How to Use OpenEASE: An Online Knowledge Processing System for Robots and Robotics Researchers (Demonstration)

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ABSTRACT

Autonoumous robotic agents performing human-scale manipulation activities in open environments will need extensive knowledge processing capabilities. In previous work we presented OPENEASE, an online knowledge representation and reasoning framework with interfaces for both autonomous agent systems and robotics researchers. We propose to hold an interactive session during AAMAS 2015 to show researchers from the robotic agents community how to use the web interface of OPENEASE. The demonstration will feature two datasets recorded on leading-edge mobile manipulation platforms: A robotic mobile pick-and-place scenario, and an experiment in which a safety-aware robotic agent physically interacts with a human co-worker. Participants will learn how to use the expressive Prolog-based query language of OPENEASE to analyse the comprehensive datasets available in the system.

Categories and Subject Descriptors

I.2.5 [**Programming Languages and Software**]: Expert system tools and Software

Keywords

Personal robotics; Open-source software tools for agent-based system development; Human-robot interactive systems

1. INTRODUCTION

Autonomous robotic agents shall soon perform human-scale manipulation activities in open and dynamic environments, such as pick-and-place tasks in warehouses, product assembly in factories, or table setting and cleaning in hotels [1]. Additionally, society will require those agents to accomplish their goals in a safety-aware manner. We argue that equipping robotic agents with such capabilities will involve interfacing their control programs with extensive knowledge processing and reasoning mechanisms [2]. Furthermore, researchers will require big amounts of high-quality data to investigate perception and control algorithms.

To address these needs, we have developed the OPENEASE framework, an online knowledge representation and processing service [3] based on the KNOWROB knowledge processing architecture [2]. It provides researchers in robotics, and autonomous agents with unprecedented access to knowledge about leading-edge autonomous robotic agents. OPENEASE is a large, remotely accessible knowledge service containing (a) a big-data database storing comprehensive data about episodes in which humans and robots perform complex manipulation tasks; (b) an ontology, i.e. an encyclopedic knowledge base, providing a conceptual model of manipulation activities; (c) and software tools for querying, visualizing, and analyzing the recorded activities.

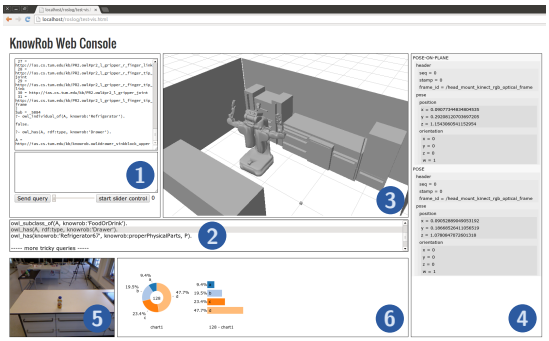

Figure 1: The web interface of OPENEASE. Image reproduced from [3].

We propose holding an interactive demonstration showing the usage of the OPENEASE web interface to the research community at AAMAS 2015. During this interaction, we hope to learn more about requirements researchers have for such a system and to find future collaboration partners from other laboratories that can help further improving the OPENEASE services and will engage in filling its data- and knowledge bases with further experiments.

During the demonstration, we will use a projector showing the presenter's screen, encouraging participants to follow along on their own computers. First, we will show how to register, login, and browse the OPENEASE interface. Then, we will introduce analysis and visualization capabilities of OPENEASE using prepared sample queries. Finally, we will provide simple exercises allowing the participants to explore the features of the system on their own.

Our demonstration will focus on two comprehensive data-sets recorded during experiments: a pick and place experiment involving mobile manipulation in a complex environment, and a human-robot interaction experiment in which the robotic agent physically interacts with a human co-worker, while ensuring her safety. Both datasets will feature leading-edge mobile manipulation platforms – the PR2 and a custom-built robot with KUKA LWR 4+ arms.

A video introducing the OPENEASE web interface using parts of the pick and place dataset is available online[1]. Note that we have already released that dataset in a beta-version of the OPENEASE website at *open-ease.org*. Additionally, scientific publications de-

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Appears in: *Proceedings of the 14th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2015), Bordini, Elkind, Weiss, Yolum (eds.), May 4–8, 2015, Istanbul, Turkey.*
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[1] https://www.youtube.com/watch?v=vBZ-Vm5nvBs

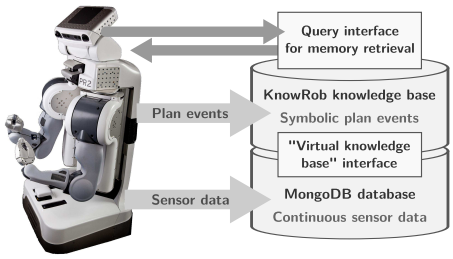

Figure 2: Conceptual overview of OpenEASE logging system. Image reproduced from [4].

tailing specification, design, and implementation of OPENEASE have been published [4] or accepted for publication [3].

