RobotCub: An International Project on Humanoid Cognitive Systems funded by the European Commission

www.RobotCub.org

September 2006

Humanoid Robotics: The Key to Artificial Cognitive Systems

Until recently, the study of cognition and the neuro-physiological basis of human behavior was the subject of quite separate disciplines such as psychology, neurophysiology, cognitive science, computer science, and philosophy, among others. Mental processes were mainly studied in the framework of abstract theories, mathematical models, and disembodied artificial intelligence. It has now become clear that mental processes are strongly entwined with the physical structure of the body and its interaction with the environment. Intelligence and mental processes are deeply influenced by the structure of the body, by motor abilities and especially skillful manipulation, by the elastic properties of the muscles, and the morphology of the retina and the sensory system. The physical body and its actions together play as much of a role in cognition as do neural processes. Human intelligence develops through interaction with objects in the environment and it is shaped profoundly by the interactions with other human beings. These concepts are now altering in a fundamental way the interaction between fields such as neuroscience, information science, psychology, and robotics which before had been worked in isolation but are now learning from each other and together are building a new interdisciplinary science.

As such, the study of cognition and intelligence is more and more dependent on the use of physical bodies, and, ultimately, on the use of humanoid robots. Humanoids are essential tools in the study of human intelligence: since cognition and the development of cognitive skills are a function of both neural and physical activity, it is important to simulate human action when investigating the components of intelligence (learning, adaptation, anticipation, reasoning, memory, communication, and language).

This new interdisciplinary agenda works both ways. Emerging theories of artificial cognitive systems are deeply influenced by current knowledge in neuroscience and psychology, but, in turn, these scientific and technological developments are having an increasingly important impact on progress in developmental psychology and cognitive neuroscience where they can be used to formulate and test new hypotheses on cognitive function in humans.

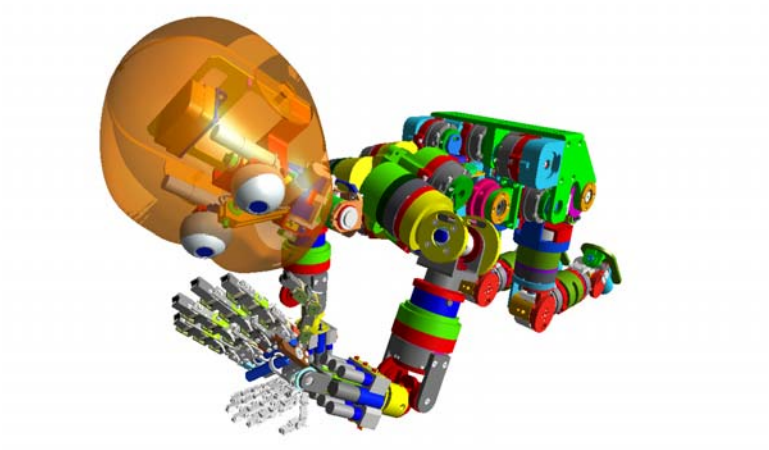
The RobotCub humanoid platform represents an important opportunity to move this research agenda forward: through open collaboration, on the common theme of embodied cognition, enabled by a shared humanoid platform, and supported an institute capable of delivering on this vision in the long run.

The RobotCub Project

RobotCub is an Integrated Project funded by European Commission through its Cognition Unit (E5) under the Information Society Technologies component of the Sixth Framework Programme (FP6). The project was launched on the 1st of September 2004 and will run for a total of 60 months. The consortium is composed of 10 European research centres and is complemented by three research centres in the USA and three in Japan, all specialists in robotics, neuroscience, and developmental psychology. The project is led by Prof. Giulio Sandini, Research Director at the Italian Institute of Technology (IIT) and professor at the Dipartimento di Informatica, Sistemistica e Telematica of the University of Genoa. Project management is shared by Prof. Sandini, Prof. Giorgio Metta (with specific responsibility for the robotic platform), and Prof. David Vernon (with specific responsibility for the cognitive architecture and day-to-day management). All three are from the University of Genoa. The total funding for the project is €8.5 million.

RobotCub has two main goals: (1) to create a new advanced humanoid robot – the iCub[1] – to support Community research on embodied cognition, and (2) to advance our understanding of several key issues in cognition by exploiting this platform in the investigation of cognitive capabilities.

The iCub is a 53 degree-of-freedom humanoid robot of the same size as a two year-old child. It will be able to crawl on all fours and sit up. Its hands will allow dexterous manipulation and its head and eyes are fully articulated. It has visual, vestibular, auditory, and haptic sensory capabilities.



The iCub is an open systems platform. Users and developers in all disciplines, from psychology, through cognitive neuroscience, to developmental robotics, can use it and customize it freely[2]. It is intended to become the research platform of choice, so that people can exploit it quickly and easily, share results, and benefit from the work of other users. This will lead to significantly greater community-wide progress in embodied cognition research.

The iCub will develop its cognitive capabilities in the same way as a child, progressively learning about its own bodily skills, now to interact with the world, and eventually how to communicate with other individuals.

Apart from the scientific aspects of the project, there is also an important component devoted to the support of the open nature of the iCub by establishing an international Research and Training Site (RTS). In addition to updating iCub designs, it will maintain at least three complete iCubs to allow scientists from around the world to use it for experimental research before committing to building their own iCub. The RTS will also provide a programme of training courses for scientists and students on building, using, and developing the iCub.

