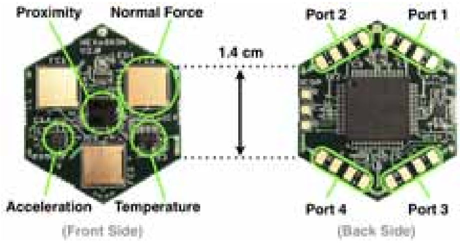
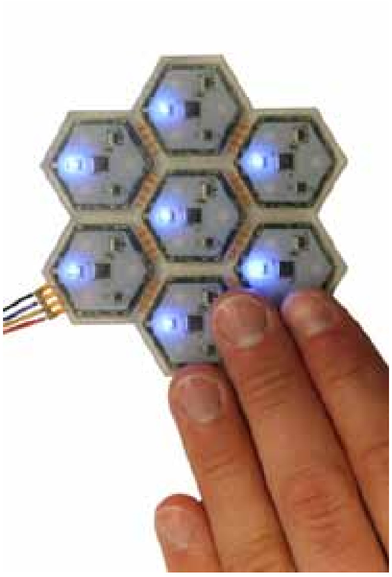
The Institute for Cognitive Systems deals with the fundamental understanding and creation of cognitive systems. As our research interests fall in line with the notion of "Understanding through Creating", three essential aspects motivate our approach [Cheng et. al. 2007]:

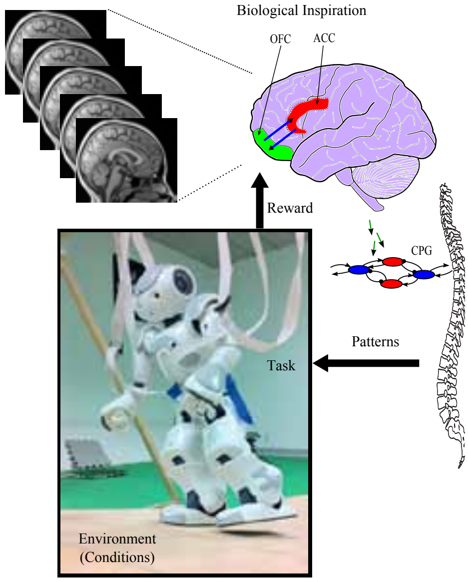
- In Engineering - Engineers can gain a great deal of understanding through the studies of biological systems, which can provide guiding principles for developing sophisticated and robust artificial systems
- Scientifically - Building of a human-like machine and the reproduction of human-like behaviors can in turn teach us more about how humans deal with the world, and the plausible mechanisms involved.
- For society - In turn we will gain genuine knowledge toward the development of systems that can better serve our society.



Technische Universität München



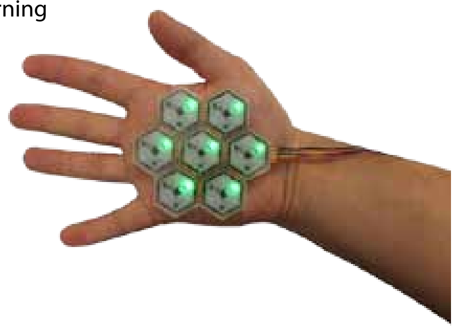


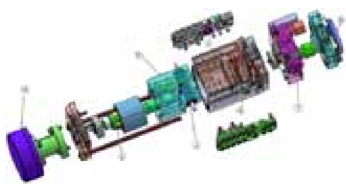


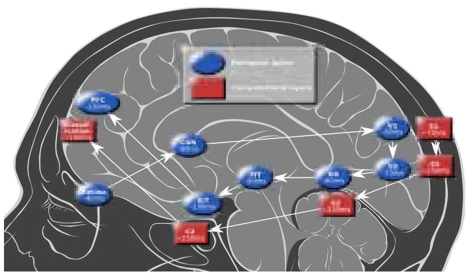
Research

- Artificial robotic skin
- Biologically inspired object recognition
- Compliant manipulation
- Cognitive architectures
- Humanoid cognitive communication
- Multi-modal tactile sensors
- Neural-based mechanisms for learning
- Reusable electronics
- Advanced actuators
- Social robotics.

Keywords
Artificial robotic skin
Biologically inspired object recognition
Compliant manipulation
Cognitive architectures
Humanoid cognitive communication
Multi-modal tactile sensors
Neural-based mechanisms for learning
Reusable electronics
Advanced actuators
Social robotics

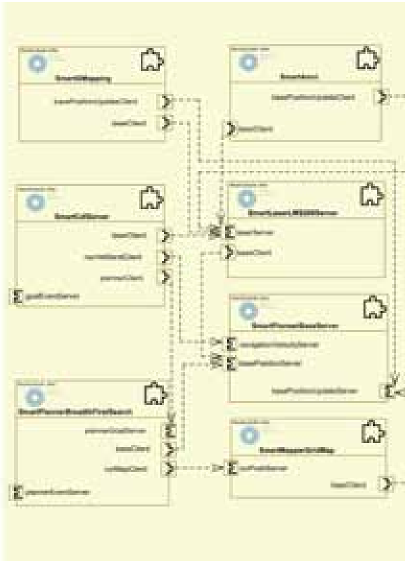






Ulm University of Applied Sciences

Department of Computer Science
Realtime Systems and Autonomous Robots



Location
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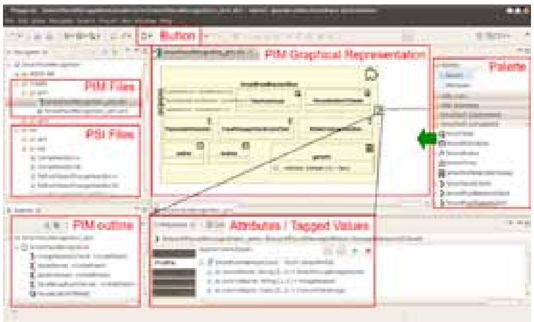
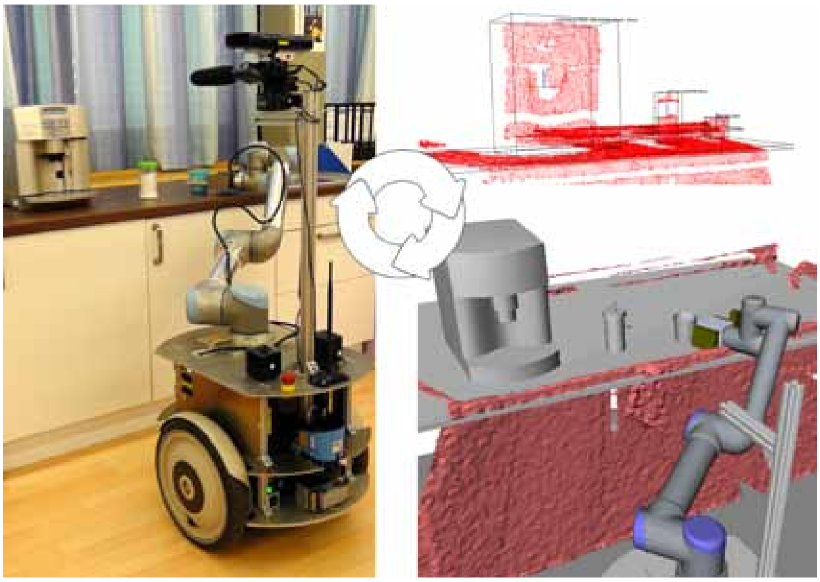
This lab pools the education, development and research activities in the field of real-time systems and autonomous robots.
Comprehensive lab equipment ranges from various real-time operating systems and development tools over embedded target systems to state-of-the-art robot systems (like P3DX, RMP50, Katana, UR Manipulator) and sensors (PMD, Kinect, laser rangers, vision).
The field of activity comprises principles, methods and applications of real-time systems, analysis and guarantees for real-time systems, design and implementation of real-time and embedded systems.
Aspects of complex distributed systems with resource constraints, probabilistic sensor data processing & sensor data fusion and systems integration under real-world conditions are addressed mainly in the domain of autonomous service robotic systems.
We prioritize our work to applied research and put it into work in practical applications.





Currently, a major focus of the lab's research activities is on model-driven software development for sensori-motor systems (separation of roles, separation of concerns) and on fully integrated service robotic systems:

- Model-driven software development for robotics
  http://smart-robotics.sourceforge.net
- Resource-aware SLAM (Simultaneous Localization and Mapping)
  http://smartslam.sourceforge.net
- Fully-integrated robotics real-world scenarios
  http://www.youtube.com/user/RoboticsAtHsUlm.

Keywords
Service robotics
Robot development process
Mobile manipulation
Model-driven software development
Multi-modal active object recognition

Hochschule Ulm

Universitat Politècnica de València

Instituto de Automática e Informática Industrial (ai2)

Location
Spain
Valencia

Website
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Contact
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martin@ai2.upv.es

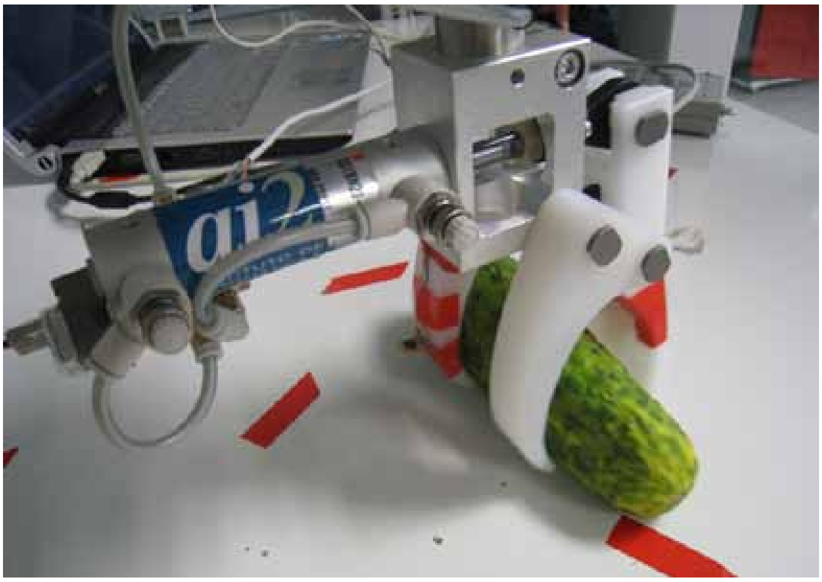
The Instituto de Automática e Informática Industrial, also known as the Institute ai2, is one of the most important research organizations at the Universitat Politècnica de València (UPV). Since our creation in 1999, our goal is the creation of new knowledge on robotics, automatization, control, computer vision and industrial computing and the application of our results to companies and institutions.

Instituto ai2 develops a multitude of R&D projects seeking to increase the value of local business and giving more competition, identifying the real needs of companies to provide feasible solutions tailored to their operation.
The participation in European and international projects allow us to become a key technological research center for the academic community and the industrial market.

UNIVERSITAT
POLITÈCNICA
DE VALÈNCIA

ai2
INSTITUTO DE
AUTOMÁTICA E
INFORMÁTICA
INDUSTRIAL

The research area on robotics of the Instituto ai2 is working more than 20 years on the study, analysis and development of basic and applied research to cover aspects of robotics such as control, sensors, planning and teleoperation of robots in several platforms (manipulator robots and mobile robots) for industrial and service applications.



Research lines

- **Inspection and manipulation of food products.** In this research line we work on food product damage characterization during its manipulation, the design of food grasping grippers with the use of new techniques, the use of tactile and inertial sensors for recognitions of food features or the development of quality inspections systems with hyper-spectral computer vision.
- **Robot dynamic control.** The objective of this line is to develop the research and the practical experiences in the field of the dynamic control of robots.
- **Active vision.** Our research on this line focus on the development of new knowledge and to transfer intelligent active vision systems into the industry.
- **Robot planning and navigation.** The main objective of this research is to innovate, implement and devise a navigation system for a mobile robot.
- **Humanoid robots.** From our experience developing mini humanoid robots and the participation on Robocup competition, our goal is to design and implement embedded systems for humanoid robots.
- **Aerial robots.** We are developing sensor based navigation and control systems for quadrotors in order to develop autonomous aerial vehicles.

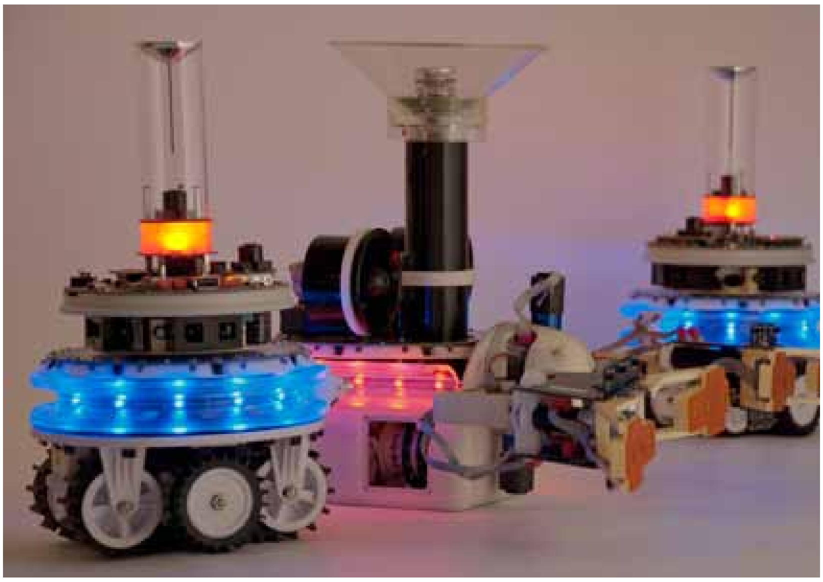
Keywords
Robot manipulation
Robot gripper
Dynamic control
Active vision
Robot planning
Robot navigation
Humanoids
Aerial robots

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

ai2 INSTITUTO DE AUTOMÁTICA E INFORMÁTICA INDUSTRIAL

Université Libre de Bruxelles

Engineering Faculty
Computer & Decision Engineering Department (CoDE)
IRIDIA (Artificial Intelligence Research Laboratory)



Location
Belgium
Brussels

Website
http://iridia.ulb.ac.be

Contact
Prof. Marco Dorigo
mdorigo@ulc.ac.be

IRIDIA is the Artificial Intelligence research laboratory of the Université Libre de Bruxelles. It is deeply involved in theoretical and applied research in computational intelligence.

The major domain of competence is swarm intelligence for robotics and optimization.

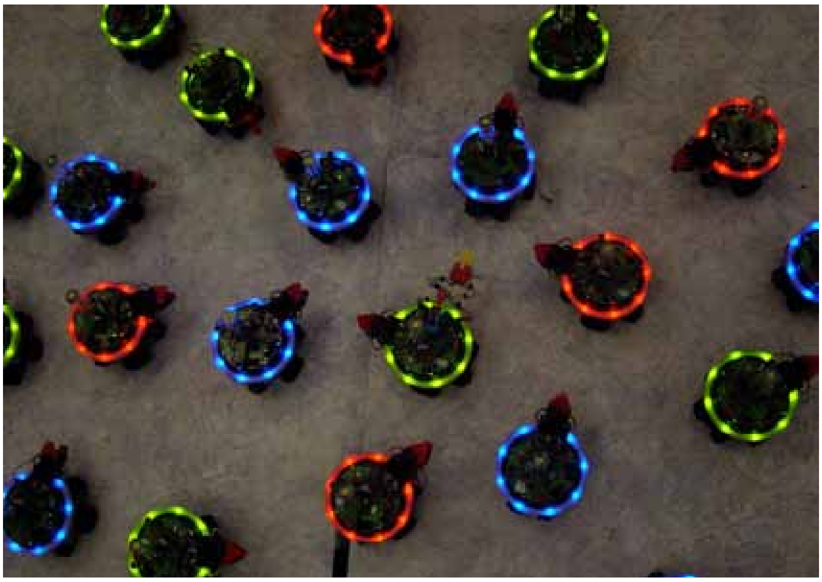
Our research program in swarm intelligence is centered around the design of algorithms or distributed problem-solving mechanisms using the collective behavior of social insect colonies as main source of inspiration.
In particular, we have proposed innovative algorithms for the solution of different types of optimization problems and for the control of swarms of robots.

We have coordinated two European Future and Emerging Technologies (FET) projects: Swarm-bots (*http://www.swarm-bots.org*) and Swarmanoid (*http://www.swarmanoid.org*).

IRIDIA
Institut de Recherches Interdisciplinaires et de Développements en Intelligence Artificielle

ULB

The main scientific objective of the Swarm-bots project was the study of a novel approach to the design and implementation of self-organizing and self-assembling artefacts. This approach was based in studies of the self-organizing and self-assembling capabilities shown by social insects and other animal societies.
The Swarmanoid project was the successor to the Swarm-bots project, and built on the results obtained during the Swarm-bots project. The main scientific objective of the Swarmanoid project was the design, implementation and control of a distributed robotic system made up of heterogeneous, dynamically connected, small autonomous robots. Collectively, these robots form what we call a Swarmanoid.



An award winning short video about Swarmanoid is available here:
http://www.youtube.com/watch?v=M2nn1X9Xlps

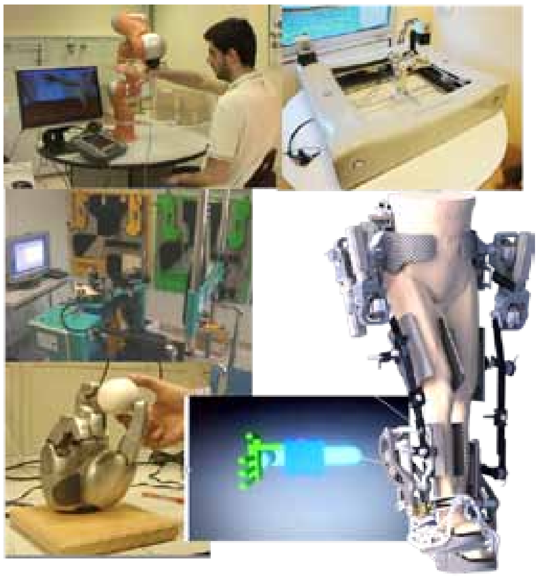
Our current research is mainly funded by the European Research Council via the Advance Grant „E-SWARM: Engineering Swarm Intelligence Systems" (*http://www.e-swarm.org*) whose goals are (1.) the development of scientific foundations for the engineering of artificial swarm intelligence systems, (2.) the creation of an engineering methodology for the construction of swarm intelligence systems, and (3.) the development of concrete tools and techniques with which to construct swarm intelligence systems.

We are also involved in the FET project ASCENS (*http://www.ascens-ist.eu*), where our goal is the exploitation of the autonomic service-component ensembles techniques developed within the project in a swarm robotics scenario.

Keywords
Swarm robotics
Swarm-bots
Swarmanoid
Ant colony optimization
Ant algorithm
Self-assembly

University Campus Bio-Medico Rome

Center for Integrated Research in Biomedicine and Bioengineering (CIR)
Biomedical Robotics and Biomicrosystems



Location
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Keywords
Rehabilitation and assistive robotics
Neurorobotics
Surgical robotics
Neuro-developmental bioengineering
Biomicrosystems

The Laboratory of Biomedical Robotics and Biomicrosystems has a solid background in human-centred design of robotic and biomechatronic systems for a variety of application domains, ranging from surgical, rehabilitation and assistive systems, prosthetics, neurorobotics and neuroengineering bio-inspired systems for environmental monitoring and hazardous environments, implantable devices, human augmentation and bionics, and more.

Lab facilities include CAD\CAE systems, rapid prototyping machines, clean room for in-house microfabrication, robot manipulators (KUKA LWR, InMotion 2 and 3, etc.), robotic exos, advanced systems for behavioral analysis, and more.

In the last decade the Lab has a consolidated track of 15+ peer-reviewed publications/year and 1 patent/year.

The Lab has a strong experience in EU-funded R&D projects, participated to FP6, ICT e-Health, NEST and Socrates\Minerva European programmes, and it currently participates in 4 FP7 (FET and ICT) European projects.

University Campus Bio-Medico Rome

Faculty of Engineering
Complex Systems & Security Laboratory

Location
Italy
Rome

Contact
Prof. Roberto Setola
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Website
http://www.unicampus.it/homepage

The Complex Systems & Security Laboratory carries out its activities within the Faculty of Engineering of the University Campus Bio-Medico of Rome.
Complex Systems & Security Lab aims to focus on fundamentals and research applications oriented to novel technological developments, in a wide range of application domains.

Main research topics

- Automation technologies
- Industrial automation
- Control
- Robotics
- Critical infrastructures protection
- Security
- Biomedical engineering
- Computer science.

Current Research Activities

Critical Infrastructures (CI) are essential to our vitality, safety and quality of life. Protecting and ensuring the continuity of CIs are crucial to the public security and health, economic vitality and societal life.

The mission of Complex Systems and Security Lab is to perform research and development, evaluate new technologies, practices and procedures supporting the improvement of durability, dependability, protection and resilience of CIs.

As well as on protection, part of our activities is focused on helping First Responders (FR), especially facing today's troubling threats.

Ensuring the smooth operation of emergency response professionals after a large scale emergency (terrorist attack or natural) is a crucial but complex challenge.

Our current research activities aim to develop an effective localization and communication service for indoor and deep-indoor emergencies, using mobile robot applications.

Some research activities on a fire-fighting robotic system for rescue and servicing has been carried out.

Our goal is to use the results of previous R&D projects and available industrial facilities to offer a solution ready to for FR, thus paving the way for a day-to-day use of effective location and communication services for indoor and deep-indoor emergencies.

More in details, our activities are focused on

- Reducing risks for FR
- Enhancing coordination tasks between FR professionals
- Improving indoor localization
- Allowing communication between emergency response professionals.

The work is being carried out using mobile robot applications and new technology solutions, working in strictly cooperation with national and international companies, R&D centers and universities.

Keywords
Critical infrastructure protection
Industrial automation
Rescue mobile robots
Indoor localization

UNIVERSITÀ CAMPUS BIO-MEDICO DI ROMA

University Joseph Fourier

School of Medicine
Techniques for biomedical engineering and complexity management (TIMC-IMAG)
Computer Assisted Medical Interventions Group (CAMI / GMCAO)

Location
France
La Tronche

Website
http://www-timc.imag.fr/cami

Contact
Dr. Jocelyne Troccaz
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The ultimate objective of the Computer-Aided Medical Interventions (CAMI) research group is clinical: the purpose is to assist the physician or surgeon in the successful execution of diagnostic or therapeutic gestures by minimizing invasiveness whilst improving accuracy.

This general objective involves the quantitative processing of multi-modal patient data and medical knowledge, the fusion of all those information, the planning of an optimal strategy for diagnosis and therapy and the ability to transfer safely and accurately this plan to the operative conditions.

This last stage is performed through navigational or robotic assistance. Simulation may also assist the planning phase or the educational part of surgery. This general framework results in multi-disciplinary research, technological development, clinical evaluation and industrial dissemination. The CAMI group activity follows those lines.

Université Joseph Fourier GRENOBLE

TIMC

The main skills of the team are in medical imaging, biomechanical modeling and simulation, biomedical engineering and robotics.

The CAMI team, created in 1985, has been a pioneer in the medical application of robotics: developing one of the first robots for neurosurgery (first patient in 1989 and thousands of patients treated), proposing the concept of synergistic devices (also called co-manipulation) and developing new generation of clinically used "on body" robots. Several of these robots are industrial products: for instance the Neuromate system for neurosurgery; more recently the Viky system from Endocontrol Medical for endoscopic procedures.

This robot won one Euron Award for Technology transfer. More than 10 companies were created to make products from laboratory concepts and systems. More than 60 international patents protect the team Intellectual Property.

CAMI team is a multidisciplinary team of about 35 persons (including permanent staff, PhD and postdocs) coming from different disciplines (computer science, applied mathematics, biomedical engineering, robotics, medicine).

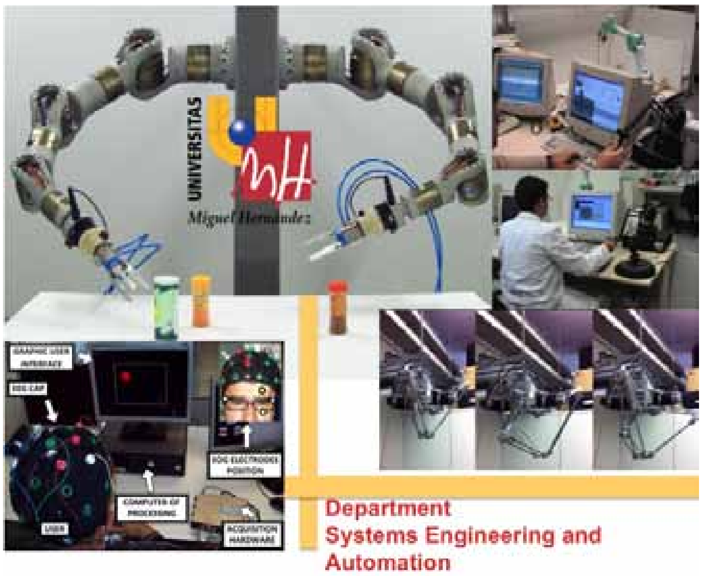
The CAMI group belongs to the ROBOTEX French national network of robotic platforms and is responsible for the "Medical Robotics" subnetwork. CAMI has launched a Center of Excellence ECCAMI (*www.eccami.com*) which purpose is to gather academics, clinicians and industrial partners and to shorten the time from the concept to the used system.

