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Global Telerobotics: Exploring Effective Internet Access to Robots

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This paper describes an Industrial Automation research project at the University of Wollongong, Australia. The project aims to develop a telerobotic planning and control architecture and human robot interface that can be used for intervention robots which require task level programming. In order to investigate global telerobotic principles, the workspace will be made accessible across the Internet via the World Wide Web. The paper describes the experimental setup and implementation of this project, focussing on a discussion of human robot interaction issues, such as interface design problems and the use of a World Wide Web browser for user interaction.

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Global Telerobotics: Exploring Effective Internet Access to Robots

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Abstract

This paper describes an Industrial Automation research project at the University of Wollongong, Australia. The project aims to develop a telerobotic planning and control architecture and human robot interface that can be used for intervention robots which require task level programming. In order to investigate global telerobotic principles, the workspace will be made accessible across the Internet via the World Wide Web. The paper describes the experimental setup and implementation of this project, focussing on a discussion of human robot interaction issues, such as interface design problems and the use of a World Wide Web browser for user interaction.

1: Introduction

This project aims to develop a task level interface for the ADEPT manipulator robot within a telerobotic environment by integrating the concepts of World Wide Web interaction with task level robot programming. The Internet (World Wide Web) was chosen as the information transport medium because it provides an inexpensive, easily accessible graphical environment in which to perform telerobotic research. Additionally, Web Browsers eliminate the need to develop telerobotic clients from the ground up as they provide many of the underlying facilities required in a human-computer interface eg. graphics, supports multimedia interaction and is standardised across many hardware platforms.

2: Background and Motivation for Research

Teleoperated robot systems have been around for about the past 30 years. Recent research has focused on the development of systems where the remote robot is given a degree of autonomy to perform various repetitious and monotonous tasks, with the operator being able to intervene when necessary. This class of system is referred to as a semiautonomous control system or an intervention robot system. In these systems, local routes and tasks are planned autonomously using information obtained on the robot, guided by a global route map and global task description provided by the human supervisor.

These systems are most suitable for navigating in unknown and often hazardous environments such as underground mining and exploration in space.

The motivation for this research project is to tackle the issues of semiautonomous telerobotics - communication time delays and sensory feedback; changing and unknown environments; and the assignment and modification of tasks. Task level programming will be attempted [1]. Being a relatively new technology, the World Wide Web and its associated tools (HTML, VRML, Java etc.) provide further research challenges in the area of human-robot interface design.

3: Experimental Setup

The project's development environment consists of the following components:

- ADEPT Robot Work Cell - ADEPT Controller, manipulator arm, manual control pendant, ADEPT vision cameras and ASCII terminal;
- two digital charge couple device cameras;
- two IBM compatible PCs;
- World Wide Web Server;
- TCP/IP compliant network.

Figure 1 illustrates how these components are physically connected.

Figure 1 - Experimental Setup

4: System Design Issues and Requirements

There are several system design issues and requirements that must be investigated during the course of the project:

- the system has no control over network loads and response times;
- the system has no control over the speed of client machines and the type of web browser software loaded on the machines;
- the system has no control over the size of client monitors. Therefore, the interface must be generic to accommodate all monitor sizes;
- the interface must be intuitive so that based on limited instructions, users can start using the system quickly. A difficult to use interface will frustrate users, causing them to move onto other World Wide Web sites.

5: Human-Robot Interface

The philosophy on which the interface is designed is one of a human-centred robot system. The human-centred approach to human-robot interaction is one in which there is a cooperative environment between humans and robots, with robots acting as robotic assistants. For this reason, an electronic storyboard interface was chosen. "Storyboarding is a technique that converts requirements into a system concept, a model of what the system will do when it is programmed" [2]. The layout of the main storyboard menu for this project is presented in Figure 2.

Figure 2 - Main Storyboard Menu

The storyboard provides the following benefits:

- real time group problem solving is supported by the interface;
- the main functions of the system are visible at a glance;
- multiple operations can be performed from the main storyboard by selecting more than one function at a time, and by varying the order of selection;
- the interface makes use of various media, graphical overlays and windowing techniques that act to encourage user interaction and ease of understanding;
- the prototype acts as a model of how the interface will perform once complete, and later it becomes the actual interface.

6: Conclusions and Future Research

The tools available for World Wide Web page development allow for the production of a highly sophisticated telerobotic interface. However, integrating all of the components of the system into a user-friendly, single functioning entity is a non-trivial exercise due to the number of system design issues to be overcome or, at least, catered for.

The aim for this project is to have a working system by the end of 1996. Future research will expand on the basic system to include enhanced sensory feedback for the robot and greater planning and control facilities through the use of artificial intelligence. It is envisaged that this technology will then be ported to other telerobotic applications such as vehicular semiautonomous robots.

References

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- [2] S. J. Andriole, *Storyboard Prototyping for Systems Design: A New Approach to User Requirements Analysis*, QED Information Sciences, Inc., Wellesley, MA, 1989, quoted by S. J. Andriole, L. S. Ehrhart & P. H. Aiken, in 'Storyboard Prototypes for Group Planning & Decision-Making', *IEEE International Conference on Systems, Man and Cybernetics Conference Proceedings*, vol. 1. 1989, pp. 253 - 258.