



Funding Period

01. July 1999 - 30. June 2002

Central Idea

The central idea of the MORPHA project is to equip intelligent robot assistants with powerful and versatile mechanisms, which enable these robots to communicate, interact, and collaborate with human users in a natural and intuitive way. These mechanisms shall facilitate intuitive teaching, programming and commanding of robot assistants and enable them to execute demanding and complex tasks under the control of and in collaboration with the human user. As robot assistants are expected to act, behave and communicate in a "human-like" way, these mechanisms have to take into account both the shape and mobility of the human body, and the performance and versatility of the human senses.

The communication between human and robot shall be human-friendly and involve all human senses and communication channels, such as natural speech, vision and understanding of visual (gesture, mimic) visual communication, for example, through gestures and mimic, or the sensing and understanding of forces (haptics).

By providing building blocks for a human-friendly, "human-like" communication between a human and a robot MORPHA will pave the way for novel assistive systems in production as well as in domestic environment. This includes robot assistants for manipulation, assembly or transportation tasks in production environments, for cleaning task in domestic as well as in public environments and intelligent assistive systems for elderly, sick, or disabled people.

Scenarios

The collaboration and co-existence between a human and a robot assistant and the

inherent problems will respect to communication, interaction, and collaboration will be studied in two scenarios:

The Manufacturing Assistant

The use of robot assistants in manufacturing environments (manufacturing assistants) will lead to significant improvements of industrial production processes, particularly in terms of increased productivity and humanization of the work place. Robot assistants in manufacturing will accomplish tasks through close interaction with people, thus supporting human workers, not replacing them. The human worker is responsible for the command, supervisory, and instructional functions, while the robot assistant will carry out boring, repetitive and strenuous operations. In cases where the robot does not know how to proceed, the human worker will intervene to provide guidance and additional instruction. Robot and human worker are, therefore, partners in joint manufacturing processes. Typical tasks in manufacturing applications are the handling of unsorted parts, the transportation of parts to machining stations or assembly work cells, and the assistance with the assembly. Accomplishing tasks like the above in real factory environments requires a maximum of flexibility. This flexibility can only be achieved by instructing the robot assistant in a sustained interactive teaching and learning process.

Robot Assistant for Housekeeping and Home Care

The scenario of housekeeping and home care robots focuses on the employment of assistive robot systems in everyday domestic settings. This is motivated in several ways: on the one side, comfort factors and a changing societal framework favor the employment of intelligent assistive systems; on the other side, an increasing number of households include inhabitants that require physical support in day-to-day life due to sickness or age. Robot assistants and helpers in various designs and with various functions will more and more take over this type of support and closely collaborate with the human user.

The housekeeping and care robot will partially have to operate in an autonomous mode and partially in close collaboration and interaction with the human in order to accomplish his house-keeping duties. These include basic fetch-and-carry tasks, setting the table, loading and unloading the dishwasher or basic cleaning tasks. A natural, human-friendly interaction and communication between human and robot assistant is of central meaning in this context. The capability to interact with a human user furthermore offers the robot system the possibility of making use of human guidance and support to expand its initial competencies.

Basic Research Topics

The two scenarios Manufacturing Assistant and Robot Assistant for Housekeeping and Home Care stand for a large variety of applications for robot assistants. The basic problems and

mechanisms of collaborative and interactive problem solving and task execution by the "team" robot-human, however, are independent of the specific application considered. In the following we identify five basic research topics which are common not only to the above but to a large number of applications.

• *Channels of Human-Machine Communication*

The goal of a reliable and effective communication between user and robot assistant makes it essential to provide a number of broadly utilizable and potentially redundant communication channels. The integration of traditional interfaces, such as graphical I/O-devices, with newer types of interfaces such as speech and visual interfaces, tactile sensors, and force/torque sensors, is indispensable for the task and will be investigated here.

• *Scene Analysis and Situation Assessment*

A mandatory precondition for efficient cooperation is a reliable perception and understanding of the structure of the environment and its dynamics. Furthermore the robot needs to develop an understanding of its task and the context within which it has to solve it. These are issues, which will be studied in the context of the research topic Scene Analysis and Situation Assessment.

• *Teaching, Learning, and Adaptation*

Providing effective assistance requires the robot to have its own intelligence. It is thus essential that the robot assistant be capable of learning and receiving instructions on various levels of abstraction. Our work in this context aims at the development of methods and mechanisms, which facilitate an intuitive instructing and programming of a robot assistant.

• *Motion Planning and Coordination, Interactive Task Planning*

The collaboration between a human being and a machine that can independently move and act represents a form of interaction that is based not only on communication but also involves motion and action. These motions and actions of the two agents, human and machine, must be planned, coordinated, and, if need be, adapted reciprocally. These issues will be studied in the context of the topic Motion Planning and Coordination, Interactive Task Planning.

• *Safety / Maintenance / Diagnoses*

The employment of robot systems which are to work directly with people naturally places highest demands on system safety, reliability, and maintainability. A suitable safety concept must account for the integrity of the system just as it must account for the integrity of its surroundings. External events affecting the proper function of the system and internal error conditions must be identified and classified according to their inherent risk factors. These are issues, which will be studied in the context of the topic Safety / Maintenance / Diagnoses.