Keywords
Medical robotics
Medical imaging
Biomechanical modelling and simulation
Bioengineering

cnrs

University Miguel Hernandez de Elche

School of Engineering of Elche
Department of Systems Engineering and Automation



Location
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Website
http://disa.umh.es

Contact
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j.sabater@umh.es

The School of Engineering of Elche (EPSE) is a centre where Industrial and Telecommunications engineering degrees and masters are taught. Annually, 450 students enrol in the university every year to study at this centre which at present has more than 2300 students.
The School has a staff of more than 120 lecturers who combine their teaching duties with research in diverse fields linked to industrial engineering and telecommunications engineering.

Material resources, laboratories and research equipment enable students to carry out their final degree projects, as well as becoming familiar and have hands on experience with advanced techniques and technologies in their specific areas.

UNIVERSITAS
Miguel Hernández
de Elche

The Systems Engineering and Automation Department has 12 full-time lecturers and 4 part-time lecturers. It focuses its teaching and research work on automation technologies, control, systems engineering, computer vision, robotics, biomedical engineering and computing sciences.
The Department is involved in teaching Industrial and Telecommunications Engineering courses both at a Technical and Degree level.
The Department also participates in Masters and Doctoral programs in Industrial and Telecommunications Technologies, and in Bioengineering.
The Department focuses its research interests on the design and control of new robotic devices, human-robot interaction and multimodal interface for different application fields: industrial and service sectors, medical and surgical robotics and rehabilitation and assistive devices.

The Department of Systems Engineering and Automation has participated in several research projects dealing with robotic manipulation such as the project „Automatic learning systems in control architectures for robot Teleoperation". This project proposes the development of a teleoperated system with a high degree of automation, which learns tasks previously done by an operator. In this project, some major results are related with the robot grasp learning, force control and simulation environments.
Others were the project „Modelling of Virtual environments for training in teleoperated systems for dynamic environments" and a joint research program between the Department and DFKI in Germany on sensor based bimanual manipulation of complex and deformable objects in different dynamic environments.

Keywords
Design and control of robotic devices
Parallel robots
Teleoperation and haptics
Multimodal interfaces
Bimanual manipulation

UNIVERSITAS
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de Elche

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The Miguel Hernandez University (UMH) is a public young dynamic university, placed in the Southeast of Spain, a high economical and enterprising potential area. UMH is an advanced University equipped with the most modern infrastructures and technological equipment which make it possible to be strong in research, with specialized units directed by professional people of high prestige.

Together with the biomedical groups of the Faculties of Medicine, Engineering, Chemical Technology and Computer Science, the UMH-IB group constitutes the Bioengineering Institute (over 100 researchers), which has a large expertise in biomedical engineering and multidisciplinary research activities.

UNIVERSITAS
Miguel Hernández
de Elche

The Bioengineering Institute has established numerous research and collaborations with both academic and industrial partners all over Europe, USA and Asia. Furthermore the UMH-IB is linked to the professional world through agreements of collaboration with hospitals, companies and institutes in order to accelerate developments in medical technology and health care.

Biomedical Neuroengineering Research Group at UMH-IB is composed by two research units: Virtual Reality and Robotics Lab and Neuroprosthesis and Neuroengineering Lab.
It focuses its research interests on medical and surgical robotics, rehabilitation and assistive devices, medical image, human-robot interaction, human-robot interfaces, computer vision, development of devices capable of two-way interaction with the nervous system (recording and stimulation), in vitro and in vivo biocompatibility studies, neuroimaging and brain plasticity.

The group is composed by 1 professor, 4 associated professors, 4 Phd engineering, 1 Phd biomedical engineering, 6 Ms engineering 3 Ms biology, 2 Ms chemistry, 3 PhD students, 5 technicians and more than 15 graduate students.

The research group is the coordinator of multiples European and national projects related with the development of devices capable of two-way interaction with the nervous system, rehabilitation robotics, human-machine interfaces, surgical robotics, multimodal interfaces, brain machine interfaces and control and design of robotic devices.

Keywords
Medical robotics
Rehabilitation robotics
Assistive robotics
Surgical robotics
Medical imaging
Brain machine interfaces
Multimodal interfaces
Brain plasticity
Neuroimaging

University of Almeria

Department of Languages and Computing
Automatic Control, Electronics and Robotics R&D Group


Left: Fitorobot
Right: Inversos robot

Location
Spain
Almería

Website
http://aer.ual.es

Contact
Manuel Berenguel Soria
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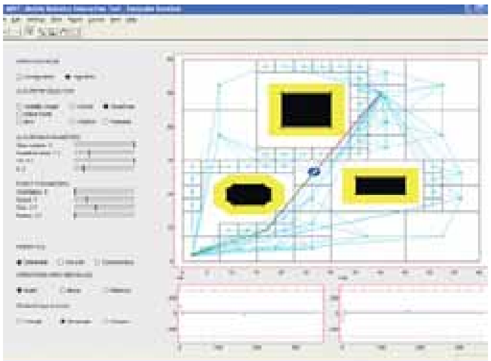
The Automatic Control, Electronics, and Robotics research group (AER, code TEP197 of the Andalusian R&D Plan) is composed by 28 researchers, 12 PhD and 16 engineers. The group also belongs to the Agrifood Campus of International Excellence (ceiA3). It is composed by a multidisciplinary team of researchers.

The main research lines are:
- Predictive, adaptive and robust control
- Modeling and simulation of industrial processes
- Electronics, mechatronics, robotics
- Design and construction of robots
- Energy efficiency and comfort control in buildings
- Control and robotics techniques applied to agriculture
- Renewable energy
- Biotechnology and bioengineering
- Control education
- Vehicle dynamics
- Vibration analysis in machines.

In the group there are some research lines dedicated to robotics, which are summarized in the following:

Mobile robotics

- Design and development of mobile robots for agricultural tasks. A mobile robot has been developed, named Fitorobot, with the main objective of replacing human beings to perform dangerous tasks inside of greenhouses. Furthermore, this robot can also be teleoperated. This project has received several awards. Another interesting project is the Inversos robot in which a mobile robot can perform different tasks inside a greenhouse such as spraying, transport, etc. It is controlled using an interesting guiding system based on laser
- Interactive tools aimed at facilitating the understanding of algorithms and techniques involved in solving mobile robotics problems.



Left: Electric vehicle
Right: Mobile Robot Interactive Tool (MRIT)

One of these tools is called MRIT (Mobile Robot Interactive Tool) and it can be downloaded from *http://aer.ual.es/mrit*

- Virtual and remote laboratories of parallel robots for teaching purpose
- Assistant mobile robots for guided-visits
- Telerobotics applies to mini-mobile robots for teaching purposes
- Dynamical modelling and control of biped robot
- Dynamical modelling and tracking robust control of tracked vehicle
- Visual odometry-based localization strategies and slip compensation controllers for mobile robots operating in off-road conditions
- Autonomous guidance of electric vehicles with optimal energy management.

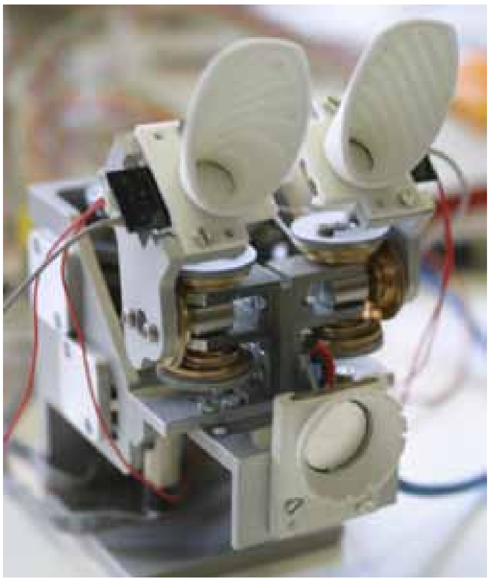
Keywords
Agricultural robotics
Energy-efficiency robotics
Off-road robotics

Industrial robotics

- Development of a SCADA software tool for remote programming and supervision of industrial robots
- Simulation tools of industrial robots for teaching purposes
- The group also collaborates with companies to improve their production chains by introducing robotic arms (industrial robots) and other automation systems.

University of Antwerp

Faculty of Applied Economics
Active Perception Lab



Location
Belgium
Antwerp

Website
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Keywords
Sonar
Biomimetic sensors
Robot navigation

The work in the lab is oriented towards the development of biomimetic sensors for environment perception by autonomous systems. This interdisciplinary research is directed at the study of biological sensory systems with the aim of extracting a better understanding of the engineering solutions nature, after a very long evolutionary optimization process, has come up with.
We maintain that the regions of the design space explored by nature are sufficiently different from the ones explored by human engineers that this approach can function as a source of interesting, new, ideas for engineered systems as well.
Because biological organisms and their environments form tightly coupled interacting systems in which all components (environmental characteristics and dynamics, sensory morphology, peripheral and central neural processing and behavioral patterns) play a significant role our research will be carried out at three levels simultaneously: The morphology and mechanics, the signal processing, and the behavioral strategies of the model animal systems.
Extraction of significant environment information is considered an emergent property from processing going on at all three levels.

Universiteit Antwerpen

University of Aveiro

Department of Electronics, Telecommunications and Informatics (DETI)
Institute of Electronics and Telematics Engineering of Aveiro (IEETA)

Location
Portugal
Aveiro

Website
http://www.ieeta.pt

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The Institute of Electronics and Telematics Engineering of Aveiro (IEETA) is one of the Research Units of the University of Aveiro. It is the Research Unit 127/94, approved by the Portuguese Foundation for Science and Technology (FCT).

The mission of IEETA is the creation, transmission and transfer of knowledge. We do multidisciplinary research and advanced development on electrical and computer engineering, and computer science, integrated in the international research community and contributing to the technological and social development of our country.

Innovative biomedical technologies and intelligent robotics are our two main application areas.

universidade de aveiro

The transverse activity on Intelligent Robotics was created in IEETA in 1999, acknowledging the strategic importance of developing this field of research in the institute. IEETA (officially, the University of Aveiro) is involved in the European Robotics Research Network (EURON) and its interest groups.

The robotics team counts currently with 15 PhD staff researchers, 2 Post-Docs and several PhD, Masters and undergraduate students. Research covers a broad range of topics, including human-robot interaction, robot learning, humanoid robots, multi-robot systems, distributed control architectures for robotics, and robots in education.

As a means of demonstrating the results of its R&D achievements, we have been actively involved in robotic competitions. Among others, we host the CAMBADA project, the RoboCup middle-size league soccer team of the University of Aveiro (see picture). This has been one of the most successful teams in the MSL RoboCup league.

Service robots are also a current topic of interest and research at IEETA. We have been working on the integration of reactivity, deliberation, learning and interactivity for intelligent robots, and we are currently collaborating (on the context of the RACE FP7 project) on the development of an artificial cognitive system able to build a high-level understanding of the world it inhabits by storing and exploiting appropriate memories of its experiences.

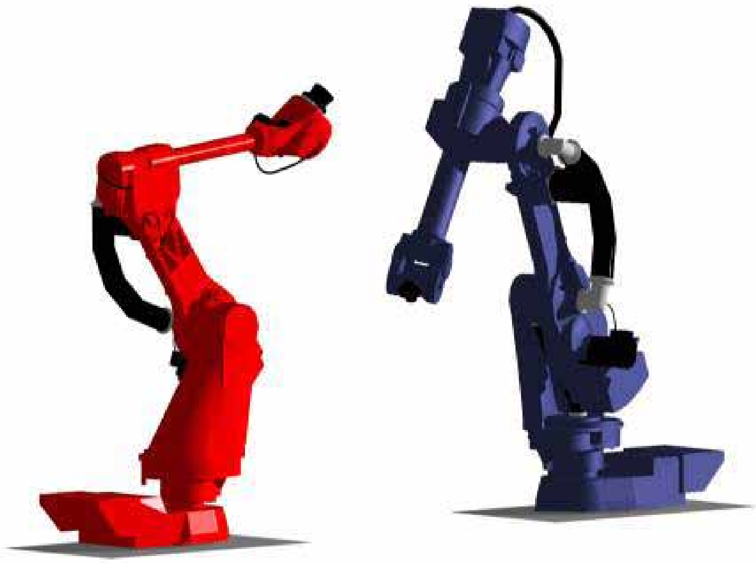
Keywords
Multi-robot systems
Anthropocentric robotics
Autonomous driving
Educational robotics

ieeta instituto de engenharia electrónica e telemática de aveiro

PRISMA Lab

University of Basilicata

School of Engineering (SI-Unibas)
AREA Laboratory (Automation, Robotics and Applied Electromagnetism)



Location
Italia
Potenza

Website
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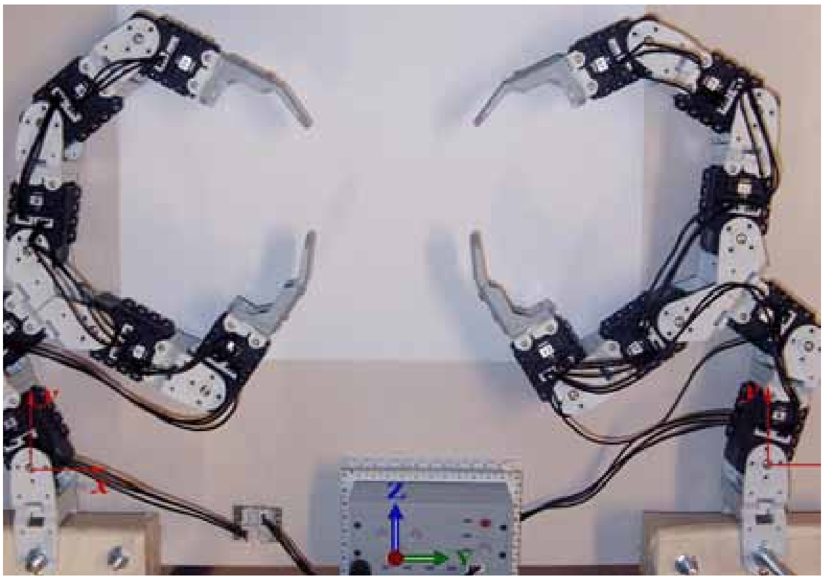
The AREA Laboratory (Automation, Robotics and Applied Electromagnetism) has been established in 2001 at the Department of Environmental Engineering and Physics of the University of Basilicata. The laboratory is currently part of the School of Engineering of University of Basilicata (SI-Unibas)

The research activities carried out at the AREA Lab, are related to automatic control and robotics.

Main research topics

- Fault diagnosis
- Cooperative manipulators
- Multi-robot systems
- Bi-manual robotic systems
- Process control.



The AREA Laboratory hosts a research group active in robotics, mechatronics and process control, which has achieved relevant research results in the following fields:

- Motion planning and control for industrial robot manipulators
- Fault diagnosis for robot manipulators
- Monitoring and control of batch chemical processes
- Force/motion control of cooperative manipulators
- Decentralized control of multi-robot systems.

The laboratory staff is currently composed by 1 professor, 1 assistant professor, 1 Ph.D. student and 1 junior researcher. The laboratory is involved in several research projects funded by the Italian government and EU.

The AREA laboratory is part of the PRISMA network (national) and of the European Robotics Research Network (EURON).

Keywords
Industrial robotics
Multi-robot systems
Manipulation

UNIVERSITÀ DEGLI STUDI DELLA BASILICATA 1982

PRISMA Lab

University of Belgrade

Institute Mihajlo Pupin
Robotics Laboratory

Location
Serbia
Belgrade

Website
http://www.pupin.rs/RnDProfile

Contact
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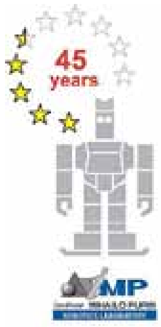
Robotics Laboratory is a part of Mihailo Pupin Institute in Belgrade, Serbia, which is a member of University of Belgrade. The basic activity of Robotics Laboratory represents research and development in the area of robotics and control of large-scale dynamic systems.

We are strongly oriented towards design of robotic hardware/software and practical implementation of robotic systems in industry, medicine, society, education, ecology, etc.
Our research directions are oriented towards advanced implementations of biotechnologies and artificial intelligence in different areas of human activities, with aim to improve the quality of human life.



Robotics Laboratory offers broad knowledge and experience in robotics, automation and control engineering.

Special competency is focused on humanoid, service and rehabilitation robotics, with emphasis on the following particular topics:

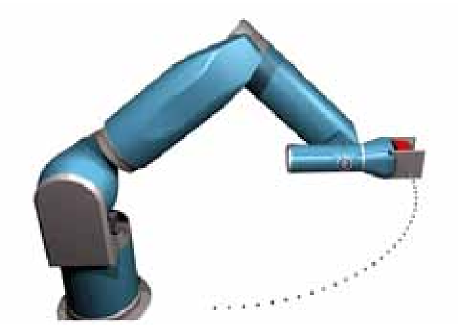
- Advanced robotic cognition
- Modeling and control of humanoid robots
- Human biocybernetics
- Service robotics
- Unmanned autonomous robotic systems
- Multi robot systems
- Modeling and control of robot manipulators.

Keywords
Service robotics
Humanoid robotics
Intelligent and cognitive robotics

institute MIHAILO PUPIN
ROBOTICS LABORATORY

University of Belgrade

School of Electrical Engineering
Signals & Systems Department
ETF Robotics Research Group



Location
Serbia
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Website
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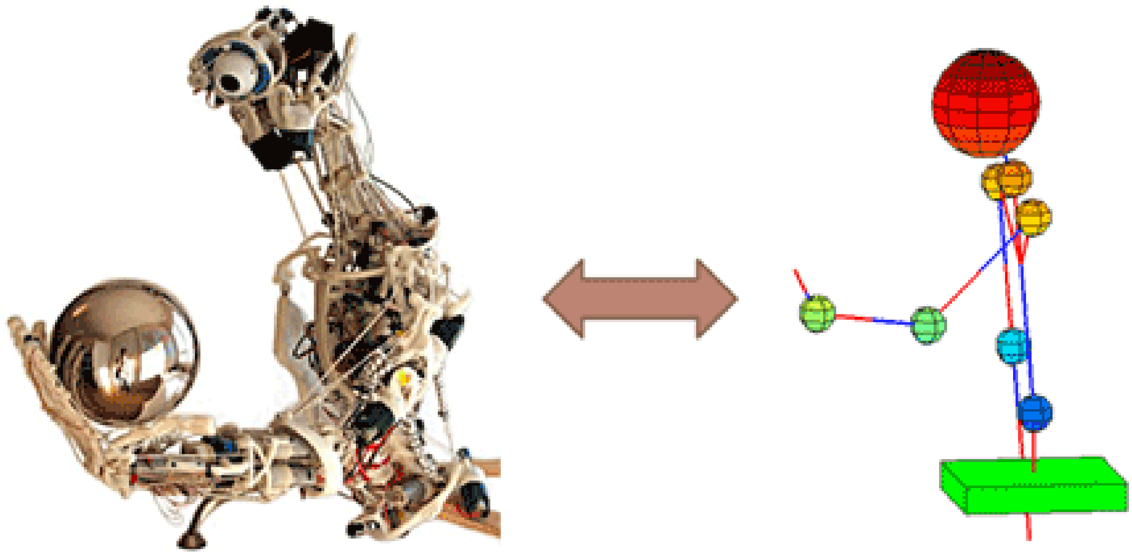
ETF Robotics is a research group situated at the University of Belgrade, School of Electrical Engineering (ETF), Signals & Systems Department.
The group is coordinated by Professor Veljko Potkonjak. Researchers associated with the ETF Robotics group are mostly PhD, MSc or BSc students at the School of Electrical Engineering in Belgrade. They are all very ambitious, hard working, but very cheerful and enthusiastic young people who are ready to learn, cooperate, and share what they have already done and learned.
Our members currently participate or have participated in several international & domestic (Serbian) research projects regarding humanoid and industrial robotics such as ECCEROBOT, Virtual Robotic Lab, Robots in Sports, Robotic Handwriting, etc.

ETF Beograd

Signali i sistemi – Katedra i Odsek
Signals & Systems Department

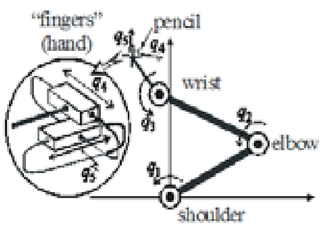


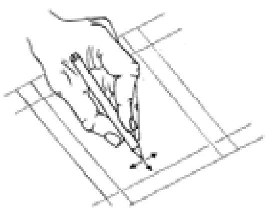
Research areas

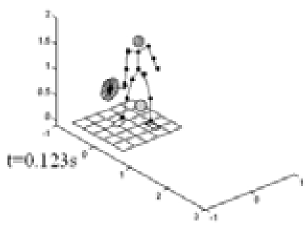
Our research focus includes mathematical modeling of a robot dynamics, robot interaction, simulation, control, and related applications of the robotic systems with a focus to novel robotics structures and actuation – anthropomimetics and bio-inspiration. Our research activities are also oriented towards education in the field of Robotics and Mechatronics. Therefore, we are developing advanced virtual laboratories for engineering disciplines in order to overcome the main obstacle in e-learning in technical sciences.

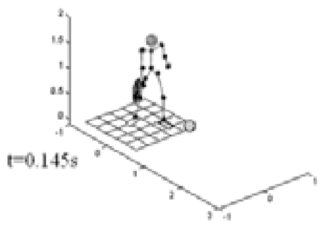
Keywords

CAD systems for robots
Dynamic analysis of human and humanoid motions in sports
Bio-inspired robotics
E-learning in robotics
Virtual laboratories in robotics and mechatronics





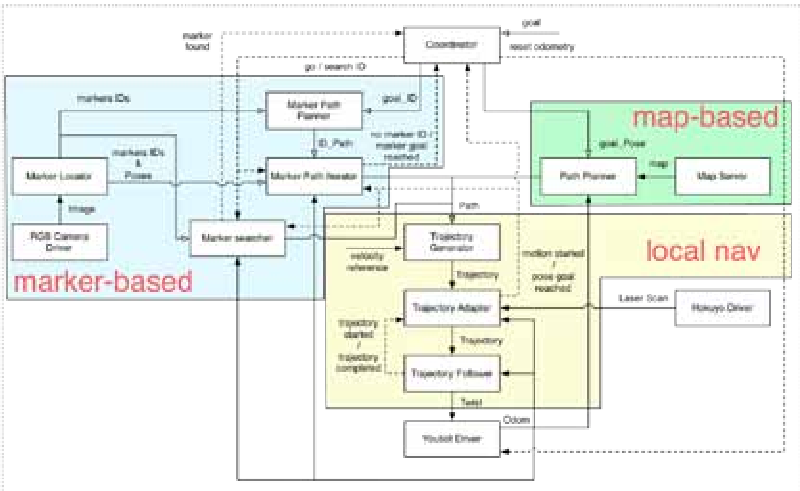




ETF Robotics

University of Bergamo

Faculty of Engineering
Information Technology and Mathematical Methods
Software for Experimental Robotics Lab (SERL)



Location
Italy
Bergamo

Website
http://robotics.unibg.it

Contact
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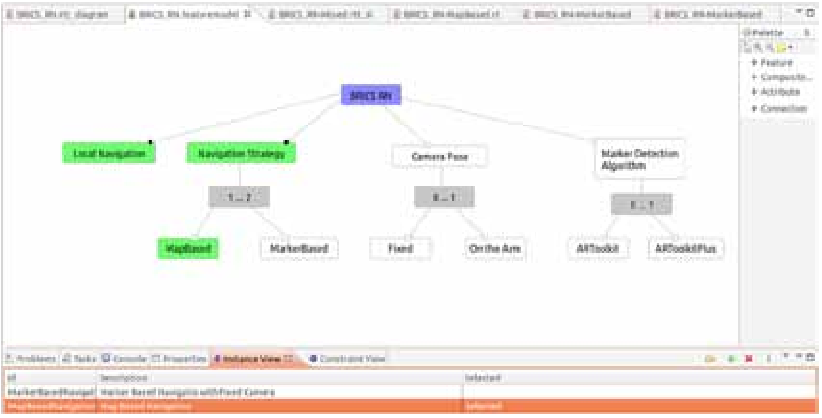
Research

The research activities of the SERL laboratory mainly focus on the definition and experimentation of software engineering techniques and methodologies for robotics systems. The underlying motivation is to support a faster and more efficient development of robotic software systems that are reusable in different scenarios, insensitive with respect to variations in the underlying hardware configuration, flexible enough to meet the requirements of a continuously evolving application field, easy to understand, use and maintain. In particular, the efforts are focused in the fields of mobile robotics and mobile manipulation in which the need for effective software engineering techniques is motivated by the simultaneous presence of several tasks such as planning, navigation, localization, obstacle avoidance and manipulation. In this fields our research is driver by the most advanced Software Engineering techniques and methodologies, such as Stability Oriented Domain Analysis, Component Based Development, Model Driver Engineering and Domain Specific Languages. In order to support these techniques we also focus on the development of software tools mainly based on the Eclipse framework.

Education

The SERL laboratory contributes in the training of engineers of the computer science area by means of lectures and hands-on experiences. Key issues include robot programming, robot simulation, embedded systems design and microcontroller programming, computer vision and 3D perception techniques, mechatronics and real-time systems. Young engineers can benefit of the presence of several robots such as an industrial manipulator, a KUKA youbot mobile manipulator, a Pioneer mobile robot and custom made robotic systems.



