Keynote 1

Prof. Dr.-Ing. Gerhard Sagerer

Faculty of Technology Applied Computer Science
Universität Bielefeld
Germany

Memory and Learning for Social Robots

Time: Saturday, August 2, 13:00 – 14:00
Venue:

While most research in social robotics embraces the challenge of designing and studying the interaction between robots and humans itself, this talk will discuss the utility of social interaction in order to facilitate for more flexible robotics. What can a robot gain with respect to learning and adaptation from being able to sociably interact? What are basic learning-enabling behaviors? And how do inexperienced human tutor robots a sociable way? In order to answer these question we consider the challenge of learning by interaction as a systemic one, comprising appropriate perception, system design, and feedback. Basic abilities of robots will be outlined which resemble concepts of developmental learning in infants, apply linguistic models of interaction management, and take tutoring as a joint task of a human and a robot. However, in order to tackle the challenge of learning by interaction the robot has to couple and coordinate these behaviors in a very flexible and adaptive manner. The active memory as an architectural concept in particular suitable for learning-enabled robots will be briefly discussed as a foundation for coordination and integration of such interactive robotic systems. The talk will build a bridge from the construction of integrated robotic systems to their evaluation, analysis, and way back. It will outline why we intend to enable our robots to learn by interacting and how this paradigm impacts the design of systems and interaction behaviors.

Keynote 2

Prof. Dr. Kazuhiro Kosuge

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Human-Robot Interaction - What We Learned from Robot Helpers and Dance Partner Robots

Time: Sunday, August 3, 12:40 – 13:40
Venue:

This talk addresses issues relating to human-robot interaction based on our developments of robot helpers and dance partner robots. First, Mobile Robot Helper and Distributed Robot Helpers are introduced as assistive systems for handling an object in coordination with a human. These robots are controlled passively based on intentional force/moment applied to the object by its user. Through several past experiments, the limitation of the coordination based on intentional-force -based-control was unveiled, although the concept could be applied to some kinds of tasks. A dance partner robot is then introduced as a research platform for human-robot interaction. A Dance Partner Robot, PBDR (Partner Ballroom Dance Robot), has been developed for Aichi Expo in 2005. It dances a waltz as a female dancer together with a human male dancer. A waltz, a ballroom dance, consists of several steps, and the step transition is controlled by a male dancer based on a transition rule. The transition rule allows the male dancer to select a step from a class of steps determined for the current step, and the female dance partner estimates the following step through physical interactions with the male dancer. The dance partner robot has a database about the waltz and its transition rule, which is used to estimate the following dance step and to generate an appropriate step motion. The step estimation is done based on the time-series data of force/torque applied by the male dancer to the upper body of the robot. The robot motion is generated for the estimated step using the step motion in the database compliantly against the interface force/moment between the human dancer and the robot in real time. We are continuing the development of the robot, and the current version could watch the human's dance step all the time during the dance and if the step is different from the estimated one, the step is corrected according to the human's step. The development of the dance partner robot suggests us important issues for future robots having interaction with a human. Finally, why we are developing the dance partner robot and how the concept will be applied to other systems will be also discussed in the talk.

Thematic Plenary 1

Prof. Dr. Michael Beetz

Head of the IAS Group
Computer Science Department, Chair IX
Technische Universität München

Cognition, Control and Learning for Everyday Manipulation Tasks in Human Environments

Time: Saturday, August 2, 8:40 – 9:20
Venue:

In recent years we have seen tremendous advances in the mechatronic, sensing and computational infrastructure of robots, enabling them to act faster, stronger and more accurately than humans do. Yet, when it comes to accomplishing manipulation tasks in everyday settings, robots often do not even reach the sophistication and performance of young children. This is partly due to humans having developed their brains into computational and control devices that facilitate knowledge-informed decision making, perspe ctive taking, envisioning activities and their consequences, and predictive control. Brains orchestrate these learning and reasoning mechanisms in order to produce flexible, adaptive, and reliable behavior in real-time. Household chores are an activity domain where the superiority of the cognitive mechanisms in the brain and their role in competent activity control is particularly evident.

In this talk, I will give an overview of our ongoing research, in which we investigate - in an interdisciplinary endeavor - cognitive mechanisms that are to enable autonomous robots to produce flexible, reliable and high-performance behavior for everyday manipulation activities. The talk will step through the "cognitive perception-action loop" for robot control focusing on the acquisition and use of environment models for housework as a running example.

