Human-Robot Interaction in the MORSE Simulator

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ABSTRACT

Over the last two years, the Modular OpenRobots Simulation Engine (MORSE) project[1] went from a simple extension plugged on the Blender's *Game Engine* to a full-fledged simulation environment for academic robotics. Driven by the requirements of several of its developers, tools dedicated to Human-Robot interaction simulation have taken a prominent place in the project. This late breaking report discusses some of the recent additions in this domain, including the immersive experience provided by the integration of the Kinect device as input controller. We also give an overview of the experiences we plan to complete in the coming months.

Categories and Subject Descriptors

I.2.9 [**Computing Methodologies**]: Artificial Intelligence—*Robotics*

General Terms

Experimentation, Human Factor

Keywords

Simulation, Human-Robot Interaction

1. THE MORSE SIMULATOR

The Modular OpenRobots Simulation Engine (MORSE) [2] is a open-source tool developed for robotics research. It is a domain independent simulator, where virtual robots can interact with a 3D environment, using sensors and actuators that behave in the same way as their counterparts in the real world. MORSE relies on the advanced 3D (OpenGL shaders) and physics simulation (BULLET physics engine) capabilities of the Blender *Game Engine*, a real-time 3D runtime integrated to the open-source Blender modeling toolkit. This allows for semi-realistic simulation of complex environments.

The MORSE components (sensors and actuators) exchange data with the robotics software via middleware bindings, using a *Software In The Loop* (SAIL) architecture. Middleware supported in the current version include ROS and YARP, as well as a socket-based raw protocol. This design allows in principle to use the same software in both the real robots and the simulator. Instructions given to the robot are interpreted in the simulator to provide the control of actuators, such as the motion of the robot and its arms. The data from simulated sensors is sent back through the middlewares, *e.g.* exporting the images from cameras, or the positions of the robot, human and other objects of interest.

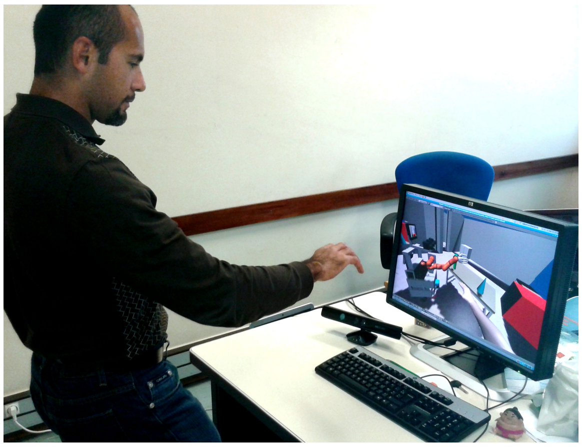

Figure 1: The experimental setup with the human avatar controlled from a Kinect.

MORSE provides support for several classes of robots *out of the box*, and allows for easy customization of those, either by composing individual sensors and actuators with empty robot structures directly in the MORSE interface, or through a Python-based script language that permits to conveniently describe robots and simulation scenarii.

Other experiments using simulation have been carried to gather data for HRI [1]. However, these do not involve the actual robot software, and it is another human who takes the role of the robot.

2. HRI SPECIFIC FEATURES

A new *human avatar* has been recently added to the MORSE assets. It provides a first-person immersive experience: when started, one can take the role of the human and control it via the keyboard, a WiiMote or, as another recent addition to the simulator, through a Kinect device (Fig. 1).