Industry Collaboration

The SERL laboratory provides services in supporting robotic and automation industry such as preliminary studies for new technologies or systems, design of prototype applications for embedded and real-time systems and development of software intensive systems.

BRICS European Project

BRICS is a collaborative project funded under the European Union´s Seventh Framework Programme (FP7) with partnerships both in academia and industry. Its prime objective is to structure and formalize the robot development process and to provide tools, models, and functional libraries, which help accelerating this process significantly. In this context the role of the University of Bergamo consists in defining design principles and implementation guidelines to develop and re-engineer open and flexible robotic software systems.

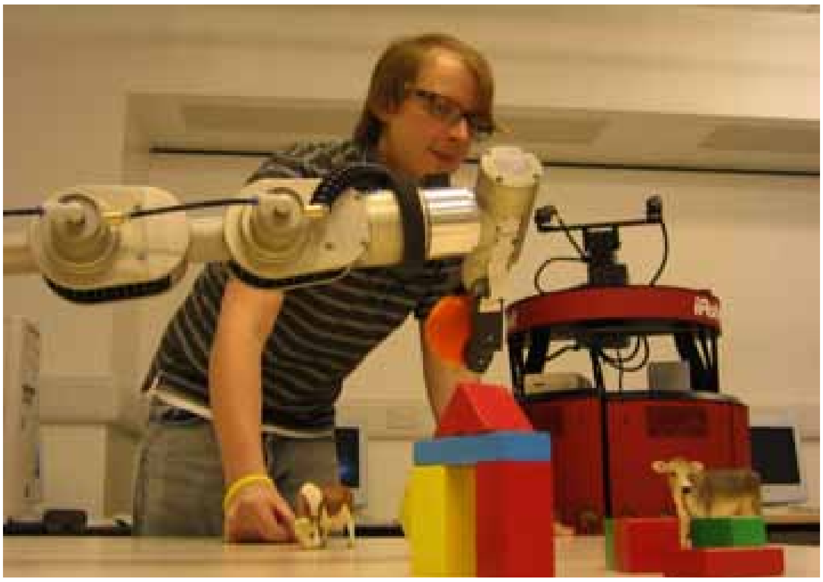
Further Directions

- Resource management and quality of service negotiation
- Runtime reconfiguration of robotic software systems
- Multi-language programming
- Domain specific modeling languages.

Keywords
Software engineering for robotics
Software architectures
Distributed control systems

University of Birmingham

School of Computer Science
Intelligent Robotics Laboratory



Location
United Kingdom
Birmingham

Website
http://www.cs.bham.ac.uk/research/groupings/robotics

Contact
Prof. Ales Leonardis
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The Intelligent Robotics laboratory is a leading team in a number of areas of high-level reasoning for robots. These include:

- The construction of complete intelligent systems, including how to integrate data from multiple subsystems and use it to reason about the world and for decision-making
- Robot vision
- Planning and decision-making under uncertainty
- Statistical machine learning
- Fault diagnosis and execution monitoring for autonomous systems
- Grasping and manipulation
- Dexterous movement in both humans and humanoid robots.

UNIVERSITY OF BIRMINGHAM

The group also collaborates extensively with psychologists and neuroscientists on developing computational models implemented in robots to test ideas about how intelligence can and should work; some lab members work with other experts in biological intelligence.

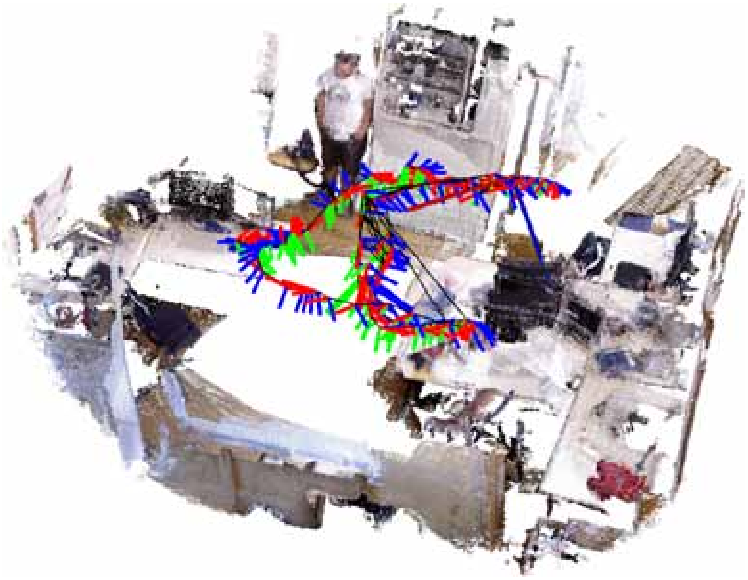
Our work is facilitated by external research funding. Projects that are in progress, or due to start, are worth in excess of 2.2 million pounds thanks to the financial support of European Commission IST Directorate Cognition Unit, the Leverhulme Trust, and the Engineering and Physical Sciences Research Council (EPSRC).

Keywords
Planning
Bayesian reasoning
Integration
Vision
Manipulation
Autonomy
Cognitive robotics
Diagnosis
Control

UNIVERSITY OF BIRMINGHAM

University of Bonn

Faculty of Mathematics and Natural Sciences
Institute for Computer Science VI
Autonomous Intelligent Systems Group (AIS)



Location
Germany
Bonn

Website
http://www.ais.uni-bonn.de

Contact
Prof. Sven Behnke
behnke@cs.uni-bonn.de

The Autonomous Intelligent Systems Group conducts research in the areas of cognitive robotics, computer vision, and machine learning.
Our goal is to create intelligent robot systems capable of interacting with the complexities of the real world.

Key challenges include the systematic treatment of uncertainties, the modeling of the environmental state, the coordination of teams of cooperating robots in dynamic environments, the interaction with humans, and learning.

The group has extensive experience in developing perception systems for robots, including learning object-class segmentation of images, object recognition, and 3D modeling of objects or mapping of environments using RGB-D cameras. The group has also significant experience in learning for control and planning for robot navigation and object manipulation. In the ECHORD experiment ActReMa that University of Bonn coordinates, for example, the group is planning grasping motions for bin-picking of unordered objects.

The Autonomous Intelligent Systems Group developed the humanoid soccer robots of team NimbRo, which won many international RoboCup competitions. The lab also investigates intuitive multimodal human-robot interaction, mobile manipulation, as well as autonomous flying robots (UAVs). The group developed the cognitive service robots Dynamaid and Cosero, which competed with great success at the international RoboCup competitions, winning the last two.

Keywords
Cognitive robotics
Semantic perception
Efficient action planning
Humanoid robotics
Autonomous flying robots

University of Bremen

Physics and Electrical Engineering
Institute of Automation (IAT)

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Website
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Contact
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The main research areas of the robotics group of the Institute of Automation (IAT) are assistive and rehabilitation robotics.

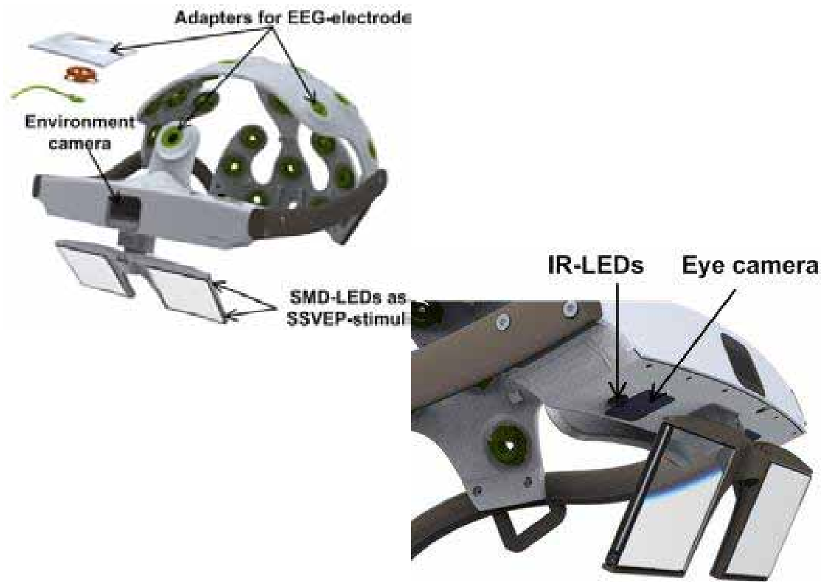
Since 1997, researchers in the group of Prof. Axel Gräser have been developing the assistive robot FRIEND (*www.friend4you.eu*) for supporting independent living of persons who have chronic or degenerative limitations in motor abilities, such as the severely disabled and the elderly. After three evolution steps, the robotic system FRIEND is now able to support end-users in all-day-living (ADL) and professional life activities, such as work in a library. In the EU - funded project CORBYS (*www.corbys.eu*) and in the national (German) project MOPASS, the IAT researchers, together with the project partners, are developing robot-assisted gait rehabilitation systems.

The IAT research and development is characterized by human-centered approach and focus on the following main components for assistive and rehabilitation robotic systems.

Universität Bremen

Control architecture. The multi-layered software architecture MASSIVE was developed to support control of complex IAT robotic systems. Starting from the MASSIVE principle, novel integrated cognitive robot control architecture will be researched, designed and validated in the CORBYS project. CORBYS architecture supports robot-human co-working with high level cognitive capabilities such as situation-awareness, attention control and goal-setting prioritization.

Environment perception for robotic applications. One of the main IAT research topics is the capability of a robot to visually perceive its environment including humans to enable autonomous robot operation in unstructured environment.



Safety. Represents an essential research topic of the IAT as the most important characteristic of a human-centered robotic system. An intelligent safety system for FRIEND, including formal analysis of hazardous situations and application of supervisory control, was researched through different projects. The concept is a basis for development of safe robotic systems in current IAT projects such as CORBYS and MOPASS.

HMI. Multimodal and easy to use human machine interface is a crucial part of assistive and rehabilitation robotic systems. Through different generations of the system FRIEND different types of HMIs were researched. Among them BCI (Brain-Computer Interface) became one of the main RTD activities of the IAT. Throughout multiple research projects, IAT researchers gained expertise in different BCI approaches. Based on the results of fundamental research at the IAT, the transfer project sBCI realised by Friedrich-Wilhelm-Bessel-Institute Research Company and coordinated by Prof. Gräser was devoted to an easy to use hybrid BCI (see fig. bellow) enabling control of home devices or robotic systems like FRIEND.

Keywords
Multi-layered software architecture
Cognitive robot control
Robot vision
Formal safety analysis
Supervisory control theory
HMI
Brain-computer interface (BCI)

University of Bristol

Bristol Robotics Laboratory (BRL)

Location
United Kingdom
Bristol

Website
http://www.brl.ac.uk

Contact
Prof. Chris Melhuish
Chris.Melhuish@brl.ac.uk

Bristol Robotics Laboratory is the leading and largest academic centre for multi-disciplinary robotics research in the UK. It is a collaborative partnership between the University of the West of England (UWE, Bristol) and the University of Bristol, and home to a vibrant community of over 70 academics and industry practitioners, which lead current thinking in service robotics, intelligent autonomous systems and bioengineering.

An internationally recognized Centre of Excellence in Robotics, BRL's state-of-the-art laboratory covers an area of over 2,700 square metres and houses workshops, wet labs, laser cutters, rapid prototyping facilities, and two flying arenas with multiple 3D motion capture systems, as well as seminar rooms and a fully equipped video conference suite. It is a unique collaboration that harnesses the collective strengths of its university partners, and brings together the best expertise from industry and the academic community to spearhead Britain's efforts to be a world leader in modern advanced robotics.

BRL's primary mission is to understand the science, engineering and social role of robotics and embedded intelligence; its vision is to transform robotics by pioneering advances in autonomous robot systems, which behave intelligently without human supervision. Home to a talented research community comprising electronic and mechanical engineers, computer scientists, mathematicians, biologists, aerodynamicists, surgeons, psychologists and material scientists, BRL is able to explore exciting new areas of research and develop innovative applications for business.

BRL maintains strong national and international links with both industry and other research institutes, and has an enviable track record of successful research and innovation, with funding from public and private bodies such as EPSRC, NERC, DSTL, Wellcome Trust, Leverhulme Trust, the European Commission, BAE Systems, and the Gates Foundation. BRL continues to develop its industrial and outreach activity, and provide targeted support to help businesses turn ideas into new products and services.

The Laboratory is currently involved in interdisciplinary research projects addressing key areas of robot capabilities and applications including: embedded intelligence, autonomous robot systems, human-robot interaction, energy autonomy, collective locomotion, tactile sensors and haptic feedback systems, motion tracking/ positioning systems, swarming behavior, dependability, wearable and pervasive systems, medical and rehabilitation robotics, and bio-inspired architectures.

Keywords
Robotics
Autonomy
Innovation
Business

In addition to its core research activities, BRL offers PhD and Masters level research programmes. The Laboratory also offers a range of taught courses at undergraduate and postgraduate levels. BRL works closely with the British Automation and Robot Association (BARA), and hosts a variety of Robotic conferences, events and competitions, including TAROS and the FIRA Robot World Cup.

brl Bristol Robotics Laboratory

UWE BRISTOL University of the West of England

University of BRISTOL

University of Cassino and Southern Lazio

Department of Electrical and Information Engineering (DIEI)
Robotics Research Group

Location
Italy
Cassino

Website
http://webuser.unicas.it/lai/robotica

Contact
Prof. Stefano Chiaverini
chiaverini@unicas.it

The mission of the group is to develop automatic control techniques for industrial and service robotic systems.
The group has a more than twenty years old experience in the field of industrial and service robotics.

In particular, the group's skills cover the areas of:
- Kinematic, dynamic and interaction control of industrial manipulators
- Motion control of autonomous mobile robots (wheeled, underwater, and marine surface vehicles)
- Coordination control of multi-robot systems.

See *http://webuser.unicas.it/lai/robotica/video.html* for videos of our experimental activities.

The group is formally connected with the PRISMA Lab (*http://www.prisma.unina.it*) and ISME (*http://www.isme.unige.it*).

Keywords
Industrial robotics
Service robotics
Mobile robotics
Multi-robot systems
Marine robotics

Integrated Systems for Marine Environment

University of Catania

Faculty of Engineering
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Website
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The University of Catania (UNICT) was founded in 1434 and is one of the oldest University in Italy. The DIEEI was originally established in 1971 with the name Istituto Elettrotecnico. The Systems and Control group of DIEEI-UNICT has been involved in research topics regarding robotics and automatic control in many European and national research projects. In the laboratory of DIEES several prototype of service and mobile robots have been designed and built. The main activities have been concentrated on techniques for robot control, robots for volcano explorations, climbing robots, telerobotics, rapid manufacturing, outdoor navigation. The group has a considerable expertise in all aspects of software and hardware design for embedded systems.
The Service robotic group UNICT has carried out research activity in the mobile robotic sector within several national and local projects also in cooperation with international industries: Local ("Control and Navigation methods for mobile robots"), national (PON TECSIS Hovering control of underwater vehicles); Realization of a robot to automatize inspection operations in hostile environments; Cooperation with private research centres (STMicroelectronics, Fuzzy logic microcontrollers for mobile robotic applications; CRAM, Control methods for orange picking robots).

Main expertise

- **Field robots.** Navigation in outdoor environment, localization, path planning
- **Agricultural robots.** Autonomous spraying in greenhouses, fruit picking, outdoor navigation
- **Climbing robots.** Adhesion technologies, industrial inspections
- **Telerobotics.** 3D teleoperation, augmented reality for teleoperation
- **Industrial robots.** Visual feedback, welding control
- **UAV.** Hardware in the loop control, UAV for gas sampling and visual inspections.

Within Europe the unit is an active member of the thematic network CLAWAR 1 and 2 and is involved now in the CLAWAR Association, is member of the EURON network and has coordinated the IST project ROBOVOLC, aimed to the realization and test of a robot for volcano exploration (*http://www.robovolc.dees.unict.it*).
Other European projects in which has been involved are EUROBOT (International Robotic competition), RAPOLAC (Rapid Production of Large Aerospace Components FP6) on rapid manufacturing of components for the aerospace industry, MOW-BY-SAT (Mowing the lawn by satellite FP7) on the navigation of autonomous lawn mowers, TIRAMISU (Toolbox Implementation for Removal of Anti-personnel Mines, Submunitions and UXO) on robotic technologies for humanitarian demining.
The unit is expert in the design, realization and testing of mobile robot prototypes, with particular reference to the development of embedded control systems.

The unit has also established a spin-off company ETNAMATICA (*http://www.etnamatica.com*) for commercially exploiting the results of the research activities.

Keywords
Service robots
Climbing robots
Field robots

University of Coimbra

Institute of Systems and Robotics

HANDLE FP7 Project

Location
Portugal
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Website
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The Institute of Systems and Robotics - University of Coimbra (ISR-UC) is a Portuguese private, non-profit research institution associated with the University.
ISR is a first class multi-disciplinary research institution able to carry out leading edge research in several important areas of science and technology, with a special emphasis in automation and robotics. ISR advanced multidisciplinary R&D in the areas mobile autonomous robotics, intelligent transportation systems, search and rescue, underwater robotics, robotics manipulation, computer vision, medical robotics, assistive technologies, biomedical engineering, advanced industrial and automation technologies. ISR-UC gives special attention to international scientific research cooperation and to training and education Initiatives. SR is involved in over 30 projects, many of which at international level (FP7, Industry and bilateral cooperation).
About 100 post-graduate students are involved in research activities, coming from around the World.

Above: Autonomous Intelligent Transportation System
Left: TIRAMISU FP7 Demining Integrated Project.

ISR-UC is organized in two research groups:

- Automation and Mobile Robotics
- Computer and Robot Vision
- Operations Management.

The overall key objective of the **Automation and Mobile Robotics Group** is to develop new algorithms, methods and architectures to performance and robustness of robotic systems for autonomous and safe robot interactions in dynamic, unstructured and complex environments.

The C**omputer and Robot Vision Group** emphasizes active vision and applications of robot vision to mobile robots navigation and localization. Several topics related to video surveillance are investigated. The work on active vision is also pursued within the framework of cognitive vision, namely the study of the mechanisms of attention in humans and their implementation in artificial vision systems.

Keywords
Robotics
Computer vision
Autonomous robots
Intelligent transportation systems
Search and rescue
Underwater robotics
Robotics manipulation
Medical robotics
Assistive technologies

University of Coimbra

Industrial Robotics Laboratory

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Portugal
Coimbra

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The Industrial Robotics Laboratory of the University of Coimbra has been active in several areas related to industrial robotics, new areas of application of robots in the manufacturing world, new methods to interact with robots and how we can make them more autonomous in their tasks.

Main areas

- Industrial robotics
- Force control
- CAD-based robotics
- Human-robot interfaces
- Human-robot interaction
- Pattern recognition
- Robot autonomy.

Keywords
Industrial robotics
Force control
CAD-based robotics
Human-robot interfaces
Human-robot interaction
Pattern recognition
Robot autonomy

· U C ·

University of Essex

School of Computer Science and Electronic Engineering
Robotics Group

Location
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Website
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The Essex Robotics group is one of the large mobile robotics groups in the UK, with advanced mobile robotics research facilities such as the Essex Robotics Arena featuring the world's largest powered floor and a real-time 3D VICON motion tracking system.

There are more than 50 mobile robots in the lab, such as flying robots, fish robots, and intelligent wheelchairs.

University of Essex

Robotics research at the University of Essex focuses on autonomous mobile robotics, and addresses a wide range of research questions.

Research is conducted in a large research laboratory on campus, the new £4m Robot Arena, which was opened in 2004.

Research areas

- Human-centred robotics
- Sensor data processing (laser, vision, sonar, infrared and tactile) and fusion
- Artificial intelligence, machine learning, self-organization, emergent phenomena
- Human-machine interaction
- Biologically inspired robotics.

Keywords
Human-centred robotics
Biologically-inspired robotics
Human-machine interaction

School of
Computer Science and
Electronic Engineering

University of Extremadura

Polytechnic School
Robotics and Artificial Vision Laboratory

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Cáceres

Website
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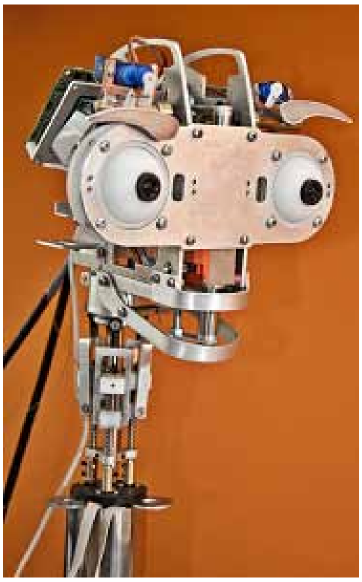
The Robotics and Artificial Vision Laboratory (RoboLab) is located at the University of Extremadura, Cáceres, Spain. Since its foundation in 2000, it is devoted to conducting research in intelligent mobile robotics and computer vision.

Since it beginnings, the researchers of RoboLab have built several robots of increasing complexity that culminate with the two-armed AMM named Loki. This robot incorporates the expressive head Muecas designed for HRI.



Along with robot design and construction, RoboLab has created the robotics framework RoboComp to facilitate the complex software development process that underlies intelligent control. RoboComp is a distributed, component-oriented framework that relies on model-based software engineering technologies to provide communications middleware independence and automated system code generation.

Finally, RoboComp is now developing a cognitive architecture based on the concept of an internal simulator capable of predicting the outcome of future actions and of learning in consequence.
This integrated approach that understands robotics as a complex engineering and scientific endeavour situates RoboLab in an excellent position to address new challenging projects and industrial collaborations.

Keywords
Robotics
Autonomous mobile manipulator
Intelligent behavior
Computational vision

University of Florence

Department of Industrial Engineering
Mechatronics and Dynamical Modelling Lab (MDM Lab)

Location
Italy
Florence

Website
http://www.unifi.it/mdmlab
http://www.arrowsproject.eu
http://thesaurus.isti.cnr.it

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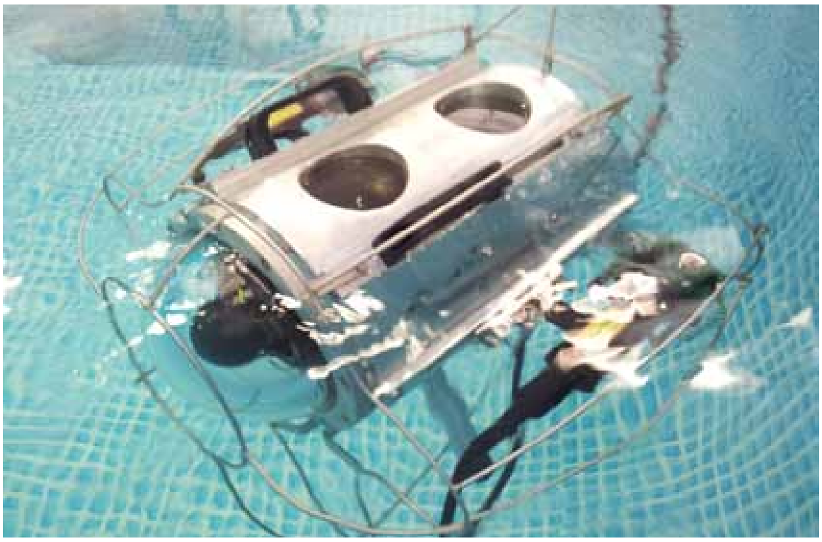
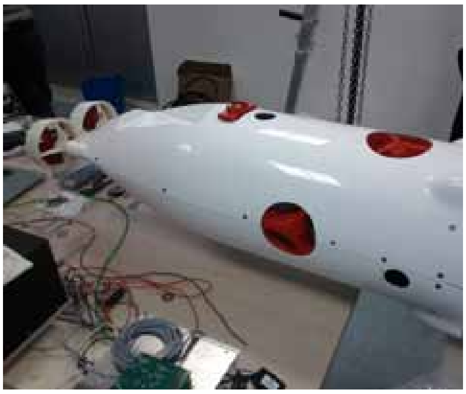
The Mechatronics and Dynamical Modeling Laboratory (MDM Lab) is active mainly in the field of underwater robotics and leads the ARROWS project (funded by EC in FP7 2012-2015) devoted to the development of AUVs for sea bottom exploration and monitoring in the framework of archaeological research and protection of underwater Cultural Heritage.

MDM Lab is also involved in the THESAURUS project, funded by Tuscany Region, aimed at developing robotic technologies for archaeological investigation in the Tuscan archipelago. In the framework of THESAURUS, MDM Lab is in charge for design, construction and control of a swarm of three underwater vehicles of the class jokingly named "Typhoon" (after the movie "Hunt for Red October"), capable of operation at depths up to 300m.





MDM Lab also collaborates with the Dept. of Earth Science of the University of Florence for the development of underwater inspection robots for modern shipwrecks.

Facilities of MDM Lab include:

- A robotic cell with a COMAU Smart Six robot with C4G open controller, several exteroceptive sensors to be used in loop closure (Force/torque, cameras, etc.)
- A rapid prototyping machine
- A water pool for wet testing of underwater robots and equipment
- Educational mechatronic systems (ball&plate, Furuta pendulum)
- Wheeled robots.

Keywords
Underwater robotics
Sensor-based control of robots
Mechatronics

MDM LAB

University of Freiburg

Faculty for Applied Sciences
Department of Computer Science
Autonomous Intelligent Systems Lab

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In the Laboratory for Autonomous Intelligent Systems at the University of Freiburg, our research is focused on autonomous mobile robots that are able to robustly operate in their environment over long periods of time.

