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EDITORIAL

Special issue on cognitive robotics

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Motivation

Cognitive robotics is concerned with endowing robots with the capacity to reason, plan solutions for complex goals, and to enact those plans while being reactive to unexpected changes in their environment. To achieve this goal, cognitive architectures for robotics attempt to provide a structure where all the functionalities of the working cognitive robot can be fit and- in conjunction with knowledge-yield intelligent behavior. Architectures typically integrate high-level symbolic processes with mid- and low-level aspects, intimately tied to the concrete representation of the situation. To complicate this scenario, cognitive robots are usually expected to be able to interact with humans in order to assist them. The interaction of these social robots with humans gives the whole scenario an additional degree of complexity. Thus, the design space of these architectures lies somewhere between cognitive architectures that study human cognition, the sensory-motor processes that connect and anchor the robot to the world, the more recently appeared human–robot interaction (HRI) field, and the possibilities offered by current hardware and software technologies working under real-time conditions. Furthermore, there are other additional aspects related to usability and acceptability that must be considered. Cognitive robotics must help to design more practical robots from a technological point-of-view but, more importantly, it must help to design robots that can be interacted with in a more natural and intuitive way, through interfaces that can be adapted and personalized to the user. Thus, to the dimensions previously defined for the design space of the cognitive architectures for robotics, we must probably add natural language and the abilities that can enable robots to represent their external surroundings and internal states using semantics. These abilities will allow robots to generate verbal explanations and also to use semantics as a means for other skills not directly related to communication. This special issue constitutes a collection of original works on these topics, which can be grouped within two research areas: cognitive architectures and semantic description using natural language.

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This article is the Editorial of the Special Section on 'Cognitive Robotics' guest-edited by Antonio Bandera, Markus Vincze, Jorge Dias, and Luis Manso.

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Special issue overview

The paper by Rodríguez-Lera et al. (2018) presents HiMoP, a motivational architecture for assistive robots. HiMoP is composed of three main elements: a hierarchy of needs to define robot drives; a set of motivational variables which are connected to the robot's needs; and a pool of finite-state machines to run the specific behaviors. The authors put the emphasis on how to endow a robot with the ability to unfold a more natural, non-repetitive behavior under similar stimuli. The work is evaluated using the 'Speech Recognition and Audio Detection test', one of the challenges of RoboCup@ Home. Experimental results show that the architecture is able to dynamically adapt to the internal and external variables. The work of Melidis et al. (2017) focused on the design of an architecture whose aim is to interface robot and user, adapting both toward the control signals emanated from the

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user and the robotic morphology. The approach is able to identify control patterns for a given robotic morphology and merge them with the control signals from the user. Inherent properties of the architecture are presented and explained. As a whole, this new paradigm of control is found to highlight the potential for a change in the paradigm of robotic control, and a new level in the taxonomy of human-in-the-loop systems.

On the other hand, the challenge of internalizing a scene and processing this information using natural language is tackled in the works by Falomir and Kluth (2017), and by Manso et al. (2017). In the first work, the authors propose a framework which is able to automatically generate explanations in natural language of complex indoor scenes. The aim is to analyze what qualitative descriptors should be used, and how they could be organized to generate a suitable cognitive explanation of the visually perceived scene. The QSn3D framework employs the output from a depth camera for identifying objects and their orientations, providing a qualitative description of their spatial relationships. These relationships are the input to a specific grammar which applies saliency rules for generating the cognitive description of the scene using natural language. Saliency rules were obtained from a survey test carried out with human participants. A final validation study shows that the artificially generated descriptions by the QSn3D are understandable to humans. The work by Manso et al. (2017) describes an approach for endowing a robot with the ability to represent the objects within a scene and to search for specific queries when required by the user. Objects are not only identified, but also located within specific 'object containers' (e.g., tables, shelving). While the internalization of the objects within its representation is continuously performed by the robot in a passive manner using mid-level perceptive modules, the search is actively executed. It involves a deliberative process, which proposes candidate containers using the semantic distance between the searched object and the descriptions of the objects typically present in each container. Upon failure to guess the right container, the robot can continue making guesses until the object is found. The paper provides quantitative results revealing the efficiency of the proposed approach.

Conclusion

The challenge of designing robots able to share everyday environments with people is addressed in this special issue from two perspectives. On the one hand, the HiMoP architecture describes a complete framework for endowing robots with the ability to interact with their surroundings. The HiMoP architecture focuses on motivation and the unfolding of non-repetitive behaviors. In this sense, HiMoP is a pioneer work on developing robots that exhibit a natural behavior. On the other hand, the work by Melidis et al. (2017) bridges the gap between complex robots and users, designing a solution for this interface that puts the user in the design loop. The interaction between robot and user is the other problem addressed on this special issue. If the framework by Melidis et al. (2017) is an original proposal for easing the user to control a tele-operated robot, the approaches of Manso et al. (2017) and Falomir and Kluth (2017) focus on autonomous robots, able to understand the scene and to use this knowledge for interacting with humans. The QSn3D allows a robot to build internal semantic representation, which can be shared with humans. The goal of being able to represent the scene and/or situation as humans do can be the base for a robot that must cooperate with humans in the same team. In the same way, the possibility of internalizing this semantic knowledge using a graph of symbolic tokens, for concepts but also for relationships, constitutes a significant advance to build and maintain these internal descriptions that can be naturally shared with humans through adequate interfaces.

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Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical approval Research did not involve human participants and/or animal.

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