Humans and Humanoids

Perspectives on Research in Cognition and Robotics

Jochen J. Steil, Gerhard Sagerer, Helge Ritter, Edgar Körner

The Research Institute for Cognition and Robotics (CoR-Lab) combines research activities at Bielefeld University in the areas of cognition and intelligent robotics and a strategic cooperation with Honda Research Institute Europe GmbH (HRI-EU). HRI-EU contributes support for PhD students in the CoR-Lab's graduate school and provides two humanoid robots ASIMO together with the operating software for research projects. Based on this unique scientific partnership, CoR-Lab will strive to answer questions like: What are the basic building blocks of cognition and learning? How can we endow robots with some social competence? How to provide them with motion intelligence to smoothly interact with humans? How can machines communicate naturally on semantic levels with humans? CoR-Lab believes that substantial progress in these fields requires the integration of experience in engineering and computer science, brain science, and cognitive sciences, including the humanities and social sciences and needs to be based on advanced technological platforms like the ASIMO robot.

1 The CoR-Lab Research Institute

In July 2007, CoR-Lab was founded at Bielefeld University with support of the Northrine-Westfalian Ministery of Innovation, Science, Research and Technology and was established as a central scientific unit of the university. It provides a center where fundamentally orientated research in university and industry can establish synergies to foster the development of cutting-edge innovative technology. CoR-Lab is also in close cooperation with the recently established Bielefeld Excellence Cluster in Cognitive Interaction Technology (CITec). Both strengthen Bielefeld University in its main focus area „intelligent systems".

CoR-Lab persues a twofold mission, firstly to serve as a strong partner for industrial cooperation, both in the local region EastWestfaliaLippe (OWL) supporting the domestic medium-sized economy, and on national and international scale, the most important partner being Honda Research Insitute Europe (HRI-EU). Via cooperation with existing Bielefeld research groups, research projects in the CoR-Lab have access to torso and mobile robots (Prof. G. Sagerer), anthropomorphic hands (Prof. H. Ritter), virtual humans (Prof. I. Wachsmuth), and a biomechanics lab (Prof. T. Schack). The CoR-Lab also hosts the EU funded project ITALK on the emergence of language in early developmental learning, through which the CoR-Lab also is in command of an iCub platform. CoR-Lab is headed by a board of directors consisting of PD J. Steil, Prof. G. Sagerer, Prof. H. Ritter (all Bielefeld) and Prof. Körner (HRI-EU).

Secondly, CoR-Lab maintains a graduate school in cognition and robotics in close cooperation with HRI-EU. The graduate school will pursue fundamental research in cognitive robots and intelligent systems in several research fields as detailed below. The graduate school is headed by Prof. F. Kummert (Bi) and co-speaker Dr. H. Wersing (HRI-EU), supported by Managing Director Dr. C. Haumann and a joint steering board consisting of Dr. R. Haschke, Dr. B. Bläsing, Dr. K. Rohlfing (all Bi), and Dr. C. Goerick, Dr. M. Gienger, Dr. F. Joublin (all HRI-EU). The graduate school projects have access to the various robot platforms and each is co-supervised by a Bielefeld and an HRI-EU member to foster the intensive collaboration between the two cooperating research institutions.

2 Research Focus Areas

Focus 1: Interaction Based Representation
Coordinators: Dr. K. Rohlfing (Bi), Dr. F. Joublin (HRI-EU).
Biological organisms have evolved in such a way that their behavior is simultaneously adapted to their needs and to the ecological niche they live in. Of particular interest for this research field is the shaping of mental representations through various types of interactions which define the range of knowledge an organism can obtain about itself, and its environment. Interactions arise on different levels.

1.) Self-Interaction allows the organism to discover its embodiment (e.g. effectors, sensors) but also some of its internal drives in the form of needs that have to be satisfied for its innate reward system. The representations to be developed through this type of interaction ground in the correlation between motor trial-and-error production, reward and related perceptions. Related research questions are: What are the basic extrinsic and intrinsic drives that lead an organism or a robot to start this kind of interaction? Which sensory-motor mappings can be learned during this phase? Which sensory-motor predictions can be used by the organism and for which purpose? Which innate mechanisms account for selection processes such as attention?

2) Interaction with inanimates: This interaction in the vicinity of the organism not only allows the discovery of basic aspects of the physics of the world (i.e. contact, reaction forces, weight, gravity, sound of contact, sources of energy, sources of pain...) but also the discovery of new sensory-motor correlations. The representations developing at this interaction level are control loops for basic functions of the organism like locomotion, the intake of energy, the manipulation of objects and representations for the classification of object affordances. Research questions are: What kind of