Video Abstract

HERMES - A Humanoid Experimental Robot for Mobile Manipulation and Exploration Services

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Abstract:

Endowing future robot generations with 'plug-and-play' capabilities is one of the fascinating challenges of robotics research. These robots could be easily installed at home and at work places; even a novice user should be able to use them effortlessly immediately after switching them on.

On our way towards this ultimate goal we have conceived and built a very flexible and adaptable humanoid robot, *HERMES*. It already integrates various sensor modalities, including vision, touch and hearing, and displays intelligence and cooperativeness in its behavior. *HERMES* communicates and interacts with humans in a user-friendly way, which has been demonstrated in experiments conducted with novice users. A unifying system architecture has been developed and implemented. Its main idea is to select and coordinate the robot's behaviors based on an assessment of the situation being perceived by both the human operator and the robot at a particular moment.

This concept places high demands on the robot's sensing and information processing. A multitude of sensors, including a stereo vision system, an on-board network comprising numerous microcontrollers, a few digital signal processors and a single PC, in combination with the proposed system architecture, is able to meet these demands.

The video summarizes in a narrative style some of the experiments that have been carried out to allow an assessment of the overall system performance. It shows several forms of interaction and cooperation between the robot and a human in jointly performing typical service tasks. Various modes of human-robot communication are also demonstrated, including instructing the robot by written language over the Internet, a combination of vision and touch during the giving and taking of objects, and dialogues in spoken natural language.

References:

Bischoff, R.; Graefe, V. (1999). Integrating Vision, Touch and Natural Language in the Control of a Situation-Oriented Behavior-Based Humanoid Robot. IEEE Conference on Systems, Man, and Cybernetics, October 1999, pp. II-999 - II-1004.

Bischoff, R. (2000). Towards the Development of 'Plug-and-Play' Personal Robots. First IEEE-RAS International Conference on Humanoid Robots. MIT, Cambridge, September 2000.

ICRA Video (3 minutes)

Titles UniBw

HERMES - Humanoid Experimental Robot for Mobile Manipulation Services

Simulation - Structure of the Robot and Drawer Sequence (39 seconds)

HERMES - A Humanoid Experimental Robot for Mobile Manipulation Services, built by the Institute of Measurement Science at the Bundeswehr University Munich, GERMANY.

HERMES was conceived in August 1996, and first preprogrammed driving and pick and place experiments have been carried out in early 1998.

It is constructed from 25 similar drive modules yielding 22 degrees of freedom. The novel manipulator system consists of two articulated arms with 6 degrees of freedom each and a two-finger-gripper. They are mounted on a body that can bend forward and backward and greatly extends the robot's workspace. Main sensors are two video cameras that always remain in favorable position for observing end effector activities.

Placing Objects Onto Table (Split Screen) (17 seconds)

In the meantime different skills have been developed and integrated in the robot's situation-oriented and behavior-based system architecture. One example is a tactile sensing skill that is based on intelligently processing joint angle encoder values and motor currents. This allows the robot to grasp and place various objects of unknown sizes gently onto a table. No external force sensors are needed.

Filling Bottle into Glass, Handing over Glass and Bottle (25 seconds)

Because of the modularity of both hardware and software components the robot can be easily maintained and new skills can be easily added, e.g., filling a bottle of water into a glass. Motor and sensor skills can be combined to check for the height of the water in the glass and to fill the glass up to a wanted level. Exchanging objects between the robot and a human is made possible by means of tactile sensing as shown before. Here, the robot would only release an object after its arm has been gently touched.

Beginning of dialogue, handing over glass (6 seconds in first pause, 10 seconds in second pause)

The most recent addition to the robot's skills have been communicative skills based on natural spoken language. They allow even novice users to interact and communicate with the robot in an intuitive way.

E-Mail Service Task

(10 seconds)

HERMES may also be commanded over the Internet. The instructions may be formulated in natural language and may be sent via e-mail to the robot's communication server. In this example, the robot has been instructed to come to the secretariat, to take over a tray and to place it onto a table in the kitchen.

(20 seconds)

Since HERMES is waiting for the next mission to accomplish, it starts as soon as the new e-mail message has been interpreted. First, it plans a way from its current location to the secretariat in terms of behaviors. Executing its plan, HERMES is visually avoiding obstacles, passing through doors, running along corridors and turning at junctions.

(11 seconds + 4 seconds)

Once arrived at the secretariat the robot takes over the tray using its tactile sensing skill and starts going to the kitchen to deliver the tray.

(19 seconds)

After having arrived in the kitchen HERMES searches for the table and drives towards it using a visual servoing method. To place the tray onto the table it has to bend forward and to keep the tray in a horizontal plane. This is achieved by appropriate motor skills. Since the tray is hiding the view towards the edge of the table the robot uses its tactile sensing skills as well to place the tray gently onto the table.