In the past, we developed a series of innovative probabilistic approaches that cover different aspects including localization, map-building, SLAM, path-planning, and exploration, among others.

UNI FREIBURG

AIS Autonomous Intelligent Systems

State estimation and environment modeling
Robots that act in the real world require a model of the environment in order to accomplish their tasks. We develop probabilistic approaches that allow multiple robots to cooperatively generate consistent 2D and 3D models of the environment and to localize themselves within these models based on their sensor data. In this context, we also investigate efficient 3D representations that can be incrementally updated and are thereby able to account for dynamic aspects of the environment. Such environment representations are the basis for navigation, grasping and manipulation tasks.

Navigation and multi-robot coordination
We investigate methods that enable robots to efficiently and safely navigate in complex and dynamic indoor and outdoor environments over extended periods of time. In our approaches to robot motion generation, we incorporate kinodynamic constraints and cost functions such as time of travel or energy consumption. Furthermore, we investigate methods that enable groups of robots to efficiently navigate in their environment without colliding or interfering with each other. We also develop strategies for the coordinated traversal of narrow passages.

Adaptive techniques and learning
It is not feasible to pre-program a robot for every possible task it might face during its lifetime. Therefore, we are interested in learning techniques that allow robots to adapt their behavior according to their current observations. We apply learning techniques to different classes of problems, for instance to adapt the actions of the robot to changing environmental conditions, or to learn about human motion behavior and thus how to navigate in a socially compliant way. Furthermore, we investigate how to learn skills, such as opening doors, manipulating objects, or cleaning a whiteboard from the observation of a human demonstrator.

Keywords
Probabilistic robotics
State estimation and models
Adaptive techniques and learning
Robot navigation and control
Multi-robot systems
Robot applications

Applications
We apply our approaches to a wide variety of different platforms. This includes robots that are able to navigate indoors and carry out different tasks, for example a museum tour-guide or a household cleaning robot. We also employ outdoor platforms that demonstrate their navigation capabilities in challenging and dynamic urban and non-urban environments. Furthermore, we conduct research on some flying vehicles, e.g., blimps and quadcopters that are intended for surveillance and exploration tasks in disaster scenarios.

UNI FREIBURG

AiS Autonomous Intelligent Systems

University of Genova

Faculty of Engineering
Department of Mechanics and Machine Construction (DIMEC)
Laboratory of Design and Measurement for Automation and Robotics (PMAR Lab)

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The latest engineering developments leaded to sophisticated machines and systems technically complex that require deep theoretical knowledge and a multidisciplinary approach for their design.

Machines and products need to satisfy, during the whole life cycle, specific requirements: functionality, quality, reliability, safety, easy maintenance, re-use. The roles chosen as reference need to be respected for a development aiming at the improvement of the companies efficiency to reach a better international competitiveness.

The research group of the PMARlab operates following these introductory statements. During its research activity, the PMARlab tries to create a didactic context to support the development of the integrated design of complex systems.

UNIVERSITÀ DEGLI STUDI DI GENOVA

Main research areas

- Robotics to suggest efficient advanced solutions for industrial: robots, service robots, mobile robots, and extreme robotics
- Kinematics, statics, dynamics, singularities of mechanisms with any architecture: parallel and complex, metamorphic, deployable and reconfigurable
- Synthesis and analysis of mechatronic robotic architectures and MEMS
- Grasping and manipulation of soft parts (leather, fabric, carbon fiber...)
- Life-cycle design and development of innovative instrumental robotic devices
- Smart materials applied to integrated actuation/structural functions-fusion design
- Intelligent automation, energy efficient and eco-sustainable manufacturing.

Keywords
Creative mechatronic design
Screw theory
Kinematics and dynamics
Reconfigurable mechanisms
Mobile manipulation

UNIVERSITÀ DEGLI STUDI
DI GENOVA

University of Hannover

Hannover Centre for Mechatronics (MZH)

Location
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Hannover

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The Hannover Centre for Mechatronics (MZH) is an interdisciplinary research centre of the Leibniz Universität Hannover. Funded by 14 institutes of the Faculties of Electrical Engineering and Computer Science as well as of Mechanical Engineering, the MZH concentrates mechatronic competencies in research and education.

Current activities include the following topics:
- Medical engineering
- Production engineering
- Robotics
- Automotive mechatronics.

The MZH not only focuses on fundamental research. Especially application-oriented projects form the basis for an efficient knowledge and technology transfer between university institutes and industrial partners.

Since several years, one mayor research area at the Institute of Automatic Control (IRT) has been dedicated to bipedal autonomous robots. In the past, research topics focused on dynamic walking and balance monitoring, obstacle detection and online path adjustments, as well as prevent falling down and uprising. Current and future research projects include running robots and cognitive fall detection taking into consideration the actual environment of the robot.

The RTS Group develops algorithms and systems for navigation in semi-structured and dynamic environments. Our work is based on 3D environment perception, carried out with a 3D laser scanner developed at the RTS.

This active 3D laser perception allows us to build robust applications working in real world environments as has been demonstrated successfully at the diverse ELROB trials. See the picture with HANNA driving in a forest. In addition to localization and path planning, the 3D perception can also be used for object recognition. One example is the recognition of Euro pallets on the autonomous fork-lift truck (see the corresponding picture), developed in cooperation with Still GmbH.

Keywords
Bipedal walking machines
Autonomous vehicles
Medical robotics

In order to minimize operative time, postoperative trauma, as well as convalescence time for patients, a minimally invasive approach to cochlear implantation is proposed. The main idea is to drill a single channel from the mastoid to the basal turn of the cochlea. Therefore, a miniaturized parallel robot, which can be directly mounted on a patient's skull, is developed at the Institute of Mechatronic Systems (imes). The reconfigurable device serves as a micro stereotactic frame to guide both a surgical drill and an automated insertion tool. The project is carried out in close cooperation with the department of Otolaryngology at Hannover Medical School (MHH).

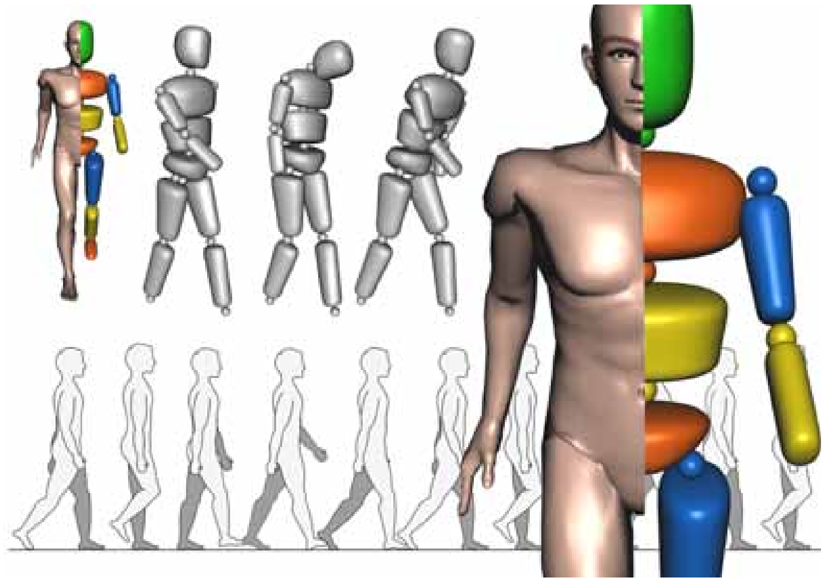
IRT

ISE RTS

imes

University of Heidelberg

Interdisciplinary Center of Scientific Computing (IWR)
Optimization in Robotics and Biomechanics (ORB) Group



Location
Germany
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Website
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Contact
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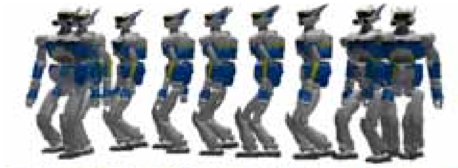
The Interdisciplinary Center for Scientific Computing (IWR) is a central research unit of the University of Heidelberg that promotes interdisciplinary research in mathematical and computational methods in science and technology.

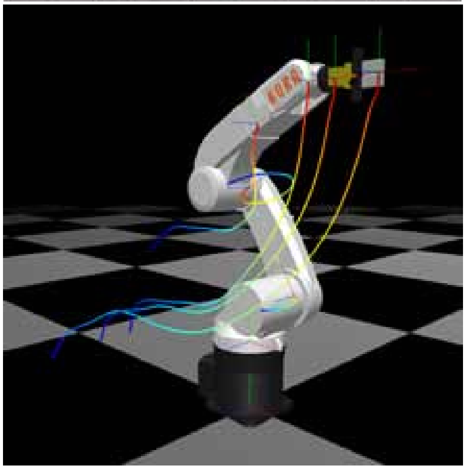
The Optimization in Robotics and Biomechanics group (ORB) focuses on the development and application of mathematical models and optimization techniques for robotics, in particular humanoid and legged robots, and for humans, studying mechanics and control aspects of motions as well as cognitive processes.

Robots (and especially humanoid robots) are extremely complicated dynamical systems for which the generation and control of motions is a difficult task, since the number of parameters to tune for a motions is very high. However, the challenges that robots will be facing in current and future applications require them to automatically generate and control a wide range of behaviors in order to be more flexible and adaptive to changing environments.

UNIVERSITÄT
HEIDELBERG
ZUKUNFT
SEIT 1386

Optimization or optimal control offers an interesting possibility to generate behaviors automatically based on elementary ingredients (objective functions and constraints). In addition, model-based optimization is a powerful approach to transfer motion principles from biology to robotics by investigating optimality principles in human or animal motion and by applying them to the robot model.





The research interests of the ORB group include

- Optimal control of walking motions of humanoid robots
- Natural locomotion trajectories of humans and humanoids
- Modeling emotional body language in locomotion
- Inverse optimal control: Identification of optimality principles in nature, e.g. in human motions
- Modeling interaction during locomotion - collision avoidance and rendezvous
- Optimal control of human and humanoid yo-yo playing
- Optimal control of human motions in sports: track running, platform diving and high bar gymnastics
- Stability optimization of hybrid dynamical systems and its application to generate open-loop stable walking, running and hopping motions of one- and two-legged robots
- Imitation of human motions by humanoid robots
- Modeling stability and robustness in human motion
- Generation of optimal paths: combination of optimal control and path planning methods to compute the best motion in a highly constrained environment
- Fast motions of industrial robot arms
- Optimal design of prostheses and orthoses
- Modeling walking and running motions of amputees
- Modeling cerebral palsy gaits
- Iterative learning control and repetitive control of robot motions
- Combination of optimization and learning approaches
- Art robots: Modeling generation and perception of art works, in particular action paintings, and implementation in robots
- Modeling head orientation during walking
- Modeling proprioception in the ankle extensor of a walking cat
- Open-loop stable juggling.

For these interdisciplinary research projects we cooperate and perform joint PhD theses with various research groups in robotics, but also in orthopedics, biomechanics, cognitive science and computer graphics.

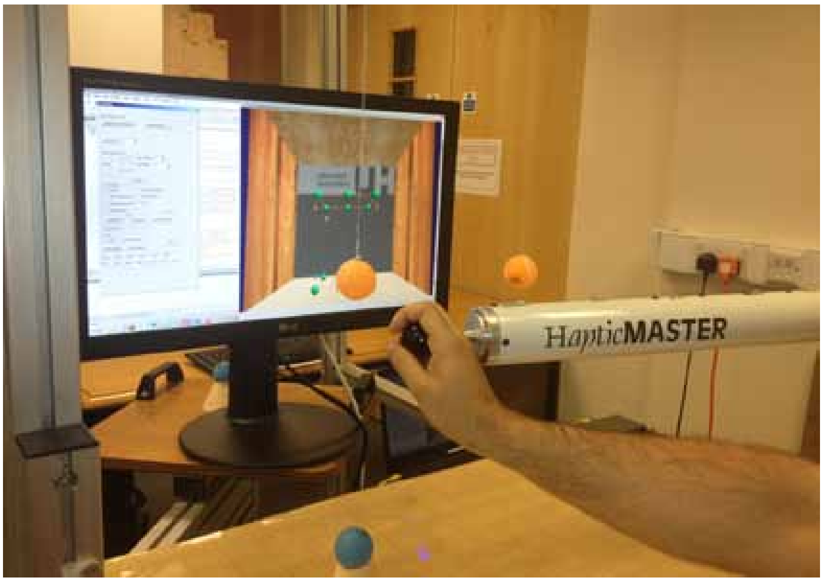
Keywords
Model-based optimal control
Humanoid robot motions
Biologically inspired walking

IWR
Interdisciplinary Center for Scientific Computing

ORB
Optimization in Robotics and Biomechanics

University of Hertfordshire

Faculty of Engineering and Information Sciences
School of Computer Science
Adaptive Systems Research Group



Right: HapticMASTER
Below: Sunflower

Location
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Hatfield

Website
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Contact
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The Adaptive Systems Research Group in Hertfordshire is a multidisciplinary group of faculty, students and research staff from the University of Hertfordshire who carry out research in the field of adaptive systems. The group is working with state of the art robotics platforms including the iCub, Care-O-bot® 3, HapticMASTER, PHANToM and NAO, as well as research platforms specifically designed in our group for human-robot interaction (KASPAR, Sunflower).
Adaptive Systems are systems that adapt via learning, evolution, development or via more subtle kinds of interaction, especially involving social interaction and/or embodiment. For the past 10 years the group has been involved in a number of European robotics research projects that we have either been coordinating or participating in. These projects address domains such as cognitive and developmental robotics, robot home companions, human-robot communicative interaction, emotion modeling, as well as assistive and rehabilitation robotics. Several of our current projects target assistive and rehabilitation robotics challenges, aiming to develop robots as therapeutic tools for children with autism, social and empathic home companion robots that assist elderly people, or robotic solutions for stroke rehabilitation.

Concerning human-robot interaction the expertise of our research group covers theoretical, methodological, experimental and evaluation/assessment methods, as well as expertise in the development of the software, artificial intelligence architectures and mechanisms, and in some cases, the hardware necessary to create socially interactive but effective companion robots.

Rehabilitation Robotics. Adaptive System's research in this area focuses on using touch-based interactive mediums such as HapticMASTER robot from MOOG BV in the Netherlands to provide adaptive therapeutic interactions for people recovering from neurological impairments such as stroke, multiple sclerosis and traumatic brain injury. The aim is to identify a person's contribution to interactions in order to provide sufficient assistance as well as challenging and motivational therapies. Research in this area includes ongoing research under FP7-funded SCRIPT project (*http://scriptproject.eu*) and PhD research in the areas of assessment robotics and remote collaboration; interactive game design and psychological factors enabling longer interactions.

KASPAR

Assistive Technologies and Social Robot Companions. Robotic and advanced ICT technologies provide a chance for augmenting our everyday environments to provide assistance. Adaptive system's research in this area focuses on human-machine interfaces and interactions. The work encompasses social, cognitive and rehabilitative interactions mediated by smart environments and smart robots. One main interest here is to have autonomous robots and interfaces that can adapt to human needs and learn from these needs. Research in this area includes the FP7-funded ACCOMPANY project (*http://accompanyproject.eu*) supporting elderly people at home, as well as research into robot assisted therapy for children with autism. In the context of the ROBOSKIN (FP7) project the KASPAR robot was extended with a skin allowing the robot to perceive touch (*www.roboskin.eu*). The KASPAR project will investigate in detail the possible long-term effects of using robotic social mediators for children with autism (*www.kaspar.herts.ac.uk*).

Robot House. The Robot House is a residential property owned by the University of Hertfordshire, providing an ecologically valid environment for carrying out human-robot interaction studies for interactions taking place at one's home. Since 2005 studies in the Robot House with elderly and other users have been carried out towards providing a more realistic and less laboratory-like environment. The house features three bedrooms and kitchen and bathroom facilities, yet is enriched with an array of sensors allowing detection of human presence and interactions, including use of electronic appliances and motion detection. The house also benefits from a number of mobile robots that provide an addition to the usual smart-house settings, allowing for manipulation of objects as well as monitoring interactions that take place in the house. The Robot House has allowed a number of long-term studies with participants interacting with robot home companions, as part of the FP6 project COGNIRON, and the FP7 projects LIREC (*www.lirec.eu*) and ACCOMPANY – using as home companions the Care-O-bot® 3 and Sunflower robots.

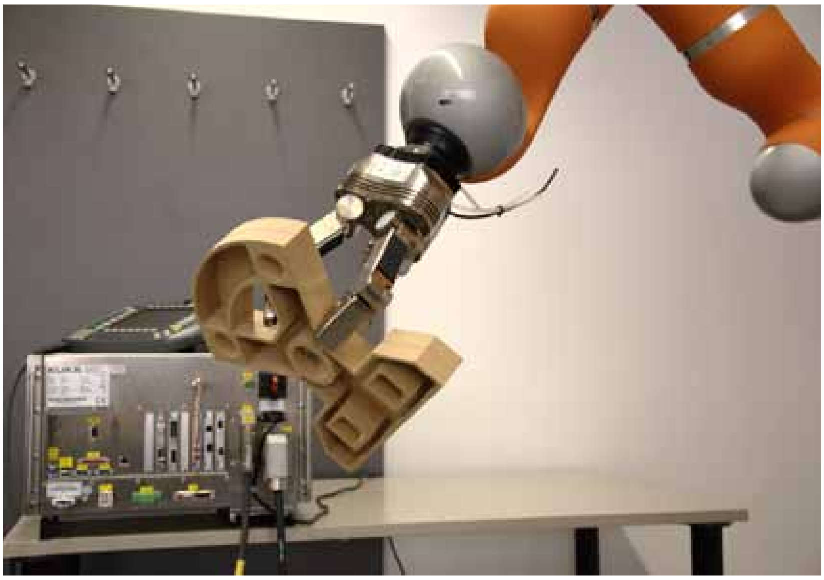
Keywords
Adaptive systems
Human-robot interaction
Assistive technology
Rehabilitation robotics
Robot-assisted therapy

SCRIPT

ACCOMPANY

University of Innsbruck

Faculty of Mathematics, Computer Science and Physics
Institute of Computer Science
Intelligent and Interactive Systems (IIS)



Location
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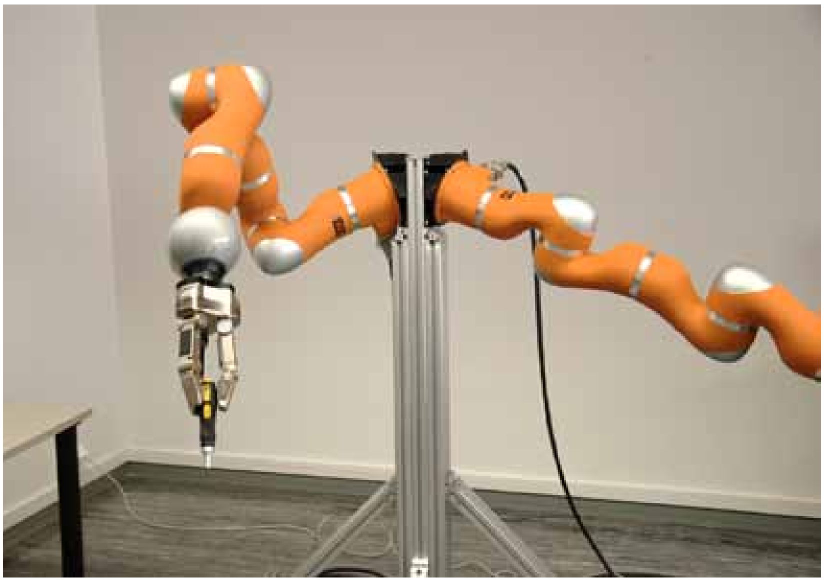
Research at IIS is situated at the intersection of computer vision, machine learning and robotics, and focuses on adaptive perception-action systems as well as on image and video analysis.

Some of our areas of activity include:

- Object models for robotic interaction
- Perception for grasping and manipulation
- Systems that improve their performance with experience
- Video analysis for applications such as sports or human-computer interaction
- Links with the psychology and biology of perception.



Our robotics-related research is motivated by the goal of constructing autonomous robots that are adaptive and intelligent enough to successfully operate in an environment not specifically designed for them.
We develop methods that allow the robot to learn about objects, their functions and purposes and how to manipulate them, and mostly focus on perceptual aspects, linking perception to symbols or directly to action.

Our current methods allow the on-the-fly construction of 3D object models useful for object detection, recognition, pose estimation, and manipulation, as well as the exploratory acquisition and refinement of object-specific grasping skills.

Keywords
Computer vision
Machine learning
Robotics
Perception-action systems

universität innsbruck

informatik institut für
in
universität innsbruck

iis

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The research Group of Robotics, Automation and Computer Vision (GRAV, code TEP 237 of the Andalusian R&D Plan) is formed by 11 researchers, 5 PhD and 6 engineers.

The main research and development lines are:

Industrial Robotics Systems
- Compliant robot motion control
- Sensor Fusion
- Open software architectures

Process Control
- Plant Modeling
- Application of advance control techniques
- Design of control hardware architecture

Machine vision for quality control
- Image processing
- Sensor planning
- Lighting systems.

Within these lines the group has developed several researching projects (funded by national and local grants) and applied technological projects.

The purpose of our research in the industrial robotic field is:

- To provide specific solutions for the control of industrial manipulators when they have to interact with a non-structured environment
- To develop control methods for multi-sensorial systems (integrating force/torque, inertial and computer vision sensors)
- To develop open software architectures in order to improve the openness, adaptability and interoperability of robotic manipulator systems.

In the control of processes there also various application fields such as:

- The automation of the measurement process of olive oil content in the olives
- To model and control the olive oil extraction process.

The application fields in Machine Vision are:

- Surface inspection for transparent parts (automotive industry)
- Automated classification system for thermoplastic recycling
- Determination of quality parameters for olive oil.

Some applied technological projects were focused on:

- A mechatronic system design for head lamp assembly
- Automated inspection of head lamp lenses
- Design and optimization of a working station to assemble car rear-lamp
- Quality control of electronic boards.

Keywords
Compliant robot motion control
Sensor fusion
Robot vision
Automatic visual inspection

GR AV
Grupo de Robótica, Automática y Visión por Computador

University of Kaiserslautern

Department of Computer Science
Robotics Research Lab

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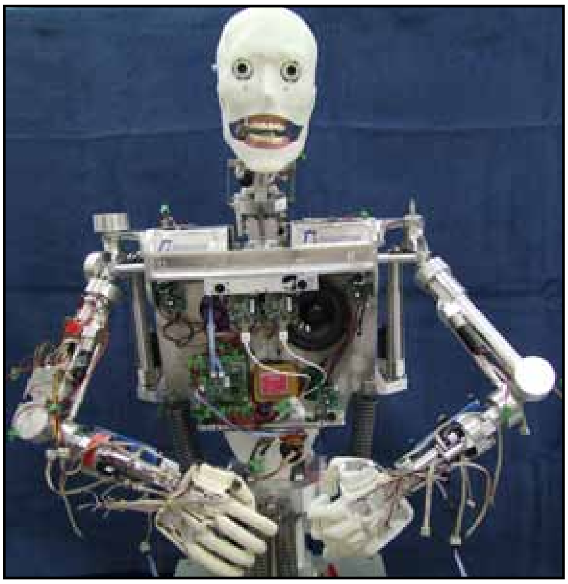
The Robotics Research Lab conducts research in various areas of robotics, with the focus being on autonomous off-road robots, human-robot interaction, and framework development.

The approximately 20 researchers have set the goal of not only developing innovative algorithms, but also integrating them into real systems that are able to operate in difficult environments. This is made possible by investigating novel development and analysis techniques that are able to handle complex systems. Results of these efforts are the framework Finroc and the behavior-based architecture iB2C. To validate their scientific approaches, several complex robotic systems have already been built in the lab, among them the off-road vehicle RAVON and the humanoid robot ROMAN.

iB2C: *http://rrlab.cs.uni-kl.de/research/research-topics/behaviour-based-systems*
RAVON: *http://uni-kl.de/ravon*
ROMAN: *http://rrlab.cs.uni-kl.de/roboter/roman*

TECHNISCHE UNIVERSITÄT KAISERSLAUTERN



The Robotics Research Lab is a member of the „Zentrum für Nutzfahrzeugtechnologie“ (Centre for Commercial Vehicle Technology) of the University of Kaiserslautern. An essential goal of this centre is the development of autonomous commercial vehicles. In the field of off-road robotics, the lab maintains numerous co-operations with manufacturers of commercial vehicles like John Deere and Volvo. Together with their industrial partners, the researchers investigate and develop assistance systems for the autonomous execution of various tasks.

A focus of research in the area of off-road robotics is the localization and navigation in unstructured environments. In this context, the Robotics Research Lab is part of the EU FP7 project ICARUS (Integrated Components for Assisted Rescue and Unmanned Search operations), which aims at developing autonomous robots for rescue missions in disaster areas.

ICARUS: *http://fp7-icarus.eu*

Keywords
Off-road robotics
Behavior-based systems
Autonomous robots
Human-robot interaction
Framework development

RRLAB
THE ROBOTICS RESEARCH LAB

University of Lincoln

School of Computer Science
Lincoln Robotics

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Lincoln

Website
http://lincoln.ac.uk/home/socs/research/autonomoussystems

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The objective of the Lincoln Centre for Autonomous Systems Research (L-CAS) is to become an internationally recognized centre for applied autonomous systems research. This research aims to integrate various aspects of machines, computing, sensing and software to create intelligent systems capable of interacting with the complexities of the real world. 'Autonomy' refers to the ability of a system to solve tasks and handle situations unforeseen by the original designers of the system.