Furthermore, to help researchers get their own iCub, the RobotCub project will be launching a call for proposals to exploit the iCub in research projects in September 2007. Up to eight successful proposers will be provided with a complete iCub kit free-of-charge and will be provided with follow-up support to help them get started in using the iCub in their work.

Approximately €2,000,000 has been reserved for these activities in the project's budget and will be managed by the University of Genoa.

---

[1] Cub stand for *Cognitive Universal Body*.

[2] The iCub is freely licensed under the GNU General Public Licence.

International Participation

The RobotCub consortium is a multidisciplinary group of leading laboratories from across the globe. The commonality between the groups is their interest in understanding and replicating human cognitive processes. These groups bring specific expertise in humanoid technologies (Genova, Pisa, Lausanne, Zurich, Salford, Lisbon, Cambridge, Tokyo and Kyoto), in developmental psychology (Uppsala), Neuroscience (Ferrara and Cambridge), and human-humanoid interaction and social behaviour (Hertfordshire).

The ten European partners and the six non-EU partners participating in the project are listed at the end of the document.

Italian Participation

Italian participation reflects the multidisciplinary nature of the project, from mechatronics, through cognitive neuroscience and robotics, to motor learning in biological and artificial systems. The LIRA-Lab at the University of Genova – and the affiliated Italian Institute of Technology – and ARTS-Lab at Scuola S. Anna in Pisa are among the leading centres in the world working on humanoid robots and biomechatronics. The University of Ferrara is investigating key issues of sensorimotor representation in different brain structures. The synergy between these centres and the IIT will contribute even further to establishing the IIT as an international reference centre on humanoid robotics.

Local Group

LIRA-Lab of the University of Genova was established in 1992 by Prof. Giulio Sandini at the Dipartimento di Informatica Sistemistica e Telematica of the Faculty of Engineering. LIRA-Lab is one of the robotics research centres in Genova, continuing the long-established tradition of the local academia on cybernetics, biophysics, bioengineering, anthropomorphic robotics, computational neuroscience. In the panorama of the Italian academia, Genova represents, for these scientific topics, an important reference point with possibly the oldest tradition in studying bio-inspired artificial systems and neuroscience-based technological development. Local industry is also active in both robotics-related and information technology activities. The “Robotics Industrial Pole” (Polo della Robotica), a recently established association collecting and fostering the industrial and academic competencies in robotics within the region, and the soon to be established technological district on “Intelligent Integrated Systems”, are just two examples of the energy and interest of the Liguria region in investing in next-generation robotics activities. We see this as an essential background to attract even more industries in the future around these academic and industrial poles.

RobotCub.org

RobotCub Project Participants

Name	Main Expertise in Project	Contact
University of Genova – LIRA-Lab, Dipartimento di Informatica, Sistemistica e Telematica – Genova – Italy	Cognitive Humanoid Robotics – Vision and Manipulation	David Vernon Giulio Sandini Giorgio Metta
Scuola Superiore S. Anna – ARTS Lab – Pisa – Italy	Robotics and Mechatronics – Manipulation Hardware	Paolo Dario
University of Zurich – Artificial Intelligence Lab, Department of Information Technology Zurich – Switzerland	Cognitive Robotics – Audition and Touch	Rolf Pfeifer
University of Uppsala – Department of Psychology – Uppsala – Sweden	Cognitive development of manipulation skills in babies	Claes von Hofsten
University of Ferrara – Department of Biomedical Science – Human Physiology –Ferrara - Italy	Physiology of Manipulation control in humans.	Luciano Fadiga
University of Hertfordshire – Department of Computer Science - United Kingdom	Cognitive Behavior and Interaction	Kerstin Dautenhahn
IST Lisbon - Computer Vision and Robotics Lab Lisbon – Portugal	Cognitive Robotics – Eye-head coordination	Jose Santos-Victor
University of Salford - Centre for Robotics and Automation – Salford – United Kingdom	Robotics – Locomotion	Darwin Caldwell
Ecole Polytechnique Federal de Lausanne – Autonomous Systems Lab Lausanne – Switzerland	Cognitive Behavior and Interaction, Locomotion	Aude Billard
Telerobot S.r.l. Genova – Italy	Mechanical design and prototype manufacture	Francesco Becchi
NON-EU Partners		
MIT Computer Science and Artificial Intelligence Laboratory	Cognitive Humanoid Robotics	Rodney Brooks
MIT Department of Brain and Cognitive Sciences	Sensorimotor Coordination and motor cognition	Emilio Bizzi
University of Minnesota School of Kinesiology, Dept. of Neurology	Developmental Psychology	Juergen Konczak
Communications Research Laboratory, Japan	Humanoid Robotics and Development	Hideki Kozima
Universty of Tokyo - Department of Mechano-Informatics, Intelligent Informatics Group	Humanoid Robotics	Yasuo Kuniyoshi
ATR Computational Neuroscience Laboratories – Kyoto	Neuroscience and Humanoid Robotics	Gordon Cheng

For More Information:

Please contact:

Giulio Sandini — sandini@dist.unige.it — +39 010 353 2779
Giorgio Metta — pasa@liralab.it
David Vernon — vernon@ieee.org

LIRA-Lab, DIST
University of Genova
Viale F. Causa 13
16145 Genova
Italy