Elements of Brain-like intelligence for ASIMO
- Learning visually guided autonomous interaction -

Intelligence is a technology and a strategy for robust and flexible problem solving in complex environments (both natural and artificial) under the constraints of limited resources (e.g. time, energy). The need for intelligence becomes particularly visible when dealing with humanoid robots which are expected to behave like humans and which are in reality still much closer to their ancestors at the assembly line. Our brains are designed to achieve autonomous adaptation to a changing world, still unparalleled by any technical system. Understanding essential principles of how the brain organizes behavior may enable us to provide our technical artifacts at least with some aspects of brain-like intelligence. The challenge of understanding how brains work is, on a technical level, the challenge of understanding how an intelligent system can so rapidly and stably self-organize its successful behaviors in response to an unpredictably changing, or non-stationary, world. Our approach is based on the assumption that the essence of brain computing is not in the local processing or learning algorithm but in the way the brain organizes processing. The challenge of such an approach is that rather than modeling isolated subsystems, large-scale computational models of complete functional blocks at several interacting levels of complexity have to be investigated. The simulation of large-scale hypotheses on brain function is limited by the available technology. Therefore, at the Honda Research Institute Europe, we investigate different levels in parallel and convey fundamental results between these levels in order to circumvent the incorporation of all complexity levels in one system set-up. We target control architectures that are required for brain processing at the following levels: (1) the control of growth processes and development by gene-regulatory networks; (2) the detailed cortical columnar architectures for self-referential control for storing experience; (3) the behavior based dynamic allocation of systems resources for predictive visual scene analysis; and (4) the global behavior control architecture for autonomous interaction of our humanoid robot research platform ASIMO. Following the short outline of the basic philosophy of our approach, the focus of the talk is on above mentioned levels (3) and (4). Step by step we implemented nested control loops for reflexes, attention modulated behavior, on-line learning from sensory experience, and generating predictions for interaction. This enables ASIMO to learn to recognize objects through the interaction with humans, to learn associations between acoustic and visual objects, as well as to associate sound with behavioral concepts for interaction, and to demonstrate first steps of prediction driven behavior.

Curriculum Vitae

Prof. Dr. Edgar Koerner
Honda Research Institute Europe GmbH

Carl-Legien-Str. 30
63073 Offenbach

Tel.: +49 (0) 69 89011-750
Fax: +49 (0) 69 89011-749
Email: edgar.koerner [at] honda-ri.de

Edgar Körner studied electrical engineering, control engineering, and biomedical cybernetics at the Ilmenau Institute of Technology, Germany. From 1976 to 1984 he served as an assistant professor/senior staff researcher and established the bionics research laboratory at the same university. The research activities included experimental work in neurophysiology and neural systems modelling as well as applied psychophysics and medical expert systems.

He received his Dr.-Ing. in biomedical cybernetics in 1977 and the Dr. Sci. in biocybernetics in 1984, both from Ilmenau Institute of Technology. From 1984 to 1987, he joined the Bioholonics Project of JRDC (Tokyo) as a research fellow dealing with brain-like vision systems. Back at the Ilmenau Institute of Technology, he continued research in biological vision and neurofuzzy control systems as an associate professor. In 1988, Dr. Körner was appointed full professor for biocybernetics and head of the Department of Neurocomputing and Cognitive Systems. In 1990, he was additionally appointed to head the Department of Neurocomputing at the Institute of Neurobiology and Brain Research at Magdeburg, Germany. In 1992 he moved to Japan to join Honda R&D's Wako Research Center near Tokyo, focusing as a chief scientist on the brain-like computation research. In 1997 he started research in computational neuroscience, evolutionary technology, and cognitive robotics at Honda R&D Europe, where he served as an executive vice president and head of the Future Technology Research Division.

Starting from the 1st January 2003, the former "Future Technology Research Division" of Honda R&D Europe (Deutschland) GmbH has been established as a new company, the Honda Research Institute Europe GmbH (HRI-EU). Since then, Prof. Dr. Körner serves as the president of the Honda Research Institute Europe GmbH. Since October 2007, he additionally serves as a co-director of the Research Institute for Cognition and Robotics (CoR-Lab) including the attached Graduate School at the University Bielefeld. His research interest covers brain-like intelligence, with a special focus on self-referential control architectures, self-organization of knowledge representation, and autonomous robots.