L-CAS specialists in the integration of perception, learning, decision-making and control capabilities in autonomous systems such as mobile robots and smart devices, together with the application of this research in fields including personal robotics, food and agriculture, security and surveillance, environment monitoring, games and simulation technology, and intelligent transportation.

UNIVERSITY OF LINCOLN

L-CAS is among the first groups to have studied long-term mapping with mobile robots and has recently published a set of data sets for long-term mapping acquired over periods of up to 2 months.
This data is hosted at *http://robotics.researchdata.lncn.eu*.

Six permanent academic staff currently contribute towards the academic output of the centre, along with a number of postdoctoral researchers and PhD students. L-CAS staff have coordinated or participated in a large number of collaborative projects, such as VAMPIRE (FP5), COGNIRON (FP6/IST), FEELIX GROWING (FP6/IST), HERMES (FP6/IST), LOCUST (FP6/ICT/FET), EYE2E (FP7/IRSES), LIVCODE (FP7/IRSES), and CogX (FP7/ICT). We are always interested in participating in future national and international projects, so please contact us if you are interested in collaboration.

Research areas

- Artificial intelligence
- Biologically inspired robotics
- Long-term autonomy
- Machine learning
- Sensor fusion
- Social robotics
- Vision systems.

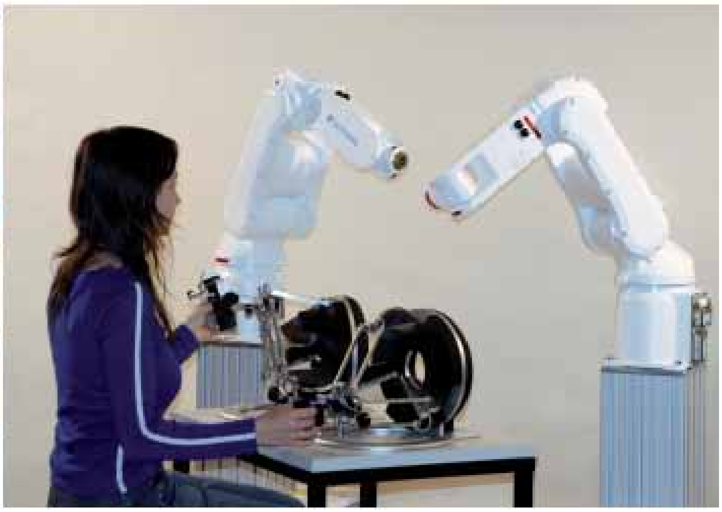
Keywords

Long-term autonomy
Mobile robotics
Cognitive vision
Machine perception
Social robotics
Learning and adaptation

UNIVERSITY OF LINCOLN

University of Ljubljana

Faculty of Electrical Engineering
Laboratory of Robotics



Location
Slovenia
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The Laboratory of Robotics at the University of Ljubljana, Faculty of Electrical Engineering has long-standing excellence in the field of man and machine movement analysis as well as artificial and natural motor control.

The group has wide experience in research and applications in the areas of industrial and rehabilitation robotics.
In the rehabilitation field, the robot systems and control principles are being developed for a safe and efficient man/machine interaction in medicine, sport, and rehabilitation environments, while in the area of industrial robotics the complex solutions are being built for an automation of industrial manufacturing processes.

University of Ljubljana
Faculty of Electrical Engineering

robolab
laboratory of robotics

The main topics of recent theoretical and practical research in the field of rehabilitation are:

- Multimodal rehabilitation system for upper extremities (MIMICS, EU FP7)
- Experimental environment for analysis of infants activity (CareToy, EU FP7)
- Sensory system for exoskeleton robot for walking assistance (Evryon, FP7)
- Cognitive module for amputee motor intention detection utilized in control of cybernetic prosthesis (CYBERLEGs, EU FP7)
- Several advanced interactive rehabilitative devices for training of standing, standing-up, walking, and rowing.

In the industrial field the recent topics of the research are

- Control of a large scale hydraulic telescopic handler for e-construction (3rd prize of the 2010 EUROP/EURON Robotics Technology Transfer Award)
- Haptic bimanual teleoperation system of industrial robots
- Robot cell for visual inspection and welding of protectors
- Micro-teleoperation robotic system.

Keywords
Rehabilitation robotics
Haptics
Industrial robotics
Biomechanics
Motion sensors

University *of Ljubljana*
Faculty *of Electrical Engineering*

robo**lab**
laboratory of robotics

University of Lübeck

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The institute of robotics and cognitive systems at the university of Lübeck works in medical robotics. This field of research is interdisciplinary between medicine, computer science, physics, mathematics and engineering.
Likewise, the work group is interdisciplinary with scientists from these disciplines. Scientists from our group have designed the first medical robotics systems worldwide. Specifically, methods for robotic radiosurgery developed by our group have started to replace conventional radiosurgery, and by now over 130000 cancer patients worldwide have been treated with our methods. Beyond radiosurgery, applications of the methods developed arise in orthopedic surgery, cardiology and neurology.

UNIVERSITÄT ZU LÜBECK

The main topics of current research are mathematical methods for motion correlation and prediction, as well as methods for image-guided navigation and inverse planning. Members of the institute have initiated large-scale and nationwide research efforts, such as the national research program 'medical navigation and robotics', funded by Deutsche Forschungsgemeinschaft, and the Graduate School of Computing in Medicine and Life Science, funded under the recent program 'Exzellenzinitiative des Bundes und der Länder'.

Today's most advanced methods for navigation in radiosurgery have originated in methods developed by our group. In this case, requirements with respect to accuracy and temporal resolution are very high. For functional interventions in the brain, these requirements are even higher. In addition, the interpretation of the data acquired during functional procedures is a major challenge. Major goals of research are the minimally invasive and non-invasive acquisition of electrophysiological data from the brain in vivo, the interpretation of the data, and their correlation to external motion. This gives rise to very basic research questions, and also a large potential for novel clinical procedures.

Research goals
The goal of our research is the development of advanced robotic systems for surgery. Such systems allow new surgical procedures which are highly economical and precise. Improved treatment outcome, patient comfort and less invasive treatment are further benefits of these technologies. We investigate both new methods for planning robotic surgeries, delivering robotic surgery under real-time tracking of respiration and pulsation, and basic imaging technologies for navigation.

Projects
Our technologies in the field of navigation and robotics have found widespread clinical applications in neurosurgery, orthopedic surgery and radiosurgery. Technologies invented by members of our group are in routine clinical use at many leading clinical facilities worldwide. To date, more than 150.000 patients have been treated with our new technologies. The range of applications includes trauma surgery, corrective osteotomy, lung-, spine- and brain-cancer treatment.
Our group has developed the respiration tracking system and the planning system in the Cyberknife Robotic Radiosurgery System, which is now installed in more than 200 clinics worldwide.

Keywords
Medical robotics
Navigation
Navigation in medicine
Radiosurgery
Computer-assisted medicine
Computer-assisted surgery
Computer-aided surgery

UNIVERSITÄT ZU LÜBECK

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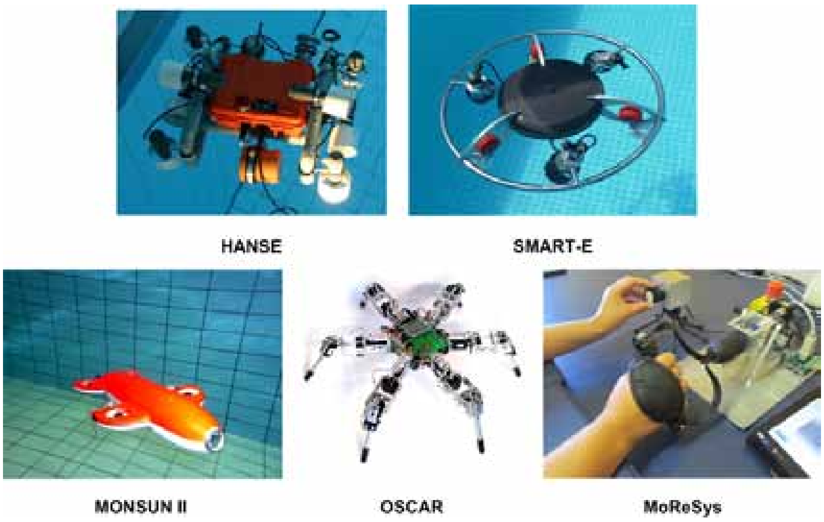
The Institute of Computer Engineering (ITI) of the University of Lübeck deals with the architecture of hardware and software systems as well as their prototypical implementation and evaluation. Research focuses mainly on mobile autonomous robots, cyber-physical systems and adaptive digital systems in form of SoCs (System-on-Chip).
Current projects are connected with both basic research and applications in the areas of medicine, environmental monitoring and industrial automation.
These works are carried out by an international and interdisciplinary team of computer scientists, electrical engineers and mechanical engineers, in many cases in cooperation with external partners from academia and industry.

One important area of research at ITI are Autonomous Underwater Vehicles (AUVs) for monitoring tasks in shallow waters like lakes, harbors or the Baltic Sea. A main goal is a low-cost and robust design using as many standard parts as possible. The research focuses on new techniques e.g. for underwater SLAM (Simultaneous Localization And Mapping) based on scanning sonar, for underwater vision, and for acoustic communication by low-cost modems.

UNIVERSITÄT ZU LÜBECK

The AUV HANSE was built for the Students Autonomous Underwater Challenge - Europe SAUC-E where it won the Innovation Award, the first prize and the second prize in 2009, 2011 and 2012 respectively. SMART-E offers a novel omnidirectional underwater drive which provides it with high agility. For this it received the SAUC-E Innovation Award 2012.

MONSUN is a small AUV which is currently developed for underwater robot swarms using visual and acoustic communication among swarm members. The goal is to apply it to environmental monitoring with some swarm members staying at the



surface while the others are diving. The surfaced AUVs shall take GPS positions and communicate with the external world by wireless links as well as with submerged swarm members by acoustic modems.

Other research areas are biologically inspired robots and rehabilitation robots. In the course of the Organic Computing Initiative in Germany, the six-legged walking robot OSCAR was developed together with an Organic Robot Control Architecture (ORCA). OSCAR is e.g. able to pass rough terrain even in case of severe faults like lost legs. This can be achieved with little engineering and design effort by organic principles like self-organization and controlled emergence.

MoReSys is a Modular Rehabilitation System to train hand functions after a stroke. Its modularity allows a broad spectrum of training and progress assessment possibilities while reducing complexity and costs. This shall facilitate a wide distribution in hospitals and home rehabilitation. The system uses visual feedback distortion, which has been introduced as a new concept in neurorehabilitation.

Keywords
Underwater robots
AUVs
Underwater robot swarms
Omnidirectional AUVs
Rehabilitation robots
Neurorehabilitation
Walking robots
Organic computing
Organic robot control architecture
Biologically inspired robots

UNIVERSITÄT ZU LÜBECK

ITI

University of Malaga

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The Department of Systems Engineering and Automation of the University of Malaga is a teaching and research group with a wide experience in robotics. Its main research topics include: search and rescue robotics, surgical robotics, telerobotics, computer vision and automation.

It has participated in national and international research projects such as CROMAT, ALACRANE, RAMBLER or CISOBOT. In these projects, the group has developed several mobile robots and manipulators, and it has made considerable contributions to kinematics for tracked mobile robots, automation of climbing maneuvers for mobile manipulator, power analysis for skid-steered tracked mobile robots, etc. It is also responsible for the design and construction of several mobile robots especially adapted to field operations. ALACRANE is the last one developed for exploration, and search and rescue in disaster areas and natural environments. It is also experienced the design of manipulators controlled by haptic devices and has developed teleoperated robot assistants for surgical applications (ERM robots). The last ERM version was transferred to industry.

UNIVERSIDAD
DE MÁLAGA

The department has several research laboratories equipped with wheeled and tracked mobile robots, unmanned aerial vehicles, industrial manipulators, aerial transportation systems, prototyping systems, etc.

Research topics

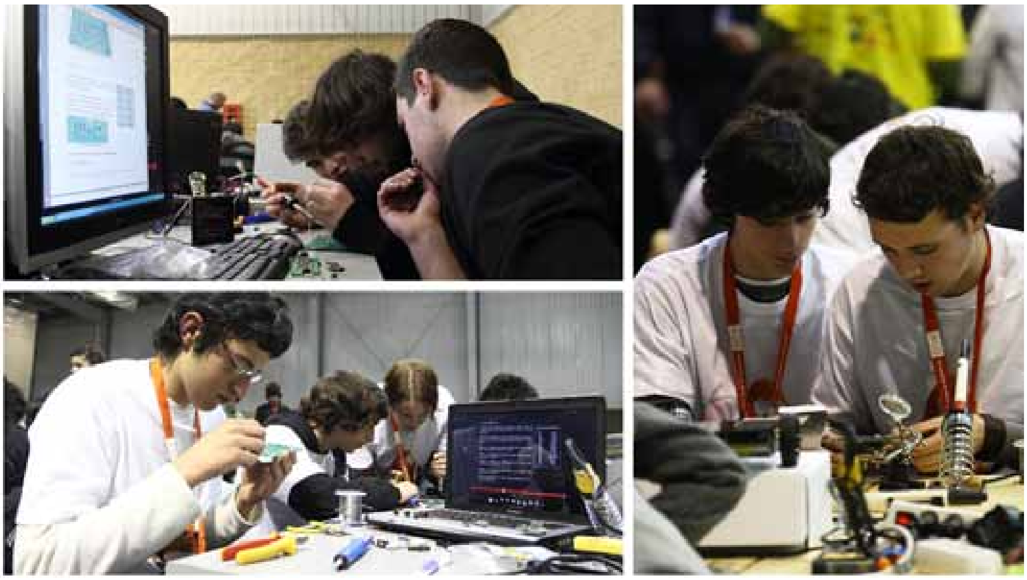
- Mobile robotics
- Computer vision
- Remote sensing
- Telerobotics
- Surgical robotics
- Automation
- Search & rescue robotics.

Keywords
Mobile robotics
Computer vision
Remote sensing
Telerobotics
Surgical robotics
Automation
Search and rescue robotics

DEPARTAMENTO DE INGENIERÍA
DE SISTEMAS Y AUTOMÁTICA

University of Minho

Centre Algoritmi / Department of Industrial Electronics
Laboratory of Automation and Robotics



Location
Portugal
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The Laboratory of Automation and Robotics was founded in 1998 and has been developing automation and autonomous mobile robotics ever since. The laboratory is now part of the Control, Automation and Robotics group of the Algoritmi Research Center.

The laboratory develops its own robots, from mechanics to electronics, finishing in the programming in different hardware and software platforms. Computer vision is the basis for providing robot's autonomy. Robot development enriches the student's knowledge at the mechatronics level. Both indoor and outdoor robots are being developed.

Applied research is the main focus of the laboratory having produced more than thirty robot prototypes for a variety of applications, both industrial and educational. Participation on major robotic competitions is also been attained.

The laboratory is also responsible for RoboParty since its creation in 2007. It is an educational event once a year where youngsters build a small robot in three non-stop days, from soldering the components, assembling the mechanics and programming the robot's behavior based on the infrared sensors. This event is an enormous success as many teams are already participating in worldwide robotic competition (e.g. RoboCup) with the robot built during the event.

Keywords
Mobile and autonomous robotics
Computer vision and sensors
Domotics
Agrobots
RoboParty

Main research topics

Design, development and testing of:

- Mobile and autonomous robotics
- Computer vision
- Automation and sensors
- Domotics
- Agrobots
- RoboParty.

CENTROALGORITMI

Minho Team

University of Minho

Centre Algoritmi / Department of Industrial Electronics
Mobile and Anthropomorphic Robotics (MAR) Lab

Location
Portugal
Guimarães

Website
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Contact
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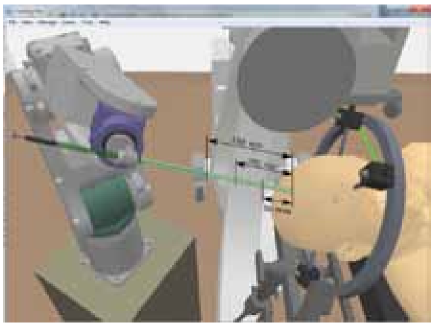
The Mobile and Anthropomorphic Robotics (MAR) Laboratory is part of the Control, Automation and Robotics Group of the Research Centre Algoritmi & Department of Industrial Electronics. Research concentrates on the design and implementation of Cognitive Control Architectures for single and multi-robot systems, including Human-robot Interaction & Collaboration.
The MAR Lab has large experience in international and national funded projects (e.g. ARTESIMIT – Artefact Structural Leraning Through Imitation, JAST – Joint Action Science and Technology, LEMI – Learning to Read the Motor Intentions of Others, COOPDYN – Synthesis of Cooperative Behavior in Multi Robot systems, NETT – Neural Engineering Transformative Technologies, TURNTAKE - Turn-Taking in Human-Robot Interactions: a developmental robotics approach).

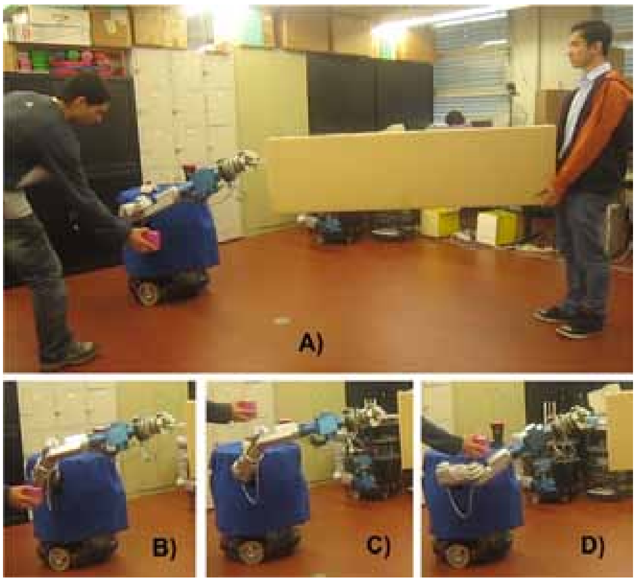
Our Robotic Platforms
The lab is equipped with ARoS – a human-size anthropomorphic robotic assistant--, two mobile manipulators each with a 7 Dofs arm & 3 fingers Barret hand, and several wheeled robots. All robotic platforms (except the robotic arms & hands) have been developed and built at the lab.

Success Story

Recently, our work on Human-Robot Joint Action developed in the context of the FP6 JAST Project, was selected as one of the EU's ICT success stories (see the ICT News website "JAST- Robots get power of prediction", *http://staging.esn.eu/projects/ICT-Results/Success_stories.html)*.

At the 2012 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2012) a video of our work was among the 6 finalists for the Jubilee Video Award (*http://spectrum.ieee.org/automaton/robotics/robotics-hardware/iros-2012-video-friday*)





Main research topics:

Cognitive Robotics

- Natural human-robot Interaction & Collaboration
- Robots capable of action understanding and goal inference
- Robots capable of Error monitoring and error recovery
- Goal-directed imitation learning
- Robots capable of learning to read the motor intention of others

Anthropomorphic robotic systems

- Human like shape and movement

Multi-robot systems

- Cooperative Object transportation
- Cooperative object search
- Formation control (2D and 3D)

Medical Robotics

- Development of a robotic system to assist neurosurgeons in minimally invasive stereotactic procedures.

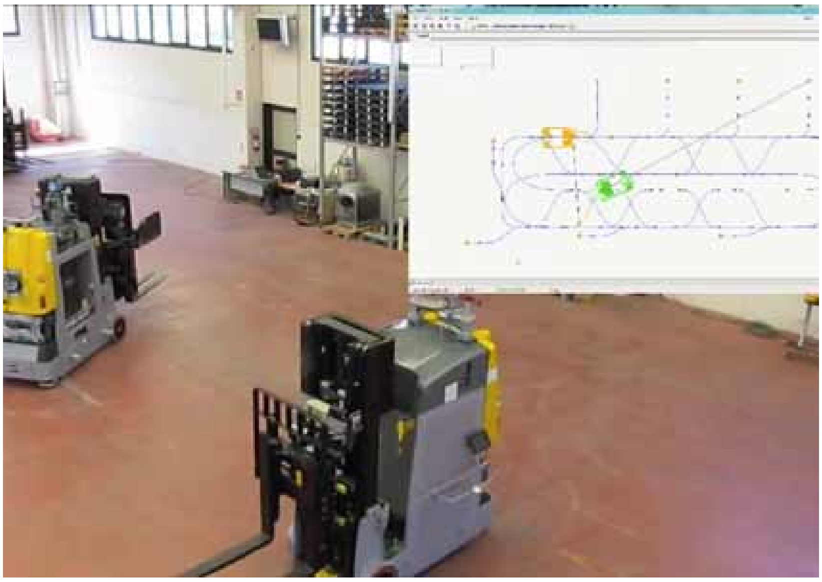
Keywords

Autonomous robots
Cognitive robotics
Human-robot interaction & collaboration
Medical robotics
Neural engineering
Neurorobotics
Dynamical systems
Dynamic neural field theory

CENTROALGORITMI

University of Modena and Reggio Emilia

Department of Science and Methods of Engineering (DiSMI)
Automation, Robotics and System Control (ARS)



Location
Italy
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ARS, the Automation, Robotics and System Control at University of Modena and Reggio Emilia is a group of researchers who have as primary focus the research on application of control theory, robotics and automation.

The group is active since 2001 at the Department of Science and Methods of Engineering, with several projects in the areas of:

- Robotics (traffic control of mobile robots, control of multirobot system, teleoperation and visual servoing)
- Automation (Modeling of control software with UML, mechatronic machine modeling with SysML)
- System modeling and control (modeling of mechanical system for control, Prognostics for industrial machineries).

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

A distinctive aspect of the ARS researches is in the willingness of constructing strong link between industry and academia, seeking to set up strong cooperation to tackle real technical problem faced everyday by application engineering in industry with innovative methodologies and solutions from academia.

The ARS group is also committed to the training of students in the faculty courses in the area of control system theory and application at Engineering Faculty of Modena and Reggio Emilia (Reggio Emilia branch), with the aim of disseminate the base theory of automatic control and merge it with the knowledge achieved as follow up of the applied research with enterprises.

Manufacturing Systems

- Control of agricultural mechatronic devices (ISOBUS)
- Fault identification and predictive maintenance
- Manufacturing modeling and simulation
- Mechatronic systems modeling and control.

Robotic Systems

- Cooperative control of multi-robot systems
- Haptics and teleoperation
- Traffic control of multi-robot systems
- Vision in robotic applications.

Keywords
Robotics
Industrial automation
System control

ARS CONTROL

University of Murcia

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Department of Information Engineering and Communication
Applied Engineering Group
Robotics Lab

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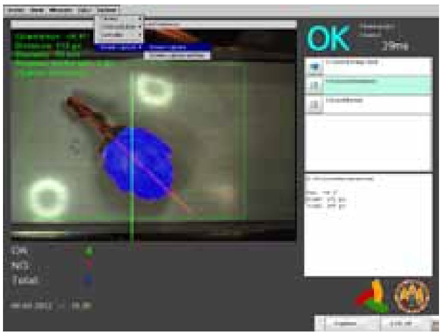
The Applied Engineering Research Group (GIIA) is a group of recent constitution (2009) but formed by researchers with a solid trajectory.
The groups is multidisciplinary, with members coming from different areas of knowledge (Informatics, electronics, telecommunications, physics and mathematics).
This allows to tackle different projects related to robotics and automation, be they of fundamental research or applied research.

In addition, the group has a high capability to apply results in technology transfer projects with companies, in technologies such as:

Robotics and Automation
Mobile robots, autonomous vehicles, industrial machinery, production lines, etc.

Computer vision
Failure detection, quality control, intelligent inspection, face detection, 3D reconstruction, etc.

Grupo de Investigación Ingeniería Aplicada



The group has participated in more than 20 contracts with companies for technology transfer.
We can highlight some areas with important technology transfers:

Automotive sector
Automated waste container trucks, active security for a 3 persons electric car.

Agriculture sector
Climate and irrigation intelligent distributed control.

Food sector:
Quality control of bottled juices, automated cut of artichokes, manipulation and drilling of lemon, automatic transport of lettuce pallets, traceability of lettuce products.

Chemical sector
Fully automated micro-encapsulation in continuos cycle, predictive maintenance.

Keywords
Mobile robotics
Industrial automation
Computer vision
Embedded systems

Grupo de Investigación
Ingeniería Aplicada

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PRISMA Lab

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Italy
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Research topics
- Aerial robotics
- Assistive robotics
- Cognitive control of robotic systems
- Control and monitoring of chemical batch reactors
- Dual-arm/hand manipulation
- Dynamic parameter identification
- Fault diagnosis and fault tolerant control
- Force control
- Human-robot interaction
- Lightweight flexible arms

- Mobile multirobot systems
- Mobile robots
- Novel actuation and sensing systems for robotic applications
- Postural synergies of robotic hands
- Redundant manipulators
- Service robotics
- Simulation control theory of discrete event systems
- Supervisory control implementation
- Supervisory control theory of Petri nets
- Underwater robotics
- Visual servoing.

