Lecture Notes in Artificial Intelligence 4760

Edited by J. G. Carbonell and J. Siekmann

Subseries of Lecture Notes in Computer Science

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Towards Affordance-Based Robot Control

International Seminar
Dagstuhl Castle, Germany, June 5-9, 2006
Revised Papers

Springer

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Library of Congress Control Number: 2008920268

CR Subject Classification (1998): I.2.9, I.2.10, I.2.8

LNCS Sublibrary: SL 7 – Artificial Intelligence

ISSN 0302-9743
ISBN-10 3-540-77914-0 Springer Berlin Heidelberg New York
ISBN-13 978-3-540-77914-8 Springer Berlin Heidelberg New York

Springer is a part of Springer Science+Business Media

springer.com

Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India
Printed on acid-free paper SPIN: 12224166 06/3180 5 4 3 2 1 0

Preface

Today's mobile robot perception is insufficient for acting goal-directedly in unconstrained, dynamic everyday environments like a home, a factory, or a city. Subject to restrictions in bandwidth, computer power, and computation time, a robot has to react to a wealth of dynamically changing stimuli in such environments, requiring rapid, selective attention to decisive, action-relevant information of high current utility. Robust and general engineering methods for effectively and efficiently coupling perception, action, and reasoning are unavailable. Interesting performance, if any, is currently only achieved by sophisticated robot programming exploiting domain features and specialties, which leaves ordinary users no chance of changing how the robot acts.

The latter facts are high barriers for introducing, for example, service robots into human living or work environments. In order to overcome these barriers, additonal R&D efforts are required. The European Commission is undertaking a determined effort to fund related basic, inter-disciplinary research in a line of Strategic Objectives, including the Cognitive Systems calls in their 6th Framework Programme (FP6, [1]), and continuing in the 7th Framework Programme. One of the funded Cognitive Systems projects is MACS ("multi-sensory autonomous cognitive systems interacting with dynamic environments for perceiving and using affordances").

In cognitive science, an affordance in the sense of perceptual psychologist J.J. Gibson [2] is a resource or support that the environment offers an agent for action, and that the agent can directly perceive and employ. Only rarely has this concept been used in robotics and AI, although it offers an original perspective on coupling perception, action, and reasoning, differing notably from standard hybrid robot-control architectures. Taking it literally as a means or a metaphor for coupling perception and action directly, the potential that affordances offer for designing new powerful and intuitive robot-control architectures is obvious.

Perceiving affordances in the environment means that perception is filtered through the individual capabilities for physical action and through the current goals or intentions, thereby coupling perception and action deep down in the control architecture and providing an action-oriented interpretation of percepts in real time. Moreover, affordances provide on a high granularity level a basis for agent interaction and for learning or adapting context-dependent, goal-directed action.

The main objective of the MACS project is to explore and exploit the concept of *affordances* for the design and implementation of autonomous mobile robots acting goal-directedly in a dynamic environment. The aim is to develop affordance-based control as a method for robotics. The potential of this new methodology will be shown by going beyond navigation-like tasks towards goal-directed autonomous manipulation in the project demonstrators.

During the MACS proposal phase in late 2003, the idea of organizing an interdisciplinary Dagstuhl seminar related to the core MACS topics emerged. The planned purpose of the seminar was threefold, namely, (1) to disseminate the MACS project ideas and concepts into related scientific communities, (2) to receive feedback on and discuss these ideas, and (3) to discuss the usage of affordances in other research areas.

The organizers saw researchers in four broad areas (philosophy and logic, artificial intelligence and computer science, psychology, and economics and game theory) addressing highly related (in some cases, the same) problems, in which work in one area in all likelihood would benefit research in another. Hence for the Dagstuhl seminar, the organizers felt that valuable interactions and contributions could be anticipated by bringing people together from these areas. The aim of the seminar was to bring together researchers from robotics, informatics, and the cognitive sciences to exchange their experiences and opinions, and generate new ideas regarding the following essential questions:

– How could or should a robot-control architecture look like that makes use of affordances in perceiving the environment?
– How could or should such an architecture make use of affordances for action and reasoning?
– Is there more to affordances than function-oriented perception, action, and reasoning?

The answers to these questions are currently wide open. Two points can be stated with certainty, however. First, an affordance-based or affordance-inspired robot-control architecture cannot simply be an extension (an "added layer," so to speak) to existing modern control architectures. The reason is that affordances would spring into existence in low-level perception, would have to pass filters in the control, such as attentional mechanisms, in order not to flood the robot's higher processing levels, and serve in some explicitly represented form of a structured result of perception as a resource for action selection, deliberation, and learning. So if there is such a thing as an affordance-based control architecture, affordances will have to play a role in all of its layers.

Second, the answers to the seminar questions do not depend on whether or not the cognitive sciences agree that Gibson is "right" in the sense that affordances exist in biological brains or minds or exist in the interaction between biological individuals and their environment. The point is, if Gibson's description of phenomena of functional coupling between perception and action is correct, then it is of high interest for robot control designers, independent of how it is best understood according to cognitive science standards. Therefore, the seminar would profit from either proponents or opponents of the affordance model. The aim here was discussion and exchange, not unanimity.

The organizers brought together 32 researchers from different scientific communities to attend the seminar. Given that the scientific background of the participants was not homogeneous, and that there was only little technical work that directly fit the seminar topic (as remarked above, there are only relatively few examples of using explicitly the concept of affordances), the program (cf. [3])

was composed of six overview talks centered around the state of the art, serving to inform the heterogeneous audience, and 13 technical presentations of mainly young researchers working in related areas.

Presentations, an abstract collection of all contributions, and an executive seminar summary can be found at the Dagstuhl Web site [3]. Twelve of the seminar contributions have been elaborated as full articles for this post-proceedings volume. Additionally, a highly relevant paper from Alex Stoytchev has been invited to complement the seminar contributions.

The organizers express their gratitude to the Dagstuhl foundation for their support and for hosting this seminar in their exceptional facilities, and to the participants for their contributions and for making the seminar successful and enjoyable. The work of organizing and conducting the seminar was partly funded by the European Commission's 6th Framework Programme IST Project MACS under contract/grant number FP6-004381. The Commission's support is gratefully acknowledged.

September 2007

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