Planning for Agents with Changing Goals
(Demo Storyboard)

Kartik Talamadupula*   Paul Schermerhorn°   J. Benton*
Subbarao Kambhampati*   Matthias Scheutz°

* Arizona State University   ° Indiana University

Abstract

One of the most important applications of planning technology is guiding robotic agents in an autonomous fashion through complex problem scenarios. Increasingly, real-world scenarios are evolving in ways that require intensive interaction between human actors and the robotic agent, mediated by a planning system. We propose to demonstrate an integrated system in one such problem that falls under the aegis of an urban search and rescue (USAR) scenario. We show a simulation of a run through one such problem where a mobile robot is given certain goals to achieve in a layout of interest, and discuss how the various capabilities of the planner are instrumental in achieving the agent's goals.

Setup

Our scenario involves a mobile robot executing within a layout of interest, while in communication with a human commander (who is removed from the area). While the robot is executing the actions given to it by the planner, the commander gives it new information about injured humans being in rooms, and a new goal to report the location of these injured humans. The commander also specifies that the robot may use the "push" action available to it (for pushing boxes) in order to push doors, thus opening that door and allowing it access to the room behind that particular door.

We now provide an illustration of a similar (but not the same) scenario in lieu of a storyboard, in order to show the flow of the demonstration. We describe the scenario in its first – the robot is initially placed in a layout of interest at the beginning of a long corridor. The corridor has doors leading off on either side into rooms that contain injured humans – a fact that that robot (and planner) do not know at the beginning. The human commander gives the robot an initial goal of getting to the end of the corridor by a specific time, and the robot starts executing actions that will achieve this.

While it is traversing the corridor, the commander also gives it the additional information that there exist rooms behind doors, and that there may be injured humans in these rooms. An additional goal – that of reporting the locations of injured humans – is specified along with this knowledge. The planner must thus replan taking the new information and objectives into account, while respecting the original objective and the deadline specified for achieving it.

We now provide a storyboard that consists of screenshots from the simulator on which this problem was run. Though the task described above is not the exact scenario that we wish to demonstrate (since it does not account for changes to the action model), it is a close approximation. Following the storyboard, we attach a link to a video of the planner guiding a real robot through a sample problem run.

Storyboard

Figure 1: Initially, the robot starts at the beginning of a long corridor that has doors leading off into rooms on either side. The robot's hard goal is to reach the end of the corridor (ostensibly to deliver supplies). In the following screenshot, the robot is the red object in the beginning of the corridor. There are breaks in the corridor that are doors – these doors lead in to rooms. Rooms may house humans, who are represented in the simulator as boxes. Green boxes stand for injured humans, while a blue box denotes a normal human. At this stage, the robot does not have the information regarding injured humans – this is relayed in succeeding stages. Along with the map, there is also diagnostic text output, and a view of the robot's front lasers.
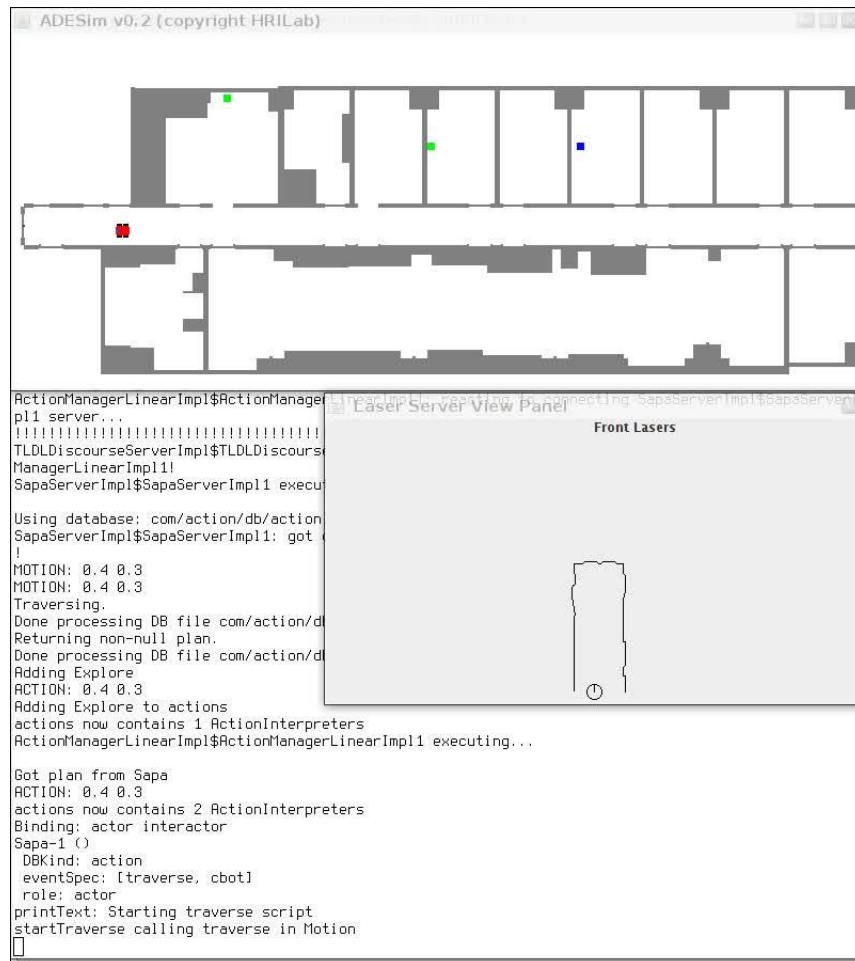