Keywords
Industrial robotics
Service robotics
Mechatronics

PRISMA Lab

University of Nice Sophia Antipolis (UNS) / CNRS

I3S Laboratory (Computer Science, Signals and Systems)
OSCAR Team

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The I3S Laboratory is a joint laboratory between the University of Nice Sophia Antipolis (UNS) and the French National Centre for Scientific Research (CNRS), specialized in informatics, signals and systems.

The OSCAR team of I3S focuses on the development of the theory and technology enabling the operation of dynamical aerial robotic vehicles.

The team is active in the development of algorithms for unmanned aerial vehicles (UAVs) both on the theoretical and practical side.

The research activity involves the following four directions:

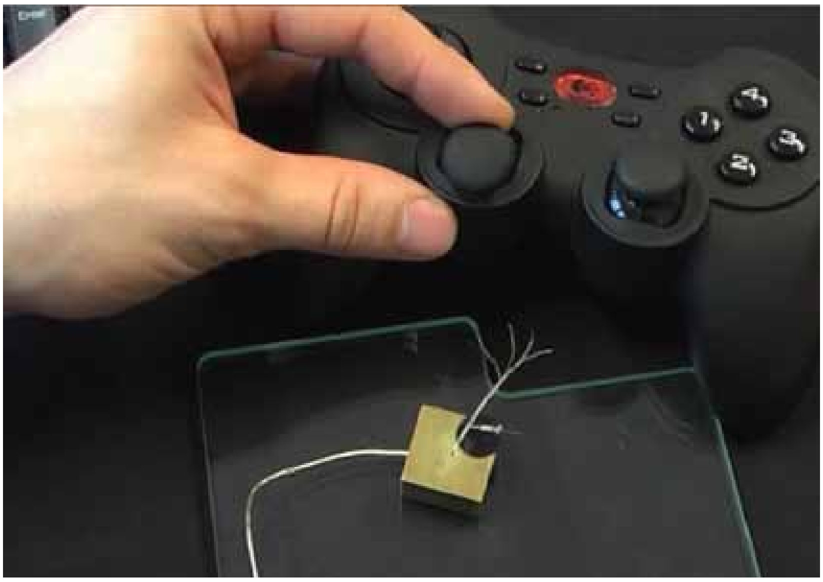
- Modeling of autonomous aerial vehicles and development of nonlinear control strategies
- Nonlinear observer design
- Visual servo control of dynamic systems
- Teleoperation of UAVs
- Fault diagnostic and fault-tolerant flight control.

The I3S OSCAR team is currently involved in the ECHORD TUAV project that deals with the teleoperation of UAVs for the inspection of walls, bridges, dam walls, power lines and other industrial facilities.

Keywords
Unmanned aerial vehicle (UAV)
Nonlinear flight control and observer and isolation
Visual servo control
Teleoperation

University of Oldenburg

School of Computing Science, Business Administration, Economics, and Law
Department of Computer Science
Microrobotics and Control Engineering Division (AMIR)



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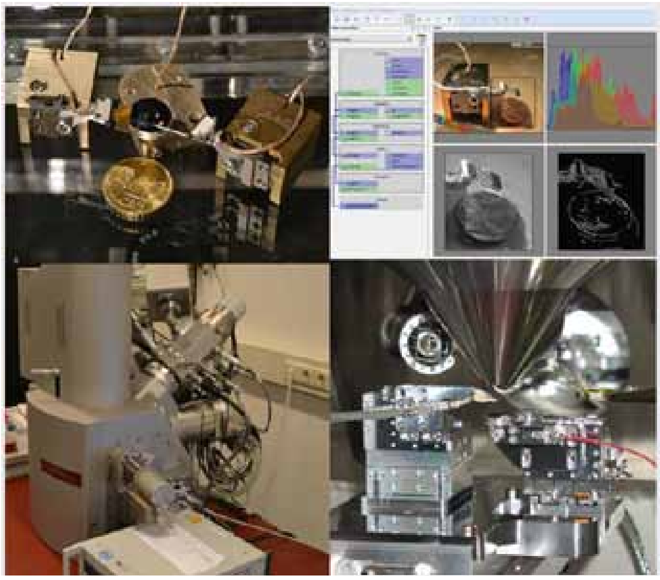
The goal is the development of automated nanomanipulation approaches to address high throughput fabrication and characterization of micro- and nanosystems. Application-specific nanohandling strategies are investigated: sensing technologies; advanced control approaches; new nanohandling robots and tools. Especially the automated nanohandling inside a scanning electron microscope (SEM), and the use of an atomic force microscope (AFM) as a nanorobot are very powerful approaches.

Novel mobile robots for nanohandling are able to perform steps as small as 1 nm with velocities of up to 15 mm/s. The versatile robots can work in vacuum chambers, optical microscope slides and custom setups. Furthermore, they can be equipped with different tools. High-speed visual servoing techniques allow for very high accuracy and positioning speed.
Automated handling of micro- and nanoscale objects requires visual feedback. Ongoing R&D includes fast and reliable algorithms for real-time object tracking and 3-D position determination. 2-D and 3-D object-detection, -classification and -tracking and multi modal image registration are applications of image processing.

CARL VON OSSIETZKY universität OLDENBURG

To achieve real-time high speed tracking, newly developed techniques based on embedded systems and FPGAs are deployed.
For micro- and nanohandling automation, the flexible integration of special hardware such as the SEM as well as complex analysis-software are key challenges. A rapid automation toolbox connects different types of sensors and actuators, which are controlled using a powerful scripting language.
Novel nanomaterials have become one of the most important topics in nanotechnology. Their extraordinary physical properties lead to several potential applications. For this, nanorobotic systems are integrated into different microscopic



environments facilitating the handling, characterization and processing of a wide range of 1-, 2- and 3-D nanomaterials. The integration of an AFM system into a dual beam SEM/FIB device enables the characterization and manipulation of graphene. Automated in-situ electro-mechanical mapping and pick-and-place handling of individual graphene flakes support the optimization of fabrication techniques and the prototyping of graphene-based devices.
The AFM can be applied as a nanorobotic engineering tool. The automation of AFM-based manipulation and structuring processes enables the handling and processing of bio-nanomaterials. This technology is used to design and characterize nanoelectric circuits of DNA. Exchangeable AFM probe tips and novel scanning techniques are developed for 3-D metrology.
Modular robotic systems are developed for handling, characterization and processing of nanomaterials such as carbon nanotubes (CNTs), silicon nanowires, nanocoils or wood fibrils. These materials are used to improve and downscale previous nanoelectronic devices and allow the exploration of novel actuator and sensor technologies.

Keywords
Microrobotics
Nanohandling
Control engineering
Nanotechnology

CARL VON OSSIETZKY universität OLDENBURG

University of Oviedo

Department of Electrical Engineering, Electronics, Computers and Systems (DIEECS) Multisensor Systems and Robotics Laboratory (SIMUR)

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The Multisensor Systems and Robotics (SIMUR) group, is a unit of the Department of Electrical, Electronics, Computers and Systems Engineering (DIEECS) of University of Oviedo, at the engineering campus of Gijon.
The SIMUR focuses on research and education in human centered robotics: „Robots must be able to interact with humans such that the burden of adaptation lies with the machine and not with the human".

Human centered robotics implies that natural human-robot coexistence happens because machines are able to adapt to human. To do that, the robot must be able to move safely in unstructured human-inhabited environments, and it must be able to understand and anticipate the ongoing human activity. These two skills are the basis to effective human-robot collaboration.

UNIVERSIDAD DE OVIEDO

Robots among people

To approach this vision, we work in two research themes:
- Automatic human activity recognition and motion monitoring
- Robot motion in unstructured human-inhabited environments (sensor-based robot motion).

Our interest includes the sensor systems (multisensor integration, computer vision) required to support the reliable/fault-tolerance perception needed in both problems.

The technologies we are developing for human behavior detection in robotics, allow us to monitor human motion in real time with small sensors attached to the human, for daily-life effortless use.
This opens the door to a wide range of other applications: pedestrian navigation, personal health monitoring, human activity monitoring, sport training, wearable devices, or new interfaces for man machine interaction.

We work with different public and private partners in various type of projects:
- Inertial measurement systems, with application to ergonomics, evaluation of occupational hazards (HHEs).
- Sports and physical activity evaluation: devices for research, training and sports practice and evaluation
- Localization in GPS-denied environments (pedestrian navigation).

We also work with industry in the development of multisensor systems. And we maintain a Matlab toolbox for inertial signals processing.

Keywords
Robots among people
Human activity detection
Sensor-based motion planning

Universidad de Oviedo

Robots among people

University of Padova

Department of Information Engineering
Intelligent Autonomous Systems Laboratory (IAS)

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Website
http://robotics.dei.unipd.it

Contact
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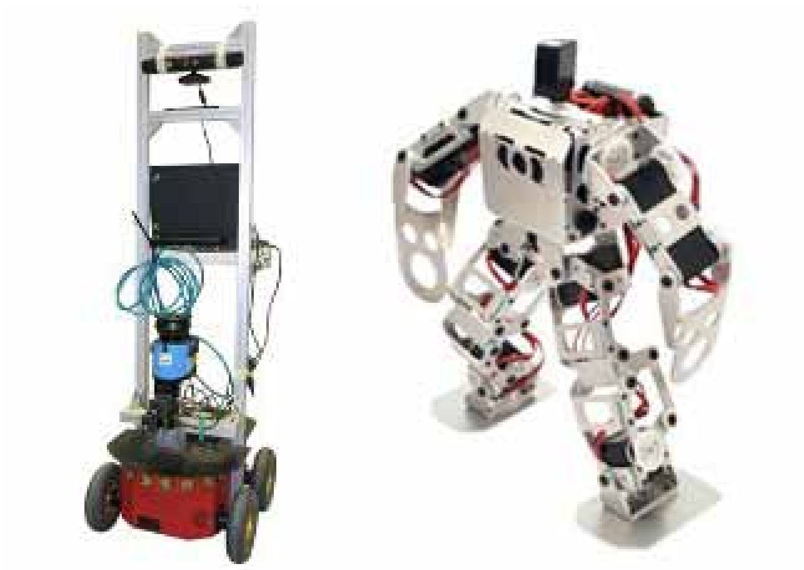
The Intelligent Autonomous System Laboratory has been established in 1999 at the Department of Information Engineering of the University of Padua to carry out researches on the fields of:

- Motion and task planning
- Multi-robot systems coordinatio
- Simultaneous and localization mapping
- Autonomous navigation
- Distributed sensory systems
- Robotics vision
- People tracking
- Humanoids
- Elastic robot design
- Musculoskeletal modeling
- Simulation and programming environments for robotics
- Robotics teaching.

Università degli Studi di Padova



IAS-Lab has generated IT+Robotics, a spin-off company active in the field of introducing autonomy into manufacturing industry and service robotics.
It keeps close research cooperation with several top-class Universities in East-Asia, and participates into Thermobot (Autonomous robotic system for thermo-graphic detection of cracks), and 3DComplete (Efficient 3D Completeness Inspection) UE Projects.

Keywords
Multi-robot systems
Motion planning for multiple DoF
Robot programming languages
Simulation systems for robotics applications
Humanoids
Musculoskeletal system models
Robotics vision
Omnidirectional vision
People tracking
Intelligent distributed sensor systems
SLAM
Educational robotics

Intelligent Autonomous Systems Laboratory (IAS-Lab)

University of Palermo

Department of Chemical, Management, Computer, Mechanical Engineering Robotics Lab

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Research at the RoboticsLab is focused to the study and development of "conscious" robotic systems. The main objective of the research is aimed at creating robots with powerful perceptual and cognitive skills, able to learn by interacting with people and with the external environment, and driven by motivations and emotions.

The RoboticsLab is a benchmark for mobile robotics applied to guide museums. Cicerobot and Robotanic are successful stories of guide robots at the Agrigento Regional Archaeological Museum and at the Botanical Garden of Palermo. They attracted interest from the scientific community and international media.

The RoboticsLab is actively working in a scientific collaboration with the group of Prof. Hiroshi Ishiguro of Osaka University of Japan under the projects Geminoid and Telenoid related to the construction of android robots.

The RoboticsLab is a leader in the researches related to „robot consciousness", aimed to equip robots with artificial consciousness and emotions.

UNIVERSITÀ DEGLI STUDI DI PALERMO

Research areas

Robot Consciousness
- Robotics models of consciousness from neuroscience and cognitive science
- Robotics models of emotions and motivations.

Android Robotics
- Perception systems for humanoids and android robots
- Evaluation of the impact of androids in everyday life.
-

Social Learning
- Robot learning by demonstration
- Learning of robot internal models.

Software Engineering for Robotics
- Formal methodologies for complex robot software
- Evaluations methodologies of robot behaviors.

Keywords
Robot consciousness
Android robotics
Robot social learning
Software engineering for robotics

ROBOTICSLAB

University of Parma

Faculty of Engineering
Computer Engineering Group
Department of Information Engineering
Artificial Vision and Intelligent Systems Laboratory (VisLab)

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Parma

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Technologies developed during last years have improved the know-how concerning sensors integration on vehicles to reach a 360 degrees environmental perception, that actually is a strong point of VisLab technologies.

The Artificial Vision and Intelligent Systems Laboratory (VisLab) of Parma University (Italy) is involved in basic and applied research developing machine vision algorithms and intelligent systems for the automotive field.

UNIVERSITÀ DEGLI STUDI DI PARMA

VisLab undertakes research in many disciplines like:

- Machine vision
- Pattern recognition
- Low-level image processing
- Machine learning
- Artificial intelligence
- Robotics, and
- Real-time systems.

But the main focus of the laboratory is to apply basic and advanced research to intelligent transportation systems and intelligent vehicles.

The laboratory know-how is world renown and was mainly developed together with automotive companies for active/passive safety systems, advanced driver assistance systems, perception of the automotive environment, up to completely automatic vehicle driving.

Some examples are:

- Lane detection
- Vehicle detection
- Pedestrian detection
- Obstacle localization
- Sensor fusion with radar and laser scanner
- Night vision
- Start inhibit.

The know-how includes monocular, stereo, trinocular, up to tetra-vision systems, using daylight, Near Infrared, Far Infrared cameras; analog and digital cameras.

Keywordsomputer vision
Intelligent vehicles
Intelligent transportation systems

VISLAB.IT
Extend Your Vision

University of Patras

School of Engineering
Department of Mechanical and Aeronautics Engineering
Robotics Group

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The University of Patras since its foundation in 1964 has been committed to pioneering teaching and research. In its 112 laboratories that boast extensive equipment and facilities, research is conducted by PhD students and teaching staff. In the international scene the University is very active, participating in a large number of European and international Educational and research programmes and consortia and in all major academic associations. Its forefront scientific research has been recognized internationally. In recent years, over 2700 research projects, financed both by the Greek state and the European Union have been carried out.

The Robotics Group belongs to the Mechanical Engineering and Aeronautics Dept., is led by Prof. N. Aspragathos and includes one PostDoc researcher, 6 PhD students and one R&D Engineer working on the following research topics:

- Motion planning and robot control based on artificial intelligence, using genetic algorithms, neural networks, agent theory and computational geometry including: 1) motion planning of redundant or non-redundant robots moving in environments cluttered with obstacles, 2) trajectory generation under accuracy constraints, (cont.)

(cont.) 3) optimal single and multiple mobile robots motion planning in environments cluttered with obstacles, 4) combined scheduling and motion planning of mobile robots and manipulators under obstacle and other constraints.

- Control of robots and mechatronic systems including: 1) robots with elastic joints, 2) control for grasping of fragile objects based on Fuzzy Logic and tactile feedback, 3) intelligent control for handling of non-rigid materials, 4) hybrid adaptive and sliding mode force/position control, 5) strategies for robot fine motion in contact with the environment - application in assembly automation, 6) manipulation of microparts towards microassembly automation, 7) intelligent control systems for rehabilitation and 8) intelligent control for co-manipulation.
- Design of mechatronic production systems and products including: 1) knowledge based systems for designing mechatronic systems and devices, 2) introduction of new indices for the evaluation of design solutions, and 3) design of metamorphic manipulators.
- Optimal performance of current industrial manipulators and design and operation of reconfigurable robots.
- Computer graphics.

The Robotics Group has been involved in several EU funded projects and Networks of Excellence, such as I*PROMS NoE (Innovative Production Machines and Systems), 4M NoE (Multi – Material – Micro –Manufacturing), EAPSTRA (EurAsian Network for Product Lifecycle Support & Training), APoST (Advanced Product and Support Technologies), HOMER (Handling of Non – Rigid Materials with Robots), ROBAS (Robotic Assembly), EURON (European Robotics Research Network) and INTERWELD- Manunet (Intelligent Robotic Laser Welding and Hardening Cell) as well as in several national funded programmes as PENED (Program for the Aid of New Researchers), PYTHAGORAS 2 (Development of a Methodology for the Systematic Conceptual Mechatronics Design), PEP of Western Greece (Development of Computational Intelligent Methods for the Rehabilitation of the Lower Limbs) and Karatheodoris (An Optimal Motion Planning for a Robot or a Set of Robots based on Computational Geometry).
Furthermore, the robotics group is involved in two Technology Platforms: the European Robotics Technology Platform (Europ) and the European Technology Platform for the Future of Textiles and Clothing (Euratex).
More than 180 papers have been published in international journals and presented in international conferences.
Laboratory facilities include three industrial robotic manipulators, one lightweight 7DOF research manipulator, two small mobile robots and one mobile platform with 5 DOF manipulator, laser scanner and sonar that are used for motion planning under ROS. Several small mobile robots and manipulators and grippers have been developed by the group. A wide range of sensor systems, force/torque, vision, tactile, IR, position, ultrasonic, etc. are available and have been incorporated in robots and several experimental devices as well as three robotic simulation platforms are available and are used for research and education proposes.
In addition, software packages have been developed for ANN, FL, GA, optimization, motion planning, kinematics, dynamics and control of robots.

Keywords
Robotics
Motion planning
Intelligent control
Human-robot co-manipulation
Metamorphic robots
Mechatronics

University of Perugia

Faculty of Engineering
Electronic and Information Engineering Department (DIEI)
Service and Industrial Robotics and Automation Lab (SIRALab)

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The University of Perugia has been established more than 700 years ago, and is one of the oldest university in Italy. Within it, the Electronic and Information Engineering Department (DIEI) covers the areas related to information systems, electronics, automation, computer science, telecommunications.

The Service and Industrial Robotics and Automation Laboratory (SIRALab), which is part of DIEI, carries out research activities on control systems, robotics and autonomous systems, engineering for medicine and biology, and systems biology. The group is also involved in a number of technology transfer projects covering the above areas, as well as general control and automation problems.
The research mission of the SIRALab group is to develop solutions and methods of interest for service robotics and autonomous systems, with application to mobile robots, underwater vehicles, and unmanned aerial vehicles.

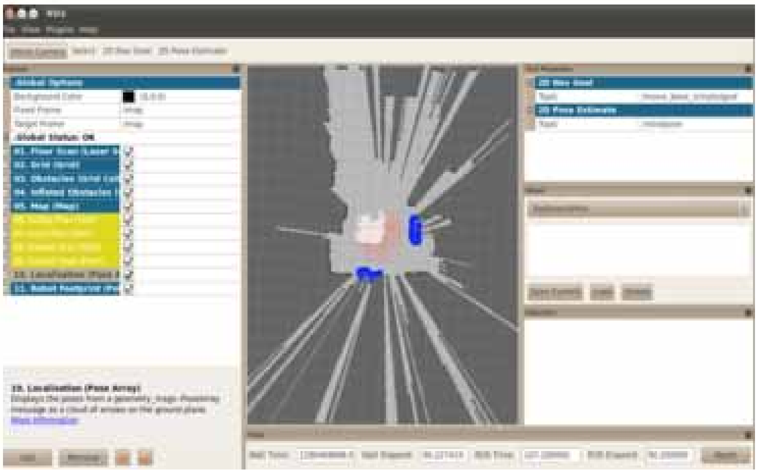
STUDIUM GENERALE CIVITATIS PERUSII A.D. MCCCVIII

FACOLTÀ DI INGEGNERIA

Main research areas

Perception in Robotics

Perception is one of the key enablers to deploy autonomous robots in realistic and unpredictable environments. Research at SIRALab focuses on the development of robot perception systems, with specific interest for systems employing vision and range sensors. Current activities cover the study of innovative methodologies for sensor fusion, the use of computer vision and machine learning tools for scene modelling, place recognition, loop closing and in general localization problems.



Aerial Robotics

Over the years many lines of research have been activated in the area of Aerial Robotics. This include design, deployment and testing of UAVs systems, flight guidance and control schemes, sensors and actuator faults diagnosis schemes, fault tolerant control, non-linear adaptive and learning control, optical feedback based control schemes for UAVs in flight operations such as autonomous aerial refuelling.

Medical and biological applications

SIRALab group is also active on engineering tools for medical and biological applications, such as artificial pancreas simulation, hydrocephalus pressure control and management, systems biology.

Keywords
Mobile robotics
Autonomous systems
Unmanned aerial vehicles
Vision for robotics
Localization
Place recognition
Technology transfer
Systems biology

FACOLTÀ DI INGEGNERIA

University of Pisa

Faculty of Engineering
Interdepartmental Research Center „E. Piaggio“

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The Interdepartmental Research Center "E. Piaggio" of the University of Pisa is devoted to multidisciplinary research in the fields of bioengineering and robotics, and to the training of personnel for careers in research and development.

More popularly referred to as "Centro Piaggio", the Center is one of the oldest multidisciplinary research centers in Europe where scientists from different disciplines converge to combine their expertise and know how to generate knowledge and provide research and training facilities.

UNIVERSITÀ DI PISA

Centro E. Piaggio
bioengineering and robotics research center

To pursue its research mission, in the 1980's the Center became an Interdepartmental Center of the University of Pisa, affiliated with both engineering departments (Aerospace; Electrical Systems & Automation; Information; Mechanical, Nuclear and Production; Chemical) and science departments (Mathematics; Chemistry).

Furthermore, the Italian Council of National Research (CNR) participates in Centro Piaggio through the Institute of Clinical Physiology, in Pisa, and the Institute for Applications of Calculus M. Picone in Rome

Affiliated departments and institutes offer their research and technical personnel to the Center to provide a truly interdisciplinary environment. Laboratory facilities comprise machine-shop, electronic, optics and fiber-optic measurement and testing, microfabrication facilities, a chemical and a cell culture laboratory.

Currently, the Center has two main research groups: Robotics and Bioengineering, cooperating with about 100 researches of the University of Pisa.
It has promoted spin-off projects with the cooperation of the University of Pisa, and it has opened laboratories and activated conventions with some hubs of industrial technology in the region of Tuscany, such as the hubs of Navacchio, Cecina and Piombino.

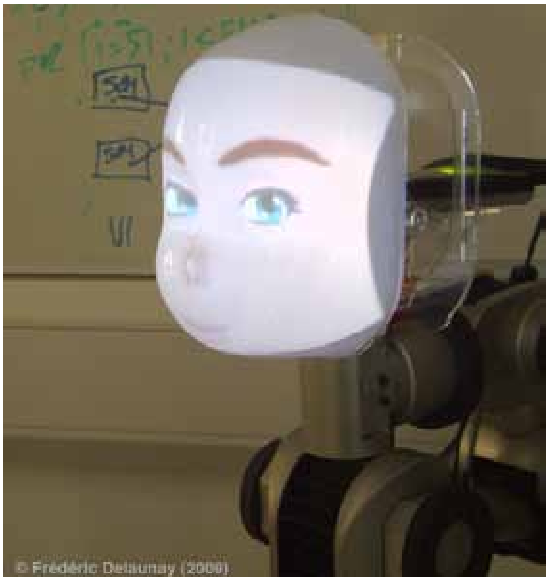
Keywords
Robotic hand
Variable stiffness actuator
Haptic interfaces

UNIVERSITÀ DI PISA

Centro E. Piaggio
bioengineering and robotics research center

University of Plymouth

School of Computing, Communications & Electronics
Centre for Robotics and Intelligent Systems (RIS)



LightHead

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The Centre for Robotics and Neural Systems is part of the School of Computing and Mathematics of Plymouth University. The centre houses a multidisciplinary group with interests in cognitive systems and robotics and their constituent technologies. The group has strong national and international links with both industry and other research institutes.

Our mission can be summarized as building a brain for robots of the future. Robots in the near future will live next to you, serving as a personal assistant, as an edutainment system, a butler or even just as a pal. For this, robots will need cognitive capacities that are beyond any robots that exist today.

Our centre aims to build components that will be used in future robots. Some of these components will serve to let the robot navigate a home at high speed without scratching the furniture; others will serve to implement low-power neural processing methods, or will help you, the user, to communicate with your personal robot in natural language.

The Centre has a range of commercial robots such as the iCub, Nao and Darwin. We also build our own robots, such as the LightHead and the Plymouth Humanoid used for competition and teaching.

COGNITIVE ROBOTICS WITH PLYMOUTH UNIVERSITY

Plymouth Humanoid teaching kit, showing world record sprint and marathon trophies

The Centre is conducting research in artificial vision (plankton classification, microscopy slides analysis, robot localization, object detection), spoken interfaces, human-robot interaction, robot gait stabilization, compliance, cognitive and neural modeling (audition, vision, language learning, behavior learning, memory, dynamical systems, neuron models), EMG for prosthetic hand control, use of a range of ARM-based processors, FPGA camera interfaces, and neural emulation hardware (SpiNNaker).
We use international competition as a driver for robot development that is tightly coupled with teaching engineers skills in robot design and construction. We compete in both FIRA robot athletics and Robocup football events, fielding kid-size humanoid robots for both athletics and playing football. We hold the world records for sprint and marathon events established at the FIRA Taiwan tournament 2011.
We closely work together with psychologists and cognitive scientists, and use insights from cognition science and developmental psychology to design intelligent robots and evaluate their behavior.

