Research Summary
A Cognitive Architecture for a Service Robot: an Answer Set Programming Approach

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1 Introduction

Service robot is one of the most promising directions of Robotics and full of challenges. Most of current work in Robotics concentrate on low-level functions, while in AI there are notable achievements on high-level functions. It would be interesting to integrate state of the art AI (particularly, KR) techniques and test if they are sufficient for developing a "good enough" service robot. New challenges will be identified and attacked on the basis of this investigation.

After more than twenty years of research, Answer Set Programming (ASP) has become a popular tool for knowledge representation and reasoning. Gelfond [1] suggested to use ASP for the design and implementation of deliberative agents. Following the perspective, we propose a cognitive architecture for our home service robot [2] in Fig. 1.

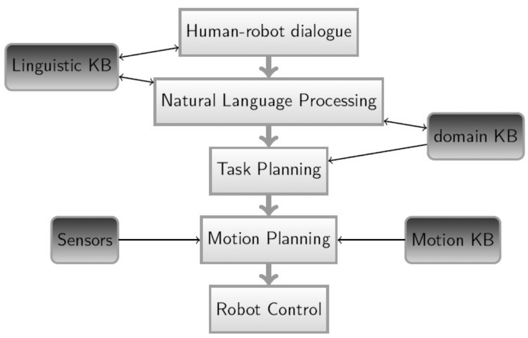

Fig. 1. An architecture for a home robot

Task Planning is a key part of the architecture, which is used to (1) access various kinds of information provided by users from Natural Language Processing; (2) compute a plan to fulfill the command with the help of information proved by the user; (3) pass sequences of atomic actions to Motion Planning. We implemented it by ASP, thus providing us a versatile and robust platform for integrating modern KR techniques. Another benefit is that, both connections of Task Planning are close and smooth, as logical formulas generated from Natural Language Processing can be easily imported to it, and sequences of atomic actions can be easily understood by Motion Planning, which helps the robot work more automatically and makes the design of the robot more easily. To the best of our knowledge, we are the first one in this kind, and the only team that constructs the architecture based on ASP.

We have implemented basic components of the architecture. Currently, the robot can accomplish the command with the help of information proved by users in the form of natural language. For example, the user said "The book is on the table. Give Jim the book.". From Natural Language Processing, we can get $i\_on(book, table)$ and $g\_give(agent, Jim, book)$. Task Planning is implemented as a answer set program with a KB for classical planning, the command is translated to the corresponding goal state, if we have $location(table, 5, 0)$ in KB, then we can derive $location(book, 5, 0)$. cmodels is used to compute the answer set, which will contain a plan: $move(5, 0), catch(book, 1), move(0, 2), putdown(3)$. Then we pass this sequence of actions to Motion Planning to accomplish the task.

We have successfully qualified for a participation in the @home competition of RoboCup09[1]. The aim of RoboCup@Home is to foster mobile autonomous service robotics and natural human-robot interaction. There is no standard scenario, but something that people encounter in daily life. The competition is a series of tests, which will steadily increase in complexity. We can test the idea and compare with other work in the competition.

So far the work is preliminary, but as a versatile and robust platform, we can integrate many modern KR techniques to solve problems for service robot.

Diagnosis [3] is one of our next goals. There are many uncertainties (external events and actions may fail) during the execution, diagnosis can explain the discrepancy between abnormal observations and correct system behavior, which helps the robot fix the problem. Another important work is to extract ASP rules from tradition knowledge bases automatically, which can ease the design of the robot and make it more flexible.

References

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3. Eiter, T., Faber, W., Leone, N., Pfeifer, G.: The diagnosis frontend of the dlv system. AI Communications **12(1-2)** (1999) 99–111

[1] `http://www.ai.rug.nl/robocupathome/`