2. SYSTEM ARCHITECTURE

At the most abstract level, OPENEASE consists of two parts: A component for logging data during robotic experiments, and one for remotely processing the recorded data.

2.1 Logging of Robotic Experiments

Figure 2 depicts a conceptual overview of the OPENEASE logging system which we have detailed in a recent publication [4]: The plan-based executive of a robotic agent logs symbolic plan events, its beliefs, and goals into a symbolic knowledge base, while a MongoDB database logs the high-volume sensor data produced by the actuators and sensors of the robot. Retrieval algorithms for answering symbolic queries can relate the symbolic and sub-symbolic data through common timestamps.

2.2 OpenEASE Web Interface

During the proposed demonstration, the participants will interact with the system through its web interface. A research publication detailing that part of OPENEASE will be available at the time of demonstration [3].

Figure 1 depicts this web interface showing several panes with different purposes. The Prolog interaction pane (1) is a Prolog queries/answer interface to the knowledge base. For new users, the query list pane (2) holds a list of prepared queries with English translation. The 3D display pane (3) at the view's center can visualize the robot and its environment. It also supports displaying and highlighting robot trajectories and object poses. The belief pane (4) shows the internal data structures of the robot's beliefs. These include –but are not limited to– object, action, and location descriptions used by the robot. Using the image pane (5) users can inspect images captured by the robot's camera. Finally, there is the visual analytics pane (6) for researchers to plot statistical data using bar charts or pie charts.

Participants can already familiarize themselves with the interface by logging into the service on the OPENEASE website *openease.org* prior to the demonstration session.

3. DEMONSTRATION DATASETS

For our demonstration we will use two comprehensive data-sets featuring leading-edge mobile manipulation platforms.

3.1 Pick and Place Scenarios

In the first demonstration, our PR2 robotic agent performed various pick-and-place tasks in a kitchen. The agent had to navigate in its environment, look for, find, grasp, transport, and place objects. From this, we recorded a rich dataset containing poses of all robot parts, detailed descriptions of perception tasks, and the robot's plan goals and failures. This also includes the agent's knowledge about the semantic map and self model. This allows us to calculate statistics over failures and evaluate the agent's performance.

From the point of view of the agent, the logging and knowledge processing capabilities of OPENEASE act as a belief state system. The agent can find temporal and causal relations between actions and effects through analyzing log data. For instance, an agent can use the logged location where it previously placed an object for validating that it is still there or for searching its surrounding area.

3.2 Safety-aware Robotic Agents

Our second demonstration dataset highlights our notion of safety-aware robotics, that is, robotic agents that know when actions may hurt or threaten humans, and that actively refrain from performing them. We believe that researchers in human-robot interaction will find memory retrieval and analysis capabilities of OPENEASE valuable tools to assess safety-awareness of robotic agents.

A custom-built mobile robotic agent with two KUKA LWR 4+ arms arranges surgical instruments on a table while concurrently reacting to a human co-worker. The co-worker may enter the agent's workspace, touch its arms, and interfere with the its actions at any time. Throughout this interaction the agent has to ensure the human's safety. In comparison to the first dataset, this set additionally contains continuously tracked poses of the human's links, as well as safety events and reactions from the robot arms' motion controllers. We will combine information from the memorized object perceptions, the human tracking system and from logged robot actions to hypothesize possible explanations, e.g. that the co-worker took the scalpel away or placed another bowl on the table.

4. CONCLUSION

We propose to hold an interactive demonstration session showcasing the features and usage of the OPENEASE web interface. OPENEASE is an online knowledge representation and processing service for robotic agents and robotics researchers. Our presentation will feature two datasets from robotic experiments: A pick and place scenario, and a human-robot interaction episode involving safety events. Through this interactive presentation we hope to learn more about the requirements of OPENEASE and invite other researchers from the community to use its services in their research.

Acknowledgements

This work was supported in part by the EU FP7 Projects *RoboHow* (Grant Agreement Number 288533) and *SAPHARI* (Grant Agreement Number 287513).

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