Keywords
Human-robot interfaces
Humanoid robots
Brain modeling
Cognitive robotics
Electronics

THE UNIVERSITY OF PLYMOUTH

COGNITIVE ROBOTICS WITH PLYMOUTH UNIVERSITY

University of Reading

School of Systems Engineering
Intelligent Systems Research Laboratory (ISR)

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Reading

Website
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Contact
Prof. Atta Badii
atta.badii@reading.ac.uk

Intelligent Systems Research (ISR) at the School of Systems Engineering, University of Reading, comprises a multi-disciplinary research group with advanced FPGA-enabled technology, computer vision, multi-modal activity tracking, machine learning, intelligent media search and dynamic usability evaluation laboratories. These support a research focus on semantic-cognitive context-aware social and service robotics, including „Robo-Humatic" (mixed-initiative taking and cooperativity support for human-robot / robot-robot teamwork) and robot self-training.

ISR maintains an unparalleled rate of sustained success in the UK university sector as evidenced by its outputs and impacts. Its internationally recognized leadership, based on its proven strengths, has to-date enabled it to lead several large scale collaborative research programmes and contribute as a core leading research partner to over 20 large collaborative projects as of July 2012.

Our work is supported by a spectrum of research funding agencies from UK (EPSRC, MoD, TSB) and the European Commission ICT and Security research Programmes.

Our projects have to-date delivered around 20 innovative outputs, including industrially deployed systems.

University of Reading

ISR's multidisciplinary competencies include:

- Semantic-cognitive control architectures for assistive-rehabilitative robotics (e.g. as in the CORBYS project) and privacy-aware companion robotics (e.g. as in the CompanionAble project– European Star Innovation Project 2011); MoD Grand Challenge (Finalist 2008).
- Real-time cognitive-load/stress minimizing multi-modal C3-Companion (Command-Communications-Control) to support mobile task forces (e.g. as in the MoveON project -C3PAL).
- Mood-responsive emotionally-literate behavior monitoring to support affective-expressive human-robot interaction (e.g. as in the CALLAS project –emotions-aware companion (robot or proxy avatar persona).
- Affective speech and /or music recognition and synthesis – and affective music composition (e.g. as in the CALLAS project).
- Secure semantic interoperability of distributed heterogeneous smart systems supported by a secure semantic middleware platform (Hydra project technology platform available open-source as LinkSmart).
- Personalized security-privacy-preserving service-oriented architecture for trustworthy Internet-of-People-Things and cloud services (Mobi-PETS-GRID), to support enhanced mobile man-machine cooperativity with service/social robotics.
- Virtual-User and Living Laboratory based user-driven integrated requirements prioritization and Dynamic Usability Relationships Evaluation Methodology (UI-REF, as deployed e.g. in the FastMatch, CompanionAble and ELLIOT projects). Psycho-cognitively inspired dynamic man-machine usability relationship modelling applicable particularly in assistive technology domains e.g. Ambient Assistive Living (AAL), Factory/Driver/Patient of the Future (Automation, Transport, eHealth and Personal Well-Being Support Systems).

These are enabled by technologies developed at ISR including:

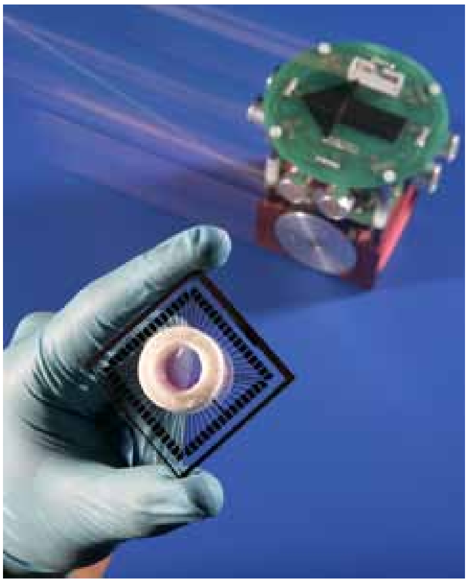
- Robot navigation in unstructured environments, dynamic (re)planning and execution monitoring, multi-agent decision support
- Object recognition and tracking, semantic scene analysis and event-triggered image processing and coding
- Intelligent clothing for real-time vital signs monitoring (stress / cardiovascular / hemo-dynamics)
- Speech and natural language processing, speech understanding and dialogue management
- Simulation and modelling, agent behaviors risks modelling, intelligent information management.

Keywords
Human-robot interaction
Robot-robot interaction
Perception, Attention, Focus
Semantic-cognitive control
Mixed initiative taking
Machine learning
LinkSmart, Middleware
Mobi-PETS-GRID. UI-REF

Amongst its leadership of a number of large integrated research programmes, ISR is also the scientific and technical director of the VideoSense European Centre of Excellence (*www.videosense.eu*). ISR visionary research has been featured prominently in the annual UK parliamentary report 2012 submitted by FAST UK and in various media reports. We maintain close research links with the Cybernetics Research Group at Reading, and, with several other leading research groups and centres of research excellence in Europe and beyond; we regularly welcome young and senior research visitors from major universities worldwide.

University of Reading

School of Systems Engineering
Cybernetics and Electronic Engineering
Cybernetics Research Group



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The Cybernetics research group at the University of Reading is a multi-disciplinary research group in the School of Systems Engineering at the University of Reading. Robotic systems form a valuable demonstration of cybernetics principals so are used to explore concepts ranging from stability and control, through to cognition and intelligence. The group maintains a strong working relationship with Prof. Atta Badii and the Intelligent Systems Research Laboratory (ISR).

Cybernetics research at the University of Reading can be considered in three interwoven themes. Neurodynamics and cognition, measurement and control, and human interaction. As such research tends to focus on the core concepts of cybernetics in animal and machines, although members of the group have ongoing interests in all areas of the field. The group ran the first workshop on cognitive robotics in 2006 (*www.cogric.reading.ac.uk*).

The Cybernetics research group has a high international profile, and welcomes research students and visitors from across the world. The group has also attracted a high level of global media interest in all areas of research.

University of Reading

The group has a strong focus in cognitive robotics and neuroscience with links to the Centre for Integrative Neuroscience and Neurodynamics and the School of Pharmacy. The group has ongoing research in embodied neuron cultures. Current work uses dissociated biological neurons cultured on a micro electrode array to send commands to a mobile robot, and to receive stimulation derived from the sensors mounted at the robot. In this way, it can be argued that the interfaced neural culture is taking at least part of the role of the controller of the robot. The principal aim of this research project was, by using experiments such as the one described above, and the data collected from them, to investigate how computational and learning capacity is encoded in animal brains.

This interest also extends to robots for stroke rehabilitation and the group has ongoing research on the technology and clinical impacts of using machines to assist assist in upper limb neurorehabilitation (Gentle/s and Gentle/g) and the application cognitive processes of upper limb movement to reaching and grasping of a force reflective robot. (*http://www.reading.ac.uk/sse/about/news/sse-newsarticle-2008-10-08.aspx)*.

The group is also studying control and sensing for unmanned aerial vehicles and mobile robots for local surveillance. Work lead by Prof. Victor Becerra involves the development of novel vision based control algorithms for unmanned aerial vehicles. The group uses both quadrocopter and single rotor helicopters for their work, with information coming from inertial sensors, sonar, GPS, and two cameras. There is a strong interest in visual guidance and the project uses biological inspiration from the use of vision by flying insects and birds to enhance the execution of complex autonomous manoeuvres, such as landing on a moving platform.

Keywords
Cognitive robotics
Unmanned aerial and ground vehicles
Neural systems
Visual localization
Sensor integration
Biologically inspired robotics

University of Reading

University of Rome „Tor Vergata"

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Automation and Robotics Group

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The Automation and Robotics (AR) research group is part of „Dipartimento di Ingegneria Civile et Ing. Informatica" at Università di Roma "Tor Vergata".

The AR members teach courses related to (non)linear control, estimation, identification and robotics and have published hundreds of scientific articles related to:

- Nonlinear control
- Robotics
- Estimation
- Modeling and identification
- Supply chain
- Vision and localization
- Saturated actuators
- Observers
- Optimal control
- Periodic systems

(cont.)

(cont.)
- Adaptive control
- Hybrid systems
- Robust control
- Smart actuators
- Network controlled systems
- Systems with impacts
- Digital control
- UAV - UGV
- Biological systems.

International Collaborations
- University of California, Santa Barbara (USA)
- University of New Mexico, Albuquerque (USA)
- University of Illinois, Urbana-Champaign (USA)
- Ohio State University, Columbus (USA)
- Imperial College, London (UK)
- University of Leicester (UK)
- Johannes Kepler University, Linz (Austria)
- LAAS-CNRS, Toulouse (France)
- University of Melbourne (Australia)
- INES-ID, Lisbona (Portugal)
- ENEA - CNR.

Keywords
Nonlinear control
Robotics
Estimation

UNIVERSITA' degli STUDI di ROMA
TOR VERGATA

AUR

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The Robotics group of DIAG (Dipartimento di Ingegneria Informatica, Automatica e Gestionale) and the associated Robotics Laboratory were established at the University of Rome „La Sapienza“ in the late 1980s with a commitment to develop innovative methods for modeling, planning and control of industrial and service robots.

The Robotics Laboratory is currently equipped with two articulated manipulators by KUKA (a KR 5 Sixx and an LWR 4+), an underactuated arm (Pendubot) and several mobile robots, including both wheeled (an iRobot MagellanPro plus a team of five K-Team Kheperas III) and legged (an Aldebaran NAO humanoid robot and two quadruped Sony AIBOs) platforms. Finally, two quadrotor UAVs by AscTec (a Hummingbird and a Pelican) are available. All these robots are equipped with sensing devices of various complexity, going from ultrasonic/laser range finders to cameras, Kinect depth sensors and stereo vision systems. In the past, we have also designed and built a two-link flexible manipulator (FlexArm) and a differentially-driven wheeled mobile robot (SuperMARIO).

SAPIENZA
UNIVERSITÀ DI ROMA

Over the years, research results were obtained on the following subjects:

- Nonlinear control of robots
- Iterative learning of repetitive motion
- Hybrid force/velocity control of manipulators interacting with the environment
- Optimization schemes in kinematically redundant robots
- Motion planning and control of wheeled mobile robots and other non-holonomic mechanical systems
- Stabilization of underactuated robots
- Robot actuator fault detection and isolation
- Safe control of physical human-robot interaction
- Control of manipulators with flexible joints/links
- Control of locomotion platforms for VR immersion
- Image-based visual servoing
- Sensor-based navigation and exploration in unknown environments
- Motion planning for high-dimensional systems
- Multi-robot coordination and mutual localization.

In addition to further development in the above mentioned areas, recent activities include:

- Control and visual servoing for unmanned aerial vehicles (UAV)
- Control-based motion planning for mobile manipulators
- Motion planning and control of locomotion in humanoid robots
- Sensory supervision of human-robot interaction.

Keywords
Robot control
Motion planning
Perception and interaction

SAPIENZA
UNIVERSITÀ DI ROMA

University of Rome „La Sapienza“

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The laboratory RoCoCo (Cognitive Cooperating Robots) is located at DIAG (Dipartimento di Ingegneria Informatica, Automatica e Gestionale) of Sapienza University of Rome.

The research developed at RoCoCo laboratory is in the area of Artificial Intelligence and Robotics and started with the participation to the RoboCup competitions in 1998.
The laboratory has contributed to several national and international projects, in particular a collaboration with the Italian National Fire Corps.

RoCoCo Laboratory currently hosts 4 faculties (Daniele Nardi, Luca Iocchi, Giorgio Grisetti, Domenico Bloisi) 1 Post Doc, 5 PhD Students and several master students.

SAPIENZA
UNIVERSITÀ DI ROMA

RoCoCo laboratory has several types of robotic platforms, that are used both for research project and as support to the courses of the Master in Artificial Intelligence and Robotics, offered at DIAG. Among the platforms available Aldebaran NAO humanoid robots (formerly Sony AIBO), wheeled mobile robots (Pioneer, Videre Erratic, TurtleBot, Segway), a mobile manipulator Kuka YouBot, and small UAVs from Ascending Technologies. In addition, several sensors are available both for mobile and fixed installations, including stereo cameras, depth sensors laser scanners, IMU, thermal cameras.

At RoCoCo laboratory several software tools have been developed, including: OpenRDK Robotic Software Development Framework, Petri Net Plans (PNP), IMBS Background Subtraction Library, WiiC C/C++ Library for Wiimote.

The following research areas have been addressed at RoCoCo Laboratory:
- Multi robot systems
- Cognitive robotics
- Robotic perception
- Simultaneous localization and mapping
- Human robot interaction.

The following domains have been targeted by the research projects carried out at RoCoCo Laboratory:
- Robotic soccer
- Service robots in the home
- Surveillance with fixed and mobile sensors
- Search and rescue robotics.

Keywords
Multi robot systems
Cognitive robotics
Robotic perception
Simultaneous Localization and Mapping (SLAM)
Human-robot interaction

University of Salerno

Faculty of Engineering
Department of Electronic and Computer Engineering
Automatic Control Group

Location
Italy
Salerno

Website
http://www.automatica.unisa.it

Contact
Prof. Pasquale Chiacchio
pchiacchio@unisa.it

Keywords
Automatic control
Robotics
Discrete event systems
Supervisory control

Automatic Control is the research area and theoretical base for mechanization and automation, employing methods and technologies for processing of information (data and signals) to automate plants, processes, and general dynamic systems. These include, for instance, manufacturing and batch processes, machines, robots, transport systems, power production and distribution systems, avionic systems, environmental systems. These very different classes of systems can be modelled, analyzed, simulated and controlled with theoretical instruments which are the same regardless of the nature of the particular system.

Research areas
- Robotics
- Discrete event systems
- Supervisory control theory of Petri Nets
- Supervisory control implementation
- Simulation based control.

The Automatic Control Group of the University of Salerno is part of Prisma Group.

University of Siena

Information Engineering Department
Systems and Control Group
Siena Robotics and Systems Lab (SIRSLab)

Location
Italy
Siena

Website
http://sirslab.dii.unisi.it

Contact
Assoc. Prof. Domenico Prattichizzo
prattichizzo@ing.unisi.it

The Dipartimento di Ingegneria e Scienze dell'Informazione at the University of Siena was established in 1996, to develop researches in the fields of robotics and automation, computer science and electronics.

The Robotics Group, coordinated by Domenico Prattichizzo is active in robotics and haptics and in particular in robotic grasping and haptic rendering for multi-point contact interaction.

The SIRSLab, the lab group, has many facilities such as eight haptic interfaces, two robotic arms, an anthropomorphic robotic hand, a 3D printer, many vision systems and mobile robots.

The main research topics of the UNISI group are:

- Visuo-haptic rendering algorithms
- Studying perceptual phenomena which characterize the kinesthetic interaction with complex virtual environments
- Developing of multi-contact grasp models
- Bio-inspired control algorithms for robotic hands
- Prototyping of wearable and portable haptic interfaces.

The group has been involved in many research projects such as

- „THE - The Hand Embodied“
- „Hands.dvi - A DeVice-Independent programming and control framework for robotic HANDS“ (ECHORD experiment),
- „DALi - Devices for Assisted Living“
- „ROBOCAST“ (VII Framework Program, European Community).

The UNISI group has been awarded at the EXPO 2011 within the Italia degli Innovatori initiative (Shanghai, China) for the „RemoTouch“ project.

Keywords
Visuo-haptic rendering
Robotic grasping and manipulation
Medical robotics
Human-centered robotics

SIRSLAB
SIENA ROBOTICS AND SYSTEMS LAB

University of Southampton

School of Engineering and the Environment
Autonomous Systems Laboratory

Location
United Kingdom
London

Website
http://blog.soton.ac.uk/robotics

Contact
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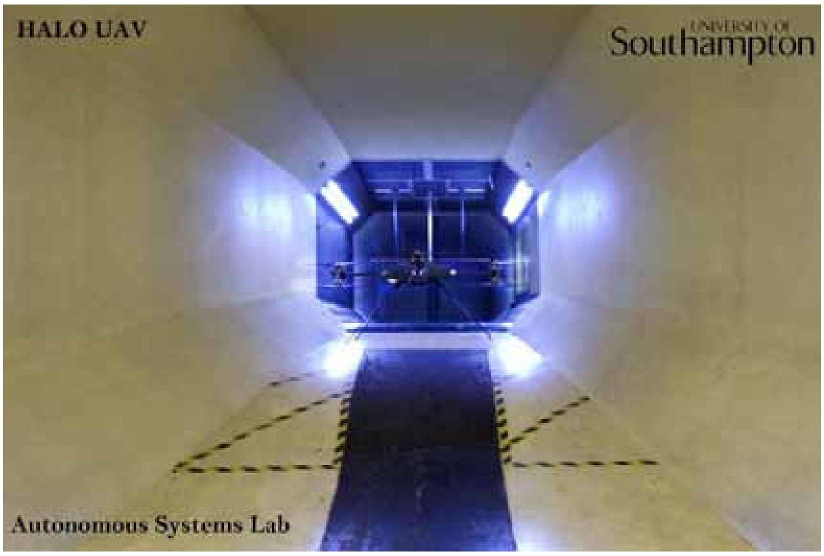
The ASL at the University of Southampton specializes in research into Autonomous Robotic Systems.

We are actively involved in cutting edge research in the areas of Unmanned Aerial Vehicles (UAVs) – both rotary wing and fixed wing, Unmanned Ground Vehicles (UGVs) as well as pole climbing systems and are keen to develop productive links with international researchers in complimentary areas.

In May 2012, our HALO team was the highest scoring team in the DARPA UAVForge challenge. An international competition to find the next generation small unmanned air vehicle for the US military. (*http://www.uavforge.net*)

Groups working on proposals for Horizon 2020 funded projects and who are looking for UK collaborators please contact us.

UNIVERSITY OF Southampton



Recent references

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- Prior, S. D. (2011) Developments in nano unmanned aerial systems. In: The First International Conference on Engineering and Technology Innovation 2011 (ICETI 2011), 11-15 November 2011, Kenting, Taiwan [Invited Speaker].

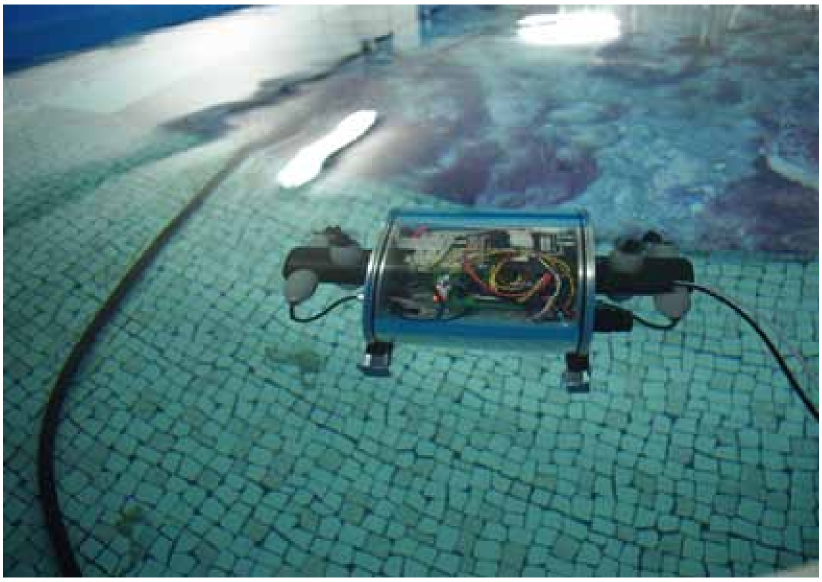
Keywords

Autonomous robotics
Unmanned Aerial Vehicles
Unmanned Ground Vehicles

AUTONOMOUS SYSTEMS LAB

University of the Balearic Islands

Department of Mathematics and Computer Science
Systems, Robotics and Vision Group (SRV)



Location
Spain
Palma de Mallorca

Website
http://srv.uib.es

Contact
Assoc. Prof. Gabriel Oliver
goliver@uib.es

The Systems, Robotics and Vision (SRV) group is integrated by members of the Mathematics & Computer Science Department of the University of the Balearic Islands. The main objective of the group is the development of scientific and engineering hardware/software solutions for real world problems, mainly focusing on industrial and mobile robotics, and also on dependable real-time control systems. Members of the group are involved in different research lines and those lines are reflected in the name of the group.

Our activities in robotics are related to service and field robotics. Our research has led to the design and development of:

- Land, underwater and aerial autonomous vehicles
- Novel hybrid reactive/deliberative control architectures for mobile robots focusing on real-time, collaborative and learning capabilities
- Novel localization and mapping strategies
- Novel obstacle avoidance strategies
- Simulation environments for mobile robots specifically oriented to training and testing.

UIB Universitat de les Illes Balears

SRV Systems, Robotics & Vision Group

Our activities in vision are related to image processing and understanding algorithms to be used in visually guided mobile robots.
The research performed in this line has led to the design and development of:

- Physics-based algorithms for image segmentation and edge detection
- Algorithms for geometric and radiometric calibration of vision cameras
- Application-specific algorithms for real-time guidance of a robot
- Algorithms for generic visual navigation.

In systems we are working on dependable and real-time distributed embedded systems. We work on problems related to the use of the Controller Area Network (CAN) protocol in critical applications within the industrial automation and automotive fields.
Specific issues that have been addressed are:

- The identification of inconsistency scenarios in CAN and the proposal of a modification to CAN in order to eliminate those scenarios
- The use of redundant hardware and distributed protocols to solve dependability problems in critical applications. This includes the design of duplicated buses, duplicated CAN controllers and triplicated CAN controllers
- The design of hardware-implemented clock synchronization services for real-time operation of CAN networks.

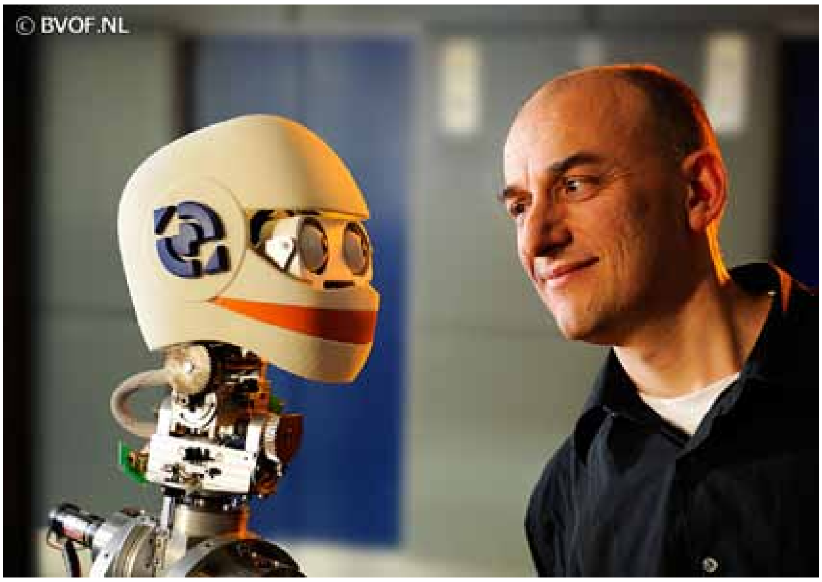
Keywords
Visual navigation
AUVs and UAVs
Real-time systems

UIB Universitat de les Illes Balears

SRV Systems, Robotics & Vision Group

University of Twente

Robotics and Mechatronics Group



Location
The Netherlands
Enschede

Website
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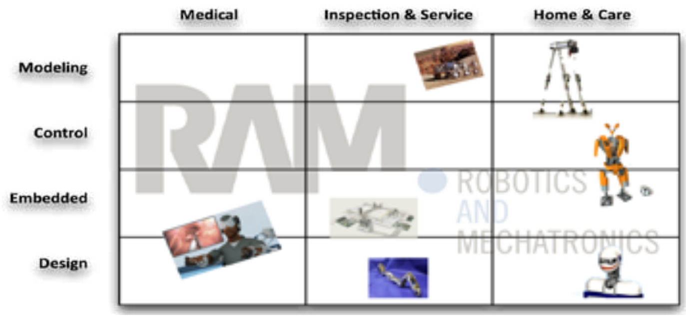
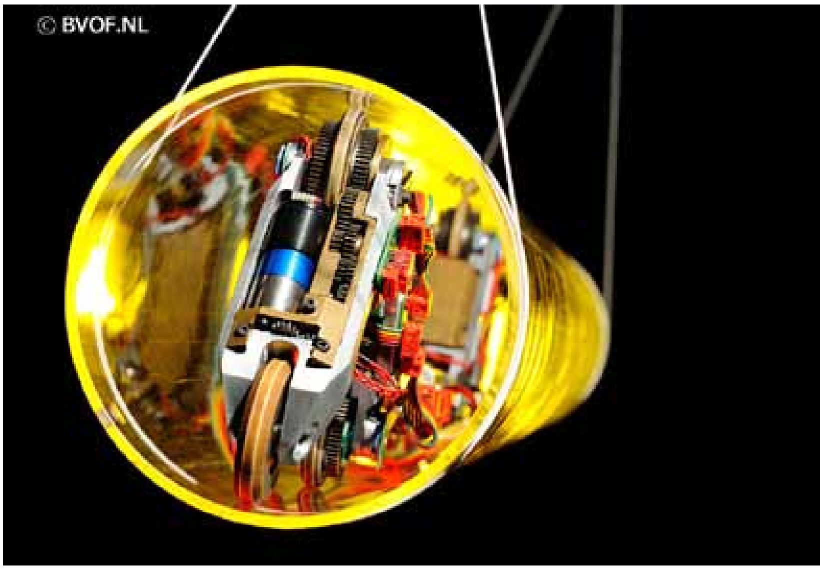
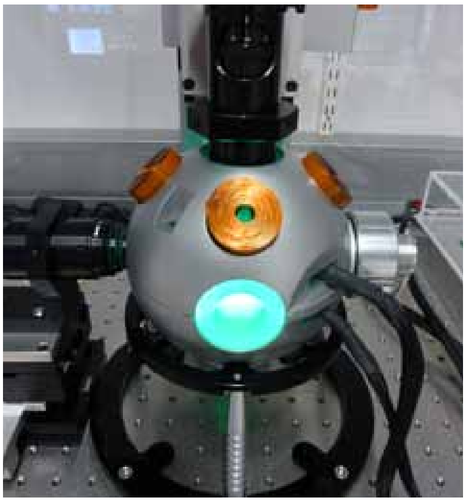
The research of the Robotics and Mechatronics (formerly Control Engineering) group has always focused on mechatronics and has currently been extended to focus on robotic systems. The research area of the group is novel technology and scientific methodologies for the design and development of complete robotic systems and similar intelligent devices, i.e. cyber-physical systems. The binding paradigm is the use of port-based methodologies for modeling, control, embedded software and design of mechatronics and robotics systems for real applications.