Figure 1: The robot at the beginning of the corridor

Figure 2: The commander then tells the robot to go to the end of the hallway and that it has seven minutes to do so, thus giving it its initial goal. At this stage, the robot starts turning in pursuit of its objective – this can be seen from its front lasers as well.
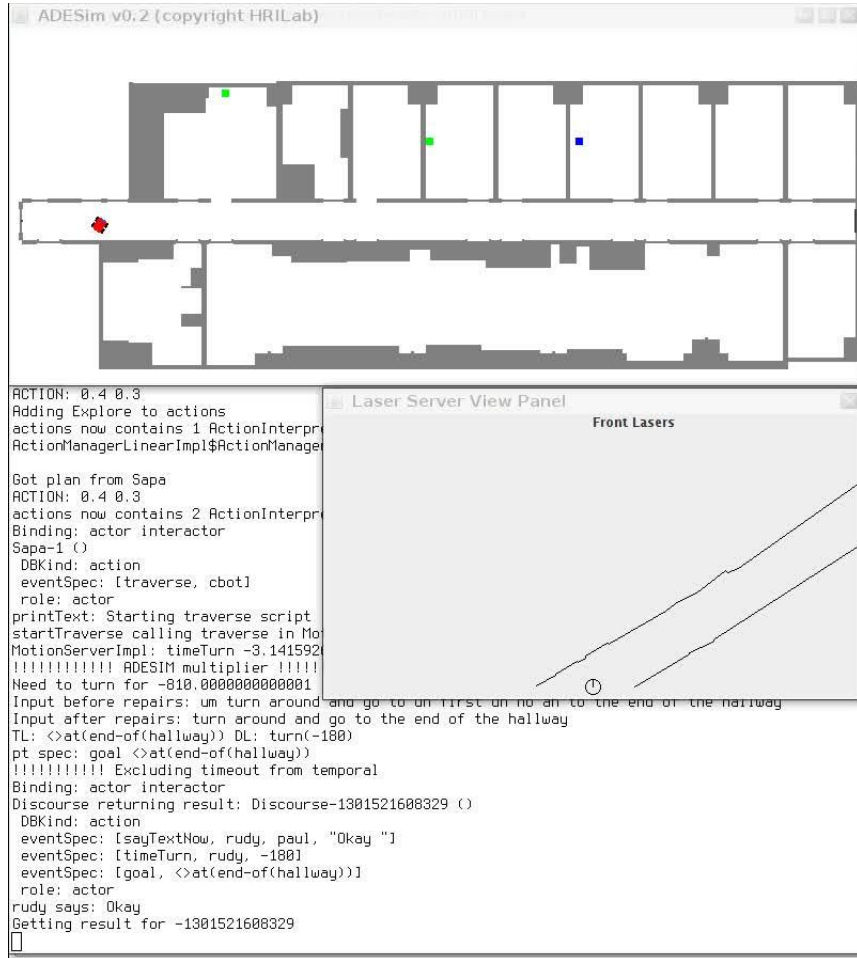

Figure 2: The robot has been assigned its initial goal.

