Using a Sketch Pad Interface for Interacting with a Robot Team

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Introduction

Researchers at the University of Missouri-Columbia and at the Naval Research Laboratory have been working on human-robot interaction and communication. Our goals have been to make such interactions more intuitive and natural, as much as human-human communication is facilitated by shared modes of interaction.

Because our research emphasis is on providing easy-to-use, intuitive interfaces for the user, the onus of maneuvering around obstacles and in general of interacting with the environment is placed on sensors onboard the robot and other capabilities that allow a robot to handle both unstructured and dynamic environments. However, higher level tasks, such as strategic planning, are the role of human users. It is, therefore, incumbent on designers of the interface to facilitate high level, human interactions and decisions. Thus, the interface should be the tool by which humans can easily, intelligently, and even intuitively communicate their goals to a robot or a team of robots.

The Sketch Pad Interface

In the past we have investigated the use of human language and gesture [1, 2] as modes for interacting with mobile robotic systems. We are now directing our attention on the incorporation of another modality for interaction; namely, the use of sketching in a human-robot interface [3, 4]. We, therefore, will be exhibiting a sketch interface to control a team of mobile robots. Users can draw environment landmarks and label them, as well as indicate goal points and paths for robot navigation for a single robot or a group of robots, by drawing on the sketch pad of a tablet PC.

Editing operations are also supported in the sketch interface, so that the user can move or delete environment landmarks and redraw goal points and robot trajectories. Once the sketch is complete with specified actions for the robots, the user sketches an arrow to begin the translation to robot commands. Sketched symbols are recognized using a Hidden Markov Model with prior training [5].

The sketch interface employs an approximate representation of the environment and landmarks with which the human user can interact. The interface extracts qualitative spatial information from the sketched landmarks on the map and the path drawn through the field of landmarks [6]. This information is then relayed to the robots for subsequent action.

The information that the human presents to the robots via the interface need not be absolute. From the robot's point of view in attempting to navigate, the task is based on its real-time sensing and the relative position of paths and landmarks, not the absolute positions of the sketched artifacts provided by the human. The path or trajectory that the robot must take and information about objects in the environment are based qualitatively on the information which the human provides via the sketch pad and quantitatively by the onboard robot sensors obtained in real time.

Our research focuses on seeing how well humans communicate information about objects and paths under different conditions that may affect the quality of the information provided to the robots via the sketch pad interface. While all information presented to the robots need only be relative, we are investigating the tolerance levels that the system must exhibit in order for it to successfully follow the human user's instructions, mapped in qualitative terms. We expect that, in conditions where the user has accurate information of the environment, she will be more accurate in presenting information to the robots and find the tasks less complicated than in situations where incomplete or altered information may be communicated. In conditions in which the human has inaccurate information about the environment, we expect the system to have to adapt more in order to achieve the same degree of success in achieving a goal, or at least be more tolerant of approximations and relative positions of

objects with respect to each other, and have to adapt to the user's misinformation about the environment. Furthermore, we expect that the workload on the human user will be greater in these latter conditions.

Ongoing Research

In conjunction with our previous work on spatial language and relations [7], we are also interested in incorporating a spatial reasoning component and providing natural language interactions. In conjunction with our work on perspective-taking and cognitive behaviors [8], we are interested in incorporating cognitive behaviors to facilitate human interactions with a system that can reason about the world from its own point of view, as well as adapt to a human user's perspective.

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