The group focuses on understanding the fundamental properties governing the dynamic and interacting behavior of mechatronic and robotic systems (modeling) and creates complete systems achieving the desired behaviors (control, embedded and design). This is done using port-based concepts (bond-graphs, port-Hamiltonian systems and process-oriented software structures). This paradigm is a common factor in the group. The port-based paradigm has proven successful in finding effective solutions for problems like telemanipulation with time delays, novel passive non-linear control strategies, power distribution, etc.

UNIVERSITY OF TWENTE.







Keywords
Control
Modelling
Simulation
Intelligent control
Embedded control systems
Robotics
Measurements
Instrumentation
Walking robots
Haptics
Telemanipulation
Mechatronics
Mechatronic design
Micromechatronics
Design tools
Port-based modelling
Bond graphs
Controller agents
Distributed control

Once a problem has been modeled, extensive simulations are run, mostly with the 20sim package of Controllab Products, one of the spin-off enterprises of the group. This software is growing in recognition and is now, among others, also used for multi-physics simulations by the European Space Agency. These results are followed by creative sessions to make choices on directions to be followed to solve the problem at hand. The solutions are then evaluated again, both via simulation and real realization of mechatronic systems and their embedded control software. The special mechanical parts are 3D-printed, or made by the group's local contacts (SME or Saxion University of Applied Sciences).

A specific part of the group is responsible for the computational and architectural part of the systems to be developed and performs research in Embedded Systems for this goal.

RAM
ROBOTICS
AND
MECHATRONICS

University of Udine

Department of Electrical, Industrial and Mechanical Engineering
Laboratory of Mechatronics and Robotics

Location
Italy
Udine

Website
http://www.mechatronics.it

Contact
Prof. Alessandro Gasparetto
gasparetto@uniud.it

The group was established in 1995 by prof. Alessandro Gasparetto. Since then, it has been very active in research and teaching in the fields of mechatronics and robotics.

The members of the group teach courses of applied mechanics, mechatronics, vibration analysis, robotics at the academic level (undergraduate, graduate and post-graduate) at the University of Udine and in some European universities.

UNIVERSITÀ DEGLI STUDI DI UDINE

The research activity is done both at academic level and in cooperation with companies. At the academic level, the research activity led to the publication of more than 150 papers in international journals, in the proceedings of international conferences and in international books.

At the industrial level, the research activity produced 20 European, US and Italian patents in the last 5 years only.

The research activity carried out by the group was granted by the Italian Ministry of University and Research, by the European Space Agency and by private companies.

The group achieved several awards, for instance the 1st place at "Premio Veneto Innovazione 2004", and the 2nd place at the 2009 European Robotic Technology Transfer Award (jointly sponsored by the European Network of Robotics EURON and the European Robotic Platform EUROP).

Research areas
- Study of vibration control for deformable manipulators
- Trajectory planning for industrial robots
- Implementation of robotic surgery
- Implementation of industrial robotic tasks (work cell)
- Development of Hardware-In-the-Loop (HIL) applications
- Remote control of robot motion using haptic interface.

Keywords
Flexible manipulators
Trajectory planning
Robot control
Hardware-in-the-Loop

UNIVERSITÀ
DEGLI STUDI
DI UDINE

University of Ulm

Faculty of Engineering and Computer Science
Department of Neural Information Processing

Location
Germany
Ulm

Website
http://www.uni-ulm.de/in/neuroinformatik/forschung/neurobotik.html

http://www.uni-ulm.de/en/in/institute-of-neural-information-processing.html

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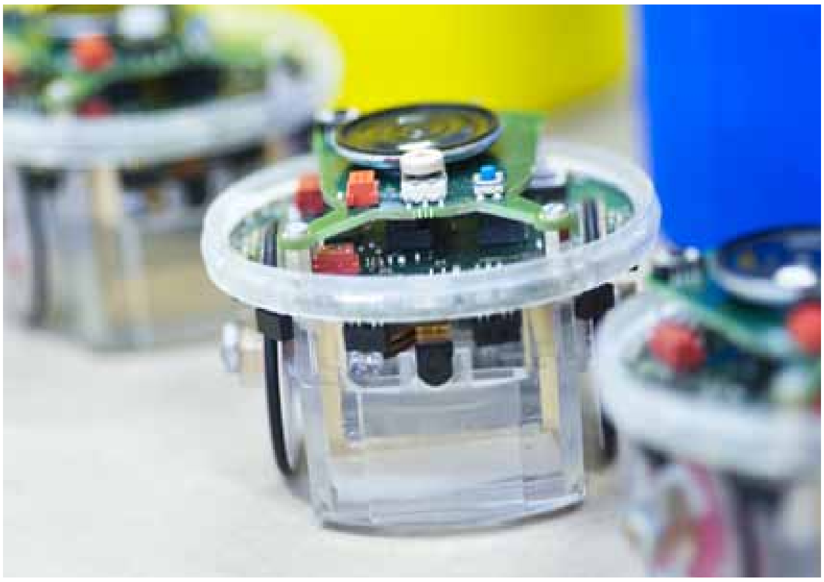
Research Goals

Our objective is to develop a new generation of embodied agents that are able to learn and develop autonomously (without human intervention) from the physical world. Rather than being programmed to solve a particular task, this agent will continually place itself in situations that contain new learnable skills in order to advance its knowledge in an open-ended way. The results of this research might trigger significant breakthroughs in creating true autonomous agents that deal effectively with changing and/or totally unknown environments, and even learn new behaviors that the programmer does not know about at the time of programming characteristics naturally means that this agent is endowed with a learning system that is task-nonspecific, has a certain degree of open-endedness, and becomes progressively more complex and sophisticated.

ulm university universität ulm



We believe that an important step toward a developmental architecture is to focus on learning process which is driven by intrinsic motivation, and socially guided within the „zone of proximal development". We imagine how the intrinsically motivated agent explores the environment in order to satisfy its inborn basic drives. We imagine how it continually wants to master the environment in order to meet challenges imposed by the general goal. We imagine how it asks for social interaction to learn from humans, what it cannot learn independently. These characteristics naturally mean that this agent is endowed with a learning system that is task-nonspecific, has a certain degree of open-endedness, and becomes progressively more complex and sophisticated.

We don't aim at discovering completely new learning algorithms to realize this objective; we rather believe that it will be sufficient to combine and occasionally augment the existing ones.

Keywords
Intrinsically motivated reinforcement learning
Adaptive critic design
Reservoir computing
Multiobjective problems
Developmental robotics
Artificial general intelligence

Thinking Robots
NEUROBOTIK

University of Ulster

Faculty of Computing and Engineering
Intelligent Systems Research Center (ISRC)

Location
United Kingdom
Derry

Website
http://isrc.ulster.ac.uk

Contact
Prof. Martin McGinnity
tm.mcginnity@ulster.ac.uk

The ISRC is a major research facility dedicated to the creation of intelligent computational systems, taking inspiration from, and learning from, biology and neuroscience. Work at the Centre is focused on achieving a high level of understanding in regards to biological signal processing and the translation of critical aspects of that knowledge into computational systems that behave in a way that humans would consider „intelligent".

We seek to research and create robotic systems that are capable of learning, evolving, adapting, self-organizing and communicating effectively with humans and other machines. Through this research, we foresee intelligent computational systems that can learn from experience, adapt autonomously to unanticipated situations and self-organize to meet dynamic environments.

University of ULSTER

To assist in this research, the Centre encompasses a world leading state-of-the-art robotics facility containing a large array of robots including four Scitos G5 robots (two are mounted with 7-DOF Schunk robot manipulators), a Willow Garage PR2, 10 Pioneer 3, various Khephera and Koala robots plus a Shadow ‚five finger' robotic hand. A high-precision Vicon motion tracking system is also permanently available in the lab for tasks such as robot tracking and experimental validation.

We strive to provide a robot with the ability to think and learn for itself, resulting in intelligent behavior without the need of human supervision. To this end, the team at the ISRC is engaged in a range of national and international research projects in key areas of robotics. Our work addresses robot learning, robot vision, collaborative robotics, networked robotics, robotics as science, tactile sensing and cumulative skills acquisition and adaptation. We maintain strong links with both industry and academia with current research initiatives funded by the European Union, the Leverhulme Trust, the N. Ireland local development corporation and InvestNI.

Some of the challenges within the lab revolve around robot manipulation, with particular focus on action learning and novelty detection. We use methods such as image-based visual servoing for object tracking and haptic feedback to add a further dimension to knowledge to assist the robot to successfully identify objects. The basic principle to this approach is to allow the robots to behave like children at play which acquire skills autonomously on the basis of „intrinsic motivations". The ISRC is currently involved in an international project (IM-CleVeR) which incorporates these principles to develop a robotic systems which can reuse the skills acquired to accomplishing multiple, complex, and externally assigned tasks.

We are also interested in creating a self learning robot ecology (RUBICON project) which will enable robots to mutually support one another's learning to identify commission and fulfil tasks more efficiently in an ambient assisted living setting. Affordable assistive robots in the home may be a somewhat delayed reality, however due to the work we do in the Centre, we believe that we are in a very strong position to contribute to the progression of this global aim.

Keywords
Autonomous learning
Reinforced learning
Intrinsic motivation
Cumulative learning
Robotics
Computational intelligence
Action learning
Simulation
Intelligent control
Modelling
Neural networks
Novelty detection
Cognitive psychology

INTELLIGENT SYSTEMS RESEARCH CENTRE

University of Verona

Department of Computer Science
ALTAIR Robotics Lab
(A Laboratory for Teleoperation and Autonomous Intelligent Robots)

Location
Italy
Verona

Website
http: //metropolis.sci.univr.it

Contact
Prof. Paolo Fiorini
paolo.fiorini@univr.it

The ALTAIR Robotics Laboratory was founded in 2000, concurrently with the establishment of the courses Automatic Controls and Robotics within the Computer Science Department of the University of Verona.

The aim of this laboratory is to lead research and development on non-conventional robotic systems that can interact with the surrounding environment in multiple ways, from teleoperation to autonomous behaviors.

Our research focuses mainly on applications for service robotics and field robotics, including all robotic systems that are not concerned with manufacturing operations. Of particular interest to us are the areas of: robotic surgery, exploration, elderly and disabled care, logistics and countermeasures against disaster and terrorism.

Keywords
Service robotics
Field robotics
Robotic surgery
Elderly and disabled care
Logistics
Countermeasures against disaster and terrorism

University of the West of England

Bristol Robotics Laboratory (BRL)

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Website
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Contact
Prof. Chris Melhuish
Chris.Melhuish@brl.ac.uk

Bristol Robotics Laboratory is the leading and largest academic centre for multi-disciplinary robotics research in the UK. It is a collaborative partnership between the University of the West of England (UWE, Bristol) and the University of Bristol, and home to a vibrant community of over 70 academics and industry practitioners, which lead current thinking in service robotics, intelligent autonomous systems and bioengineering.

An internationally recognized Centre of Excellence in Robotics, BRL's state-of-the-art laboratory covers an area of over 2,700 square metres and houses workshops, wet labs, laser cutters, rapid prototyping facilities, and two flying arenas with multiple 3D motion capture systems, as well as seminar rooms and a fully equipped video conference suite. It is a unique collaboration that harnesses the collective strengths of its university partners, and brings together the best expertise from industry and the academic community to spearhead Britain's efforts to be a world leader in modern advanced robotics.

brl Bristol Robotics Laboratory

UWE BRISTOL University of the West of England

University of BRISTOL

BRL's primary mission is to understand the science, engineering and social role of robotics and embedded intelligence; its vision is to transform robotics by pioneering advances in autonomous robot systems, which behave intelligently without human supervision. Home to a talented research community comprising electronic and mechanical engineers, computer scientists, mathematicians, biologists, aerodynamicists, surgeons, psychologists and material scientists, BRL is able to explore exciting new areas of research and develop innovative applications for business.

BRL maintains strong national and international links with both industry and other research institutes, and has an enviable track record of successful research and innovation, with funding from public and private bodies such as EPSRC, NERC, DSTL, Wellcome Trust, Leverhulme Trust, the European Commission, BAE Systems, and the Gates Foundation. BRL continues to develop its industrial and outreach activity, and provide targeted support to help businesses turn ideas into new products and services.

The Laboratory is currently involved in interdisciplinary research projects addressing key areas of robot capabilities and applications including: embedded intelligence, autonomous robot systems, human-robot interaction, energy autonomy, collective locomotion, tactile sensors and haptic feedback systems, motion tracking/positioning systems, swarming behavior, dependability, wearable and pervasive systems, medical and rehabilitation robotics, and bio-inspired architectures.

Keywords
Robotics
Autonomy
Innovation
Business

In addition to its core research activities, BRL offers PhD and Masters level research programmes. The Laboratory also offers a range of taught courses at undergraduate and postgraduate levels. BRL works closely with the British Automation and Robot Association (BARA), and hosts a variety of Robotic conferences, events and competitions, including TAROS and the FIRA Robot World Cup.

brl
Bristol Robotics Laboratory

UWE BRISTOL University of the West of England

University of BRISTOL

University of Zagreb

Centre of Research Excellence for Advanced Cooperative Systems (ACROSS) Laboratory for Cognitive and Robotic Systems

Location
Croatia
Zagreb

Website
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The long-term overall RTD objective of the ACROSS Research Centre is to be at the forefront of research and development of novel methodologies and engineering approaches for advanced cooperative systems related to robotics, networked embedded systems and renewable energy systems.

Research activities at the Laboratory for Cognitive and Robotic Systems, which is a part of the ACROSS Centre, aim to extend systems engineering to the design of individual and cooperative robotic systems that can carry out various useful tasks, such as manipulation and grasping, exploration and navigation, monitoring and control, situation assessment, communication and interaction, autonomously or in cooperation with people and/or distributed smart environments, in circumstances that have not been planned for explicitly at the design time.

The main focus of our research is on the development of cooperative robotic systems as they can often be used to fulfil the tasks that are difficult to be accomplished by an individual robot, especially in the presence of uncertainties, incomplete information, distributed control, and asynchronous computation.
The major challenges involve the realization of basic behaviors, such as trajectory tracking, formation-keeping control, and collision avoidance, or allocating tasks, communication, coordinating actions, and team reasoning. One way to resolve the above challenges is gained through cooperative control, since it allows the development of complex behavior based on several controllers combined to achieve the desired result.

Heterogeneity and interaction of cooperative robotic systems with humans increases complexity, but can also be a source of benefits when considering the exploitation of the complementarities of the robots for perception and actuation. However, formal methods to address the optimal real-time cooperation of heterogeneous robots and humans, exploiting their complementarities, are also needed.
Our research is fed by ideas from the application side and is constrained by the available technologies we could use to be able to develop advanced cooperative cognitive and robotic systems for specific target applications, such as personal care robots, human assistant robots, robots for autonomous transport and handling, site protection and surveillance robots. To assist in this research the Centre provides state-of-the art robotic platforms for experimental testing and validations.

Keywords
Optimal control
Hybrid systems
Cooperative control
Cognitive control
Autonomous navigation
Mobile manipulation
Cooperative robotic systems
Human-robot cooperative systems

ACROSS
Centre of Research Excellence
for Advanced Cooperative Systems

Vienna University of Technology

Faculty of Electrical Engineering and Information Technology
Automation and Control Institute (ACIN)

Location
Austria
Vienna

Website
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Contact
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ACIN is a member of the research cluster AUTCOM, Automation and Computer Technology, at the VUT. Our institute does basic research in the field of industrial automation, cognitive robotics as well as in modeling, optimization and control of complex dynamical systems.

We aim at applying the latest knowledge and advanced methods in our field of expertise to solve challenging practical problems in close industrial collaboration. We set a high value on the integration of the development of new theoretical concepts and applied research. Among our research partners are well-known international and national enterprises which take advantage of both our expertise in research and consultation.

TU WIEN
TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Complex Dynamical Systems Group (CDS)

The Complex Dynamical Systems group at ACIN does research in the field of modeling, simulation, analysis, optimization and control of complex dynamical systems. The primary goal of our research is the design of the closed-loop behavior of a system in view of an improvement of the dynamic properties, the accuracy, the robustness, the reliability and the flexibility. Furthermore, we aim to increase the productivity and the overall equipment efficiency (energy, resources) as well as to reduce the product costs, e.g. by minimizing the number of sensors.

Industrial Automation (IAT)

The Group for Industrial Automation at ACIN delivers research and education in the fields of precision engineering, scientific instrumentation and process measurement systems, as well as industrial automation and control systems. A special focus of these research domains is on industrially relevant applications. Our research activities aim towards the development of an integrated systems design approach, including theoretical aspects and advanced control methods, for industrial automation, production, and measurement systems.

Vision for Robotics (V4R)

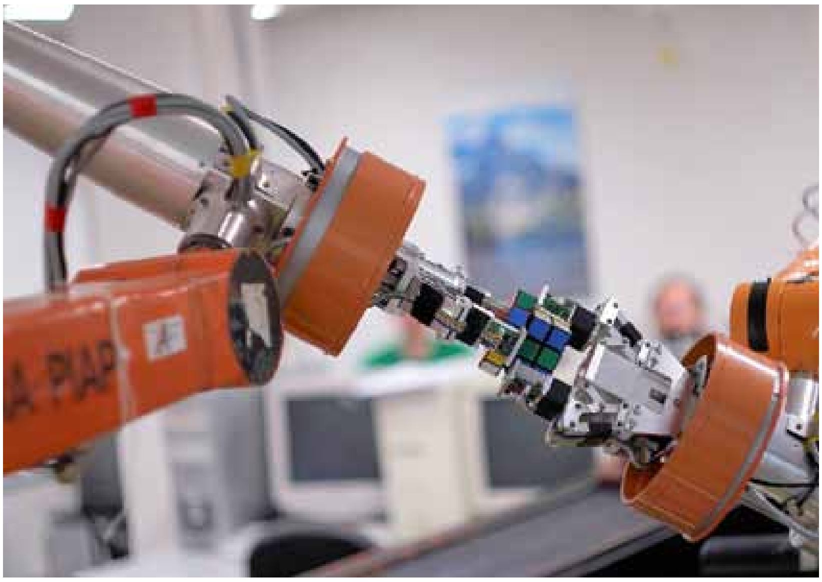
The V4R Group sets out to make robots see. That is, we devise machine vision methods to perceive structures and objects such that robots act in and learn from every day situations. This paves the way to automated manufacturing and robots performing household tasks. Solutions employ a situated approach to integrate task, robot and perception knowledge. Core expertise is safe navigation, 2D and 3D attention, object class detection (*http://www.3d-net.org*), and affordance-based grasping and manipulation.

Keywords
Control systems
Instrumentation and measurement
Robotics and automation
Cognitive robotics

ACIN
AUTOMATION & CONTROL INSTITUTE
INSTITUT FÜR AUTOMATISIERUNGS- & REGELUNGSTECHNIK

Warsaw University of Technology

Faculty of Electronics and Information Technology
Institute of Control and Computation Engineering
Robot Control and Recognition Systems Team



Location
Poland
Warsaw

Website
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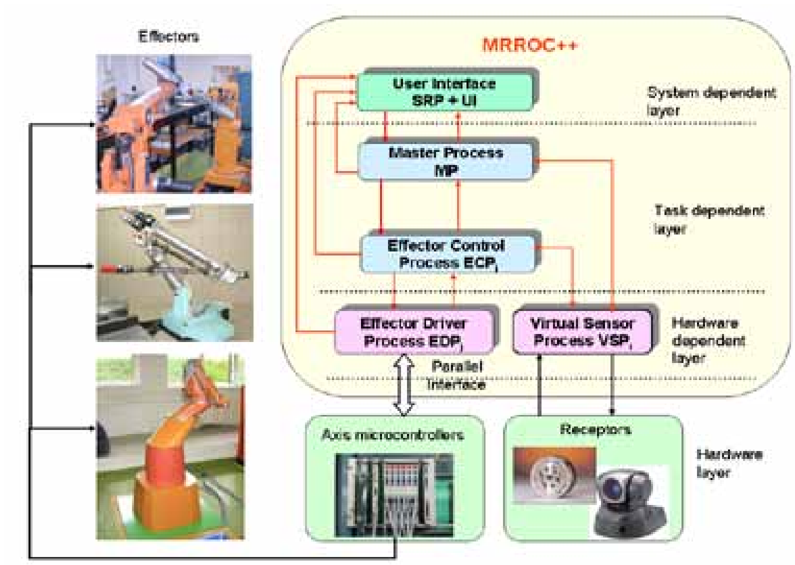
Contact
Prof. Cezary Zielinski
C.Zielinski@ia.pw.edu.pl

Robot Programming and Pattern Recognition Group is a part of the Institute of Control and Computation Engineering. Our group conducts research encompassing robot control and programming as well as pattern recognition.
The focus is on complex robotic systems, what includes design of robot programming frameworks, control of multi-robot systems, formal approach to structuring multi-robot system controllers and behavioral embodied agents, aggregation of information from diverse types of sensors, manipulation of object with inner degrees of freedom, computer vision and speech recognition.

Our main goal is to construct a robot that could operate efficiently in the natural environment as well as human-created surroundings. Majority of work conducted by our team deals with advanced applications of computer sciences in robotics. Our aim is to create one framework that would serve as a programming platform for all types of robots regardless of their type and the tasks that they have to carry out. Currently the theoretical considerations are implemented in MRROC++ multi-robot research-oriented control framework based on C++.

Robot Programming and Pattern Recognition Group



Research areas

- Formal specification of multi-agent robot systems
- Robot control architectures and programming methods
- Robot motion and two-handed manipulation planning
- Task planning and control of reconfigurable mobile fixtures
- Active sensing
- Image analysis: object recognition, hand gesture recognition, image sequence analysis
- Visual servomechanisms
- Speech recognition
- Position and force control algorithms
- Mobile robot autonomous navigation
- Real time programming.

Keywords
Robot programming
Robot control
Pattern recognition
Manipulation

Wroclaw University of Technology

Institute of Computer Engineering, Control and Robotics
Department of Fundamental Cybernetics and Robotics

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Contact
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krzysztof.tchon@pwr.wroc.pl

Research areas
- Robot modeling, control, and motion planning
- Discrete-event control in robotics and automation
- Prosthetics and therapeutic robots
- Social robotics.

Projects in progress
- LIREC: LIving with Robots and intEractive Companions, EU 7FP IP
- RobREX: Robots for Rescue and EXploration, National Center for R&D.

Wroclaw University of Technology

Videos

- LIRECWRUT: *http://www.youtube.com/user/LIRECWRUT*
- FLASH and EMYS: *http://emys.lirec.ict.pwr.wroc.pl*
- FLASH and EMYS: *http://www.facebook.com/wrut.emys/videos*
- FLASH: *http://www.youtube.com/watch?v=o8kf14SZkaQ*
- FLASH: a baseline study: *http://lirec.ict.pwr.wroc.pl/~arent/hrp-FLASH.avi*
- EMYS: *http://www.youtube.com/watch?v=MOZKDhRrdg0*

Recent contribution to robotics

- Open source software system FacET for detection of facial expressions
- Prototypic robotic companion FLASH composed of balancing platform, emotive head EMYS, and a pair of dextrous arms/hands WANDA: complete design of hardware (mechanics, electronics), software, control algorithms, and motion controllers
- New concept of behavioral identity invariants of a migrating agent, its implementation and experimental verification in robotic embodiments
- Open source software system UNIFRACX for unified description of robotic behaviors
- Expansion of the software platform Urbi and its application in the low level robot controller.

Keywords

Social robotics
Medical robotics
Mathematical robotics

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Publishing Information

European Clearing House for Open Robotics Development

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SEVENTH FRAMEWORK
PROGRAMME

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