Figure 3: Following this, the robot starts traversing the corridor to get to its end. The commander meanwhile gives it the information that injured humans are in rooms, and asks it to report on such humans. The planner detects a door and generates a plan to enter the room:
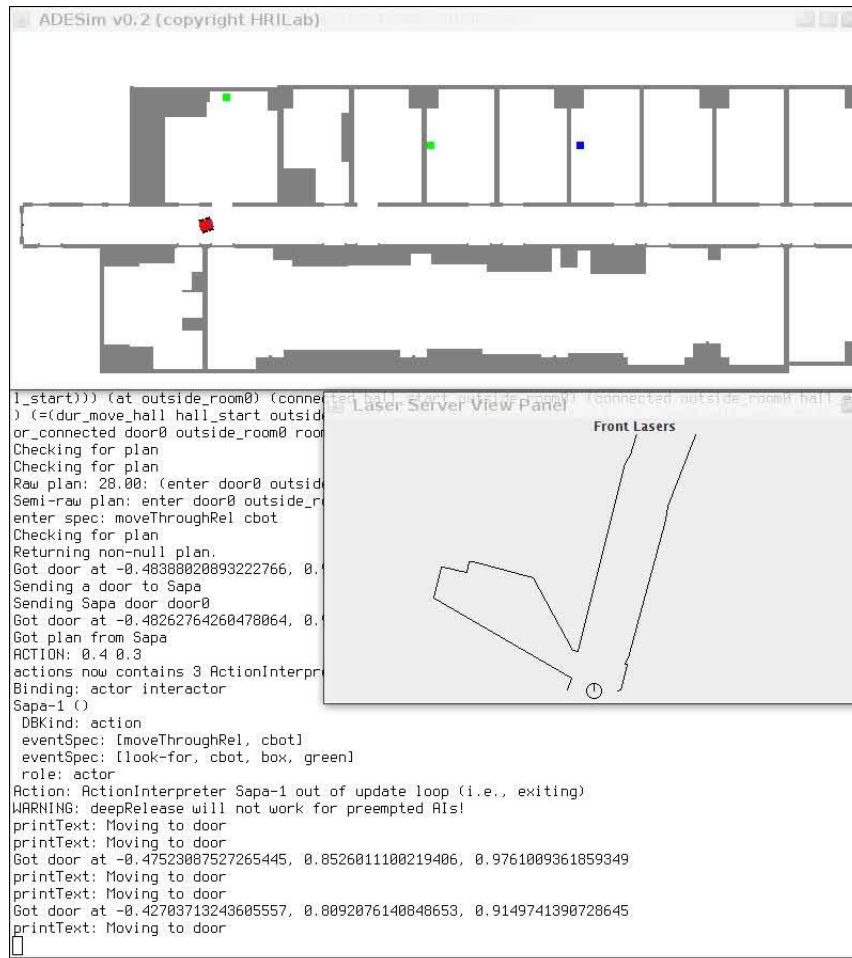

Figure 3: The robot starts traversing the corridor.

Figures 4 and 5: The robot then enters the room, and after searching for and reporting the green box (which is a stand-in for an injured human), it leaves. Here the robot is seen entering the room and recognizing the existence of an object in its field of vision.
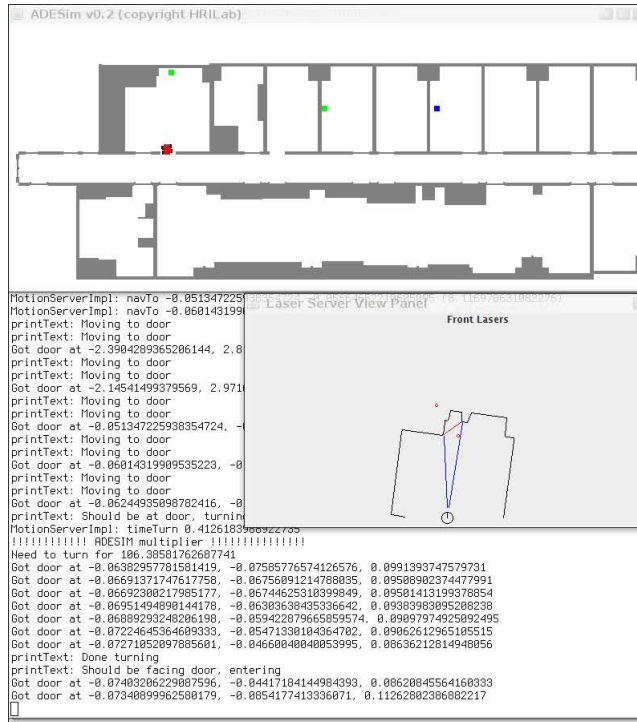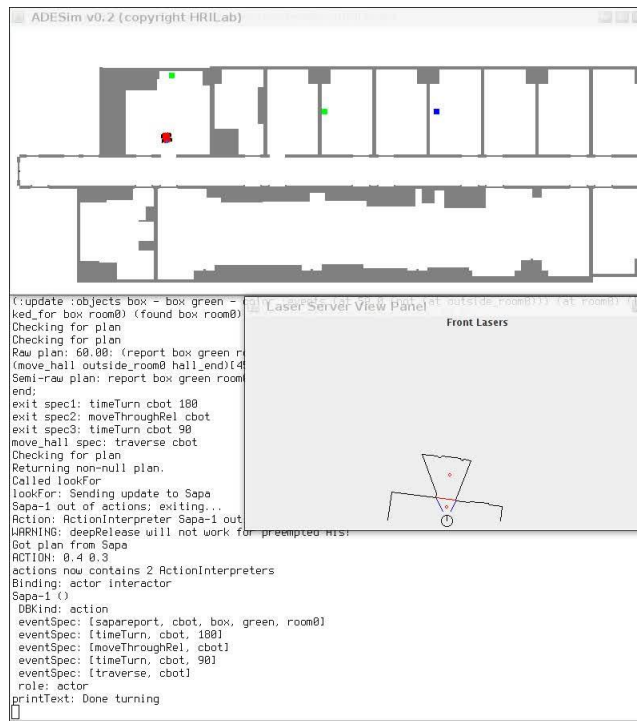

