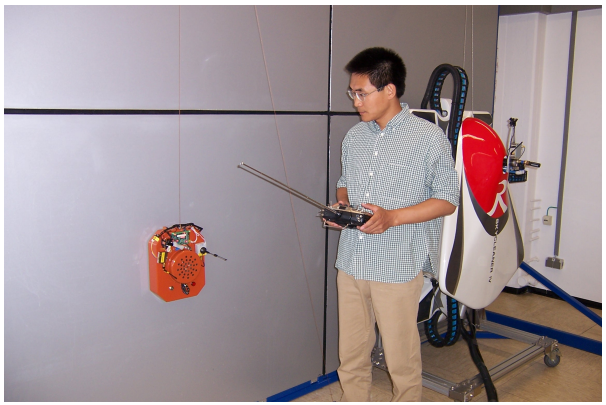
Research Overview

We expect that service robot platforms will become an important topic in research and industry within a few years. Such intelligent systems with sensory, actuatory and communicative skills can be used for research into practical problems of multimodal information processing as well as for a theoretically and methodically well-founded analysis of the complexity of these problems.

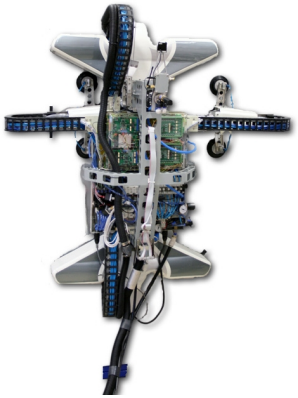
Current research topics are:

- People tracking and gesture recognition for human-machine interaction.
- Multisensor-based localization and navigation in dynamic environments.
- Visually-guided object-grasping.
- Multisensory memory representations of robot actions.
- Real-world planning based on the retrieval of episodic memory.
- Vision perception for autonomous robots.
- Smart sensors and sensor networks.
- Hardware-acceleration for image-processing.
- Smart climbing robot system (see below):



Service Robots

TASER



SkyCleaner

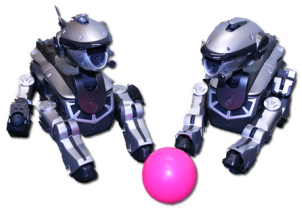
Our main research platform is a state-of-the-art mobile service robot, built on a custom version of the MP-L655 (NEOBOTIX). The robot system features a mobile platform with differential drive and wheel encoders, two laser range finders, and on-board (Pentium-IV) computer. Two identical PA10-6C (Mitsubishi) 6-DOF robot arms with three-finger robotic hands (Barrett Technologies, Inc.) are used as manipulators. A total of five cameras provide visual information: Two high-resolution cameras mounted on a pan-tilt stereo head, a high-resolution omnidirectional vision system with hyperbolical mirror for localization and navigation, and two microhead cameras at each hand.

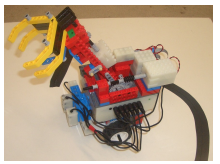
Educational Robots

Robotics is widely acknowledged as an excellent teaching tool. Programming and playing with a robot is fun and keeps the students motivated. At the same time, the students gain hands-on experience in a variety of real-world tasks and problems — including mechanics and dynamics, sensors and actuators, real-time control, action-planning, etc. Of course, construction kits like the Lego system allow the students to design their own robot, an optimal vehicle for explorative learning and team-work.

For the last few years, we have mainly used the Sony AIBO robot dogs for our BSc and MSc courses, based on our own AiboLib control software. However, we also have a collection of other popular teaching robots, including the Lego and fischertechnik systems, three Pioneer robots, and two brand-new HOAP-2 humanoid robots.

In our current "Telebots" project, we design a remote-control interface that allows the students to access, reset, and control wheel-based mobile robots based on the Lego system via an internet connection. Our software provides live feedback of sensor data and an overhead video stream. A custom on-board controller with WLAN interface was designed for the robots.





Cooperations and Projects

Our research is guided by cooperation with national and international partners from both academia and industry. At the Informatics department, the TAMS group and three groups with artifical-intelligence background form the center of intelligent systems and robotics, or ISR. We also cooperate with the neuro-imaging and neuro-physiology groups of Hamburg University Hospital to study multimodal interactions, and with the physics department for research on nanoscale manipulation. Recent partners in industry include Philips, Siemens and Volkswagen.

Recent research projects with external funding:

CINACS (2006-2010 phase 1, DFG and MOE)

Cross-modal interactions in natural and artificial cognitive systems. International graduate school in cooperation between the University of Hamburg and Tsinghua University Beijing.

MING-T (2007-2009, EU-FP6)

The project develops an architecture for interoperability between the European and the upcoming Chinese standards for mobile television, namely DVB-H, T-DMB and DTMB.

IVUS (2006-2009, BMBF)

Intelligent Vision System for Service Robots. Aims to develop a high-performance 3D-vision system with in-camera processing.

EUROPRACTICE (since 1990, EU-FP5)

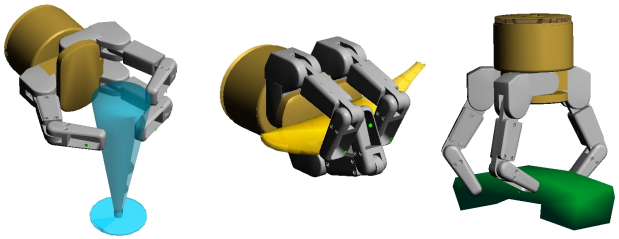
System and VLSI-Design Initiative.

Telebots (2005-2007, ELCH consortium)

The project develops a robotics course with remote internet-access to mobile robots with live sensor and video feedback.

Contact

The figure below shows an example of our current robotics research. A new learning approach is used to plan and execute the hand and finger movements required to grasp arbitrary objects. The 3D-visualization demonstrates the grasping of a glass (left), a banana (middle) and a telephone handset (right) with the three-finger robot hand.



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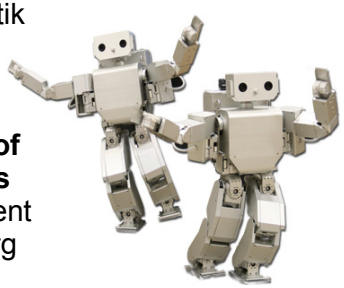

The main research topic of the group TAMS is to examine the **interaction of different modalities** of sensory and cognitive systems including vision, writing, hearing, talking, touching/feeling and grasping. The interaction between people and technical information systems and communication systems is directly related to multimodality.

The main application area and demonstrator platform of our work is **intelligent service robotics**. Our group owns several state-of-the-art robots, designed and built to our specifications, which allow us to test new system architectures and algorithms for sensor-driven manipulation, intelligent sensors, cognitive robotics, and human-machine interaction.

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