When in first-person mode, the user can interact in several ways with the environment. He/she can pick and release objects, can open drawers and cupboards. As any other object,

[1] `http://morse.openrobots.org`

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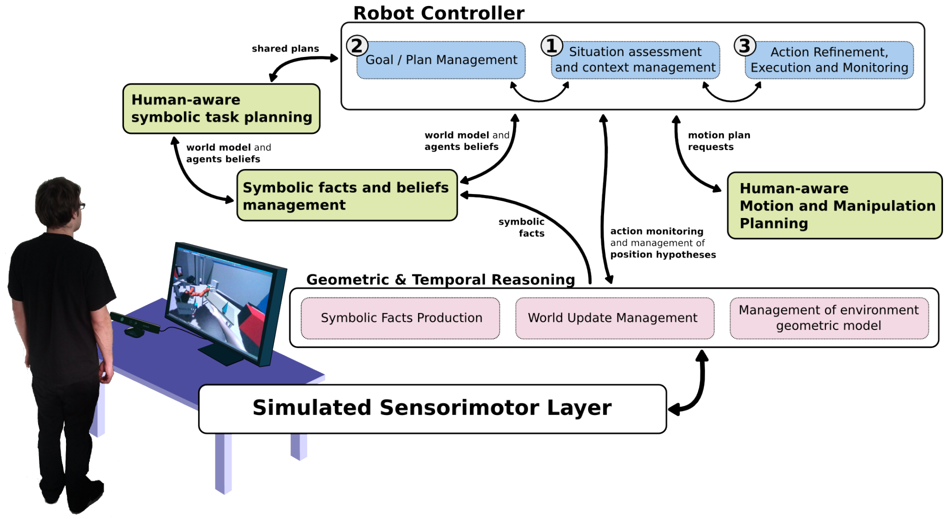
Robot Controller
shared plans
2 Goal / Plan Management
1 Situation assessment and context management
3 Action Refinement, Execution and Monitoring
Human-aware symbolic task planning
world model and agents beliefs
world model and agents beliefs
motion plan requests
Symbolic facts and beliefs management
Human-aware Motion and Manipulation Planning
symbolic facts
action monitoring and management of position hypotheses
Geometric & Temporal Reasoning
Symbolic Facts Production
World Update Management
Management of environment geometric model
Simulated Sensorimotor Layer

Figure 2: Example of integration in a software architecture: MORSE transparently replaces the real robot.

the avatar physically interacts (collision detection) with the surrounding furnitures. MORSE exports the position and posture of the avatar as a global joint state to be used by the real software components of the robot.

MORSE also offers a special sensor that exports abstracted informations of objects visible to the robot (called the *semantic camera*). This sensor typically exports the name, type (glass, table, bottle, etc.), color and location of objects. Since human-robot interaction often involves semantic-rich environments, this abstract sensor simplifies the experiments on such scenarii, by avoiding the added complexity of processing camera images to detect the objects of interest and exploiting the inherent knowledge of the simulated world.

3. CURRENT AND FUTURE EXPERIMENTS

Due to its nature, MORSE offers two main advantages compared to experiments on a real robot: light-weight deployment and repeatability. MORSE is already used for human-robot interaction in two laboratories, at the LAAS-CNRS, Toulouse, France, and at the Technical University of Munich, Germany.

Integration in the LAAS cognitive architecture: Figure 2 presents the current integration of MORSE in the LAAS' software architecture. In particular, both the human posture and the object features are integrated with SPARK [5], a module dedicated to geometric and temporal reasoning. This module is a key component providing a base of facts such as objects' relative placements, visibility and reachability by the agents present in the scene. It additionally provides a stable state of the world to the motion planners.

Human-Aware Motion Planning: The human avatar is being used to evaluate human-aware navigation planners at Munich TU. It enables developers to find and avoid errors before running on real robots. A simulated human tracker updates the position of the human and passes it to the robotic middleware. A video is available here: `http://vimeo.com/31257264`.

Interaction with Natural Language: Relying on the abstract sensors provided by MORSE, we plan to reproduce in simulation the results of a previous experiment [4] involving interactive verbal disambiguation. Natural language understanding relies on a dedicated language parsing and grounding module called DIALOGS, which is fed by a symbolic knowledge base build as a ontology server [3].

4. SUMMARY

We have presented the developments leading to an interactive experimental setup for Human-Robot Interaction. The development of particular functionalities of the robot architecture, especially those involving a quick response to changes in the environment induced by the human presence, will directly benefit from the HRI simulation capabilities provided by MORSE.

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