Figure 4: The robot enters the room.

Figure 5: The robot recognizes the existence of the object as it gets closer to it.

Figure 6 and 7: The commander now informs the robot that it has only a minute left to complete its original task (getting to the end of the corridor) – this leads to some replanning on the planner's part, and the conclusion that the robot must ignore all other doors to have enough time to achieve its hard goal.
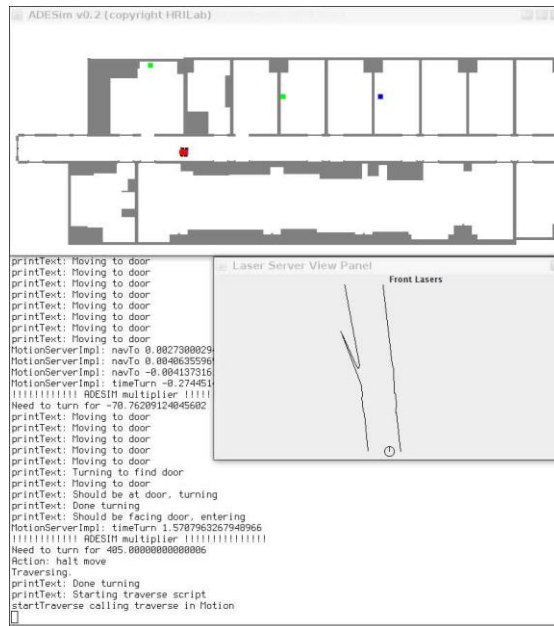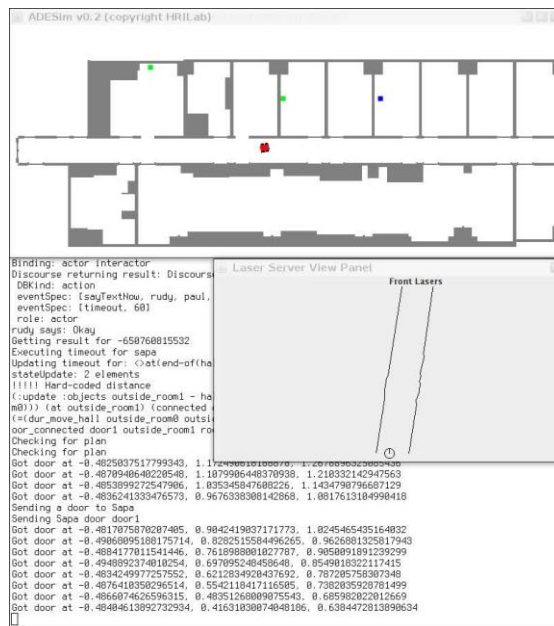

Figure 6

Figure 7: The robot ignores all remaining doors to head towards the end of the corridor.

The robot's run through this particular scenario is recorded in the following video:
http://hri.cogs.indiana.edu/~pscherme/videos/DayTimeGoldSub.avi

Though this storyboard does not reflect our exact intended demonstration (since it does not account for the addition of action effects, like the opening of doors for the "push" action), it is a reasonable representation of our submission.