Collaborative Research Center on Humanoid Robots (SFB 588)

Rüdiger Dillmann, Tamim Asfour

The Collaborative Research Center 588 "Humanoid Robots - Learning and Cooperating Multimodal Robots" was established in July 2001 by the Germany Research Foundation (Deutsche Forschungsgemeinschaft: DFG) and will run until June 2012. The goal of this interdisciplinary research project is the development of humanoid robots which resemble humans in their ways of acting in the world, of reasoning about the world and of communicating about the world. Apart from the development of mechatronics components for humanoid robots, the research efforts span a wide range of disciplines such as learning from observation, multi-modal human-humanoid interaction, human-humanoid cooperation, interpretation of human activities, as well as the execution of gasping and manipulation tasks in a household environment.

1 Introduction

Humanoid robotics is a new, challenging field of robotics and a good candidate to address the fundamental questions associated with personal, home robots. Humanoid robots are expected to exist and work together with human beings in the everyday world such as hospitals, offices and homes, and to serve the needs of elderly and disabled people. The term humanoid is commonly associated with the idea of robots whose physical appearance is similar to that of the human body. Beyond a physical resemblance, humanoid robots must resemble humans in their ways of acting in the world, of reasoning about the world and of communicating about the world. Most importantly, humanoid robots, like humans, should be provided with learning and adaptive capabilities to face a less predictable world. They should be able to interpret the actions of humans, in order both to react adequately to the humans' request and needs, as well as to learn from observing humans actions. The latter capability, often referred to as imitation learning or programming by demonstration, would facilitate human-humanoid interaction by providing humans with an intuitive way to teach humanoids.

Recently, considerable research work has been focused on the development of humanoid robots ([1, 9, 8, 5]). In contrast, our current research interest is the development of humanoid robots for applications in human-centered environments. In order for humanoid robots to enter such environments, it is indispensable to equip them with manipulative, perceptive and communicative skills necessary for real-time interaction with the environment and humans. In particular, we address the integration of perception, action and cognition in humanoid robots, which are rich in sensory and motor capabilities and hence provide on the one hand suitable framework for studying cognition and allow on the other hand the realization of service tasks in a household environment.

In this paper, we present the humanoid robots currently being developed within the SFB 588 and introduce the current state of work toward the realization of fully integrated humanoid robots in a household scenario. For a comprehensive overview the reader is referred to the project publications [1].

2 ARMAR-IIIa and ARMAR-IIIb

In designing our robots, we desire a humanoid that closely mimics the sensory and sensory-motor capabilities of the human. The robot should be able to deal with a household environment and the wide variety of objects and activities encountered in it. Therefore, the humanoid robots ARMAR-IIIa and ARMAR-IIIb (see Fig. 1) have been designed under a comprehensive view so that a wide range of tasks can be performed. The upper body of the robot has been designed to be modular while retaining similar size and proportion as an average person. For the locomotion, a holonomic mobile platform is used. From the kinematics control point of view, both robots consist of seven subsystems: head, left arm, right arm, left hand, right hand, torso, and a mobile platform. In the following the subsystems of the robot are briefly described. For detailed information the reader is referred to [3]. For a detailed description of the mechanics, the reader is referred to [2]. The head has seven DOF and is equipped with two eyes. The eyes have a common tilt and can pan independently. Each eye is equipped with two color cameras, one with a wide-angle lens for peripheral vision and one with a narrow-angle lens for foveal vision to allow simple visuomotor behaviours such as tracking and saccadic motions toward salient regions, as well as more complex visual tasks such as hand-eye coordination. The visual system is mounted on a four DOF neck mechanism (lower pitch, roll, yaw, upper pitch). For the acoustic localization, the head is equipped with a microphone array consisting of six microphones (two in the ears, two in the front and two in back of the head). Furthermore, an inertial sensor is installed in the head for stabilization control of the camera images.

The upper body of the robot provides 33 DOF: 14 DOF for the arms, 16 DOF for the hands and three DOF for the torso. The arms are designed in an anthropomorphic way: three DOF in the shoulder, two DOF in the elbow and two

[1] www.sfb588.uni-karlsruhe.de

Auszug aus: Künstliche Intelligenz, Heft 4/2008, ISSN 0933-1875, BöttcherIT Verlag, Bremen, **www.kuenstliche-intelligenz.de/order**