10401 Abstracts Collection
Learning, Planning and Sharing Robot Knowledge for Human-Robot Interaction
— Dagstuhl Seminar —

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Abstract. From 03.10.10 to 08.10.10, the Dagstuhl Seminar 10401 "Learning, Planning and Sharing Robot Knowledge for Human-Robot Interaction " was held in Schloss Dagstuhl – Leibniz Center for Informatics. During the seminar, several participants presented their current research, and ongoing work and open problems were discussed. Abstracts of the presentations given during the seminar as well as abstracts of seminar results and ideas are put together in this paper. The first section describes the seminar topics and goals in general. Links to extended abstracts or full papers are provided, if available.

Keywords. Human-robot interaction, Robot knowledge representation and sharing, Learning, Planning

10401 Summary – Learning, Planning and Sharing Robot Knowledge for Human-Robot Interaction

Autonomous robots acting in unstructured environments need sophisticated cognitive capabilities including perception, manipulation and navigation, planning and reasoning as well as knowledge acquisition and processing skills. Only when all these capabilities are combined can the robot show intelligent behavior and act appropriately in environments that are primarily designed for humans. Given the growing availability and inter-connectivity of modern agents and robots, better mechanisms to define, learn and share knowledge must be developed. Advances in robot platforms have led to their integration into society for a variety of functions, and there is a pressing need to understand how they can acquire and exploit knowledge required for their specific activities. In order to be useful,

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robotic agents must be able to recognize a wide range of objects, relations, and situations in their environment, and to understand the semantics of these. In addition, it is imperative that procedural and process knowledge also be known so that interactions are safe and meaningful. Cooperation and collaboration are also essential as well as the ability to perceive human and animal emotions and intentions to the largest degree possible. This seminar brought together 25 scientists with experience in planning, learning, knowledge processing and human-robot interaction to discuss how the high-level control concepts are to be used and adapted to human-robot interaction. Because high-level control of robots interacting with humans is of special practical importance, we invite experts with experience in assistive technology and those examining social acceptance of such systems

Keywords: Human-robot interaction, Robot knowledge representation and sharing, Learning, Planning

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2011/2935

Forms of Robot Knowledge Acquisition

Thomas C. Henderson (University of Utah, US)

Robot knowledge acquisition can be achieved through experience from sensor and actuator data, or by means of logical inference on knowledge structures, or by directly incorporating the knowledge into the robot's knowledge base. The latter can be done directly by humans (e.g., adding code) or by the robot downloading knowledge structures directly to its knowledge base. The source of such knowledge may be humans or agents (e.g., from the internet). In addition, robots can share not only knowledge and data, but also their physical platform (e.g., by teleoperation).

Keywords: Robot Knowdge Acquisition, Knowledge Sharing

Intelligent Guidance of an Unmanned Helicopter

Gordon K. Lee (San Diego State University, US)

The objective of this project is to define a science which allows for the evolution of complex software systems that can fully utilize massively parallel computers of ever-greater capability (initially dual quad cores running fewer higher-level sensors for tractability) and employ this design in human-robot interaction with a final goal of full autonomy of the robot (in this case, an unmanned helicopter). In order to test a new learning approach that can bestow intelligence on a system, based upon human (tutor) Ũ robot (student) interaction, we are working jointly to design an intelligent system architecture, based on the KASER (Knowledge Amplification by Structural Expert Randomization), and plan to implement the methodology on an aerial vehicle (a helicopter), which will execute several maneuvers such as basic hovering, steep approach, confined area approach, and basic altitude flying. The software to perform these maneuvers will be developed using two methods (teach mode with a human-in-the-loop) and classical control. Then, the knowledge amplification system will autonomously generate another set of software, which will then be tested and compared to the execution of the baseline two software codes using the same helicopter flight scenarios. We anticipate that such complex functional real-time software can be most cost-effectively written through the use of a software-writing system embodying knowledge amplification.

Keywords: Evolution, Heuristics, KASER, System of Systems, Unmanned Helicopter

Joint work of: Rubin, Stuart H.; Lee, Gordon K.

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2011/2930

The Task-State Coordination Pattern, with applications in Human-Robot-Interaction

Ingo Luetkebohle (Universität Bielefeld, DE)

We consider interaction a powerful enabling technology for robots in human environments. Besides taking commands or reporting, many other uses, such as interactive learning, are already being explored. However, HRI also poses systems engineering challenges that may hinder its adoption. To address these, we advocate a general coordination pattern for task execution: The Task-State Pattern.

Crucially, it separates interaction coordination from task-level control, thus enabling independent, but integrated, development.

In the pattern, tasks are represented using both a general, re-usable task coordination model and a task-type dependent specification. We have introduced a coordination model rich enough to support a powerful user experience, but still general enough to accomodate a variety of tasks, thus simplifying architecture and integration. Furthermore, because it is re-used in many places, it provides an attractive target for tool support.

Keywords: Coordination, software architecture, design pattern, dialog, human-robot-interaction

Joint work of: Luetkebohle, Ingo; Peltason, Julia; Wrede, Britta; Wachsmuth, Sven

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2011/2931

Human Models for Human-Robot Interaction

Katsu Yamane (Disney Research - Pittsburgh, US)

This paper discusses various human models required in human-robot interaction study. Good human models are critical for robots to realize effective interactions. For example, human behavior model is necessary to choose appropriate cost functions to determine robot actions that are comfortable for humans. We will present several case studies that attempt to model the human physiology and behavior, as well as their application to humanoid and character control.

Keywords: Human-robot interaction, neuro-muscular human model, learning by demonstration

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2011/2932