【Grant-in-Aid for Scientific Research (S)】

Integrated Disciplines (Informatics)

Title of Project : Acquisition of Body Schema, Tool Usages and Behavioral Manner through Human Observation and Interactive Practice on Various Humanoid Series

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Research Area : Informatics
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【Purpose and Background of the Research】

Considering anthropomorphic robots, i.e., humanoids, as a general form of intelligent robots, we have developed various types of humanoids ranging from small remote-brain robots to life-sized daily assistive humanoids, high-torque and high-speed humanoids and human mimetic musculoskeletal robots, while building up a common compatible intelligent robot kernel. Moreover, we have developed an observation-driven task-learning framework that enables humanoids to imitate not only motions but also intentions of humans. This framework includes an attention control system for observing people, their tools and the manipulated objects, as well as a variety of multi-level planners. Recently, we have integrated the software and hardware techniques developed so far to build a life-sized humanoid with whole-body passivity and attention inductivity.

The goal of our research is to incrementally discover a basic principle for various types of humanoid robots to obtain automatically the knowledge of how they should act, which, until now, has been given by humans manually. This process is composed of the following three stages: 1) action learning through observation of human demonstrations; 2) repeated practice with outcome evaluations provided by humans; 3) action modification through human intervention.

【Research Methods】

We have developed a system by manually constructing knowledge models of robots' bodies, environments, objects and tool usages for humanoid robots to perform various daily assistive tasks. Concurrently, we have also proposed a method for musculoskeletal robots to estimate both the intra-body space and the current state simultaneously – this is an extension of SLAM, Simultaneous Localization and Mapping, which calculates the map around a robot and its position on the map at the same time. In this research, we extend SLAM for learning tool usages and behavior patterns from human observations using iterative learning. This observation-driven method allows simultaneous estimation of tool manipulation method and target state, or human action and target reaction, using manually constructed models as a starting point. We implement this system on various humanoids and evaluate them in real environments. For the observation method, we consider the following three observer points of view: 1) first person – observer shares demonstrator's point of view; 2) second person – teacher demonstrates directly on observer; 3) third person – observer watches unconstrained movements of demonstrator.

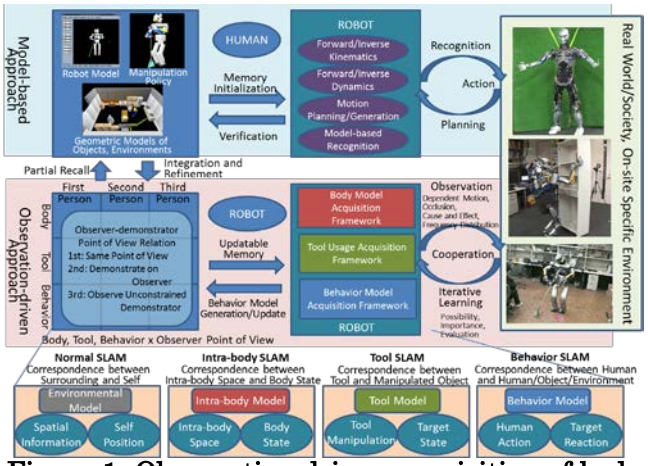

Figure 1. Observation-driven acquisition of body schema, tool usages and behavior pattern.

【Expected Research Achievements and Scientific Significance】

Our project aims to enable humanoids to acquire automatically the knowledge required for working with human tools and environments. The result establishes a robotic intelligence foundation allowing humanoids to work on behalf of humans at disaster sites, factories, farms, as well as daily environments with only on-site simple instructions given by general users.

【Publications Relevant to the Project】

Y. Nakanish, M. Inaba, et al.: "Joint Proprioception Acquisition Strategy Based on Joints-Muscles Topological Maps for Musculoskeletal Humanoids," in Proc. of ICRA2010, pp.1727--1732, 2010.

K. Okada, M. Inaba, et al.: "Task-Guided Attention Control and Visual Verification in Tea Serving by the Daily Assistive Humanoid HRP2JSK," in Proc. of IROS2008, pp.1551--1557, 2008.

【Term of Project】

FY2014-2018

【Budget Allocation】

172,000 Thousand Yen

【Homepage Address and Other Contact Information】

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