Thematic Plenary 2

Dr.-Ing. Tamim Asfour

Institute of Computer Science and Engineering (CSE)
University of Karlsruhe (TH)
Karlsruhe, Germany

Manipulation Strategies and Imitation Learning in Humanoid Robots

Time: Saturday, August 2, 9:20 – 10:00
Venue:

The development and emergence of cognition relies on artificial embodiments having complex and rich perceptual and motor capabilities. The impressive advance of research and development in robotics over the past years has led to the development of humanoid robots that are rich in sensory and motor capabilities and hence provide a suitable framework for studying cognition. Currently, the different disciplines related to the development of cognitive humanoids have usually been explored independently, leading to significant results within each discipline. However, the big challenge is how different pieces of results fit together to achieve complete processing models and an integrative system architecture, and how to evaluate results at system level rather than focusing on the performance of component algorithms.

In this talk, we will present recent work that combines various approaches and techniques, which allow a humanoid robot to interactively perform complex manipulation and grasping tasks in built-for-humans environments and real-world scenarios. Apart from the design of humanoids, the sensorimotor behaviours and the integration of perception, action, and learning components toward the realization of fully integrated humanoid robots performing grasping and manipulation tasks in a household scenario will be presented. Experimental results on the humanoid robots developed within the German Humanoid project SFB 588 will be shown. Furthermore, both limitations and shortcuts of the current implementation as well ongoing research activities on object exploration, learning from human observation and imitation of human actions will be presented and discussed.

Thematic Plenary 3

Prof. Dr. Gil Weinberg

Director of Music Technology
Assistant Professor, Music Department, College of Architecture
Adjunct Professor, College of Computing, GVU
Georgia Institute of Technology, Atlanta, GA

Robotic Musicianship

Time: Sunday, August 3, 9:00 – 9:40
Venue:

Over the last decade, inspired and motivated by the prospect of innovating the core of the musical experience, I have explored a number of research directions in which digital technology bears the promise of revolutionizing the medium. The research directions identified – gestural expression, collaborative networks, and constructionist learning – aimed at creating musical experiences that cannot be facilitated by traditional means. The first direction builds on the notion that through novel sensing and mapping techniques, new expressive musical gestures can be discovered that are not supported by current acoustic instruments. Such gestures, unconstrained by the physical limitation of acoustic sound production, can provide infinite possibilities for expressive and creative musical experiences for novice as well as trained musicians. The second research direction utilizes the digital network in an effort to create new collaborative experiences, allowing players to take an active role in determining and influencing not only their own musical output but also that of their co-performers. By using the network to interdependently share and control musical materials in a group, musicians can combine their musical ideas into a constantly evolving collaborative musical activity that is novel and inspiring. The third research direction utilizes constructionist learning, which bears the promise of revolutionizing music education by providing hands-on access to programmable music making.

While facilitating novel musical experiences that cannot be achieved by traditional means, the digital nature of these research directions often led to flat and inanimate speaker-generated sound, hampering the physical richness and visual expression of acoustic music. In my current work, therefore, I attempt to combine the benefits of digital computation and acoustic richness, by exploring the concept of "robotic musicianship." I define this concept as a combination of musical, perceptual, and social skills with the capacity to produce rich acoustic responses in a physical and visual manner. The robotic musicianship project aims to combine human creativity, emotion, and aesthetic judgment with algorithmic computational capabilities, allowing human and robotic players to cooperate and build off one another's ideas. A perceptual and improvisatory robot can best facilitate such interactions by bringing the computer into the physical world both acoustically and visually.

The first robot to demonstrate these capabilities is Haile – a perceptual and interactive robotic percussionist that is designed to "listen like a human and improvise like a machine". Haile listens to live human players, analyzes perceptual aspects of their playing in real-time, and uses the product of this analysis to play along in a collaborative and improvisatory manner. Its perceptual modules include the detection and analysis of low-level musical percepts such as onsets, pitch and velocity as well as higher-level musical percepts such as beat, similarity, stability and tension. Haile's interaction and improvisation modules utilize mathematical construct that are unlikely to be used by humans such as genetic algorithms and fractal functions that are embedded in a variety collaborative interaction schemes. When playing with human musicians, the robot's improvisational techniques are designed to inspire players to interact with it in novel manners that may revolutionize the musical experience and maybe, in the future, music itself.