Robot Task Space Analyzer

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Abstract

Background. Many nuclear projects such as environmental restoration and waste management (ER&WM) challenges involve radiation or other hazards which will necessitate the use of remote operations which protect human workers from dangerous exposures. Remote work is far more costly to execute than what workers could accomplish directly with conventional tools and practices because task operations are slow and tedious due to difficulties of remote manipulation and viewing. Decades of experience within the nuclear remote operations community shows that remote tasks may take hundreds of times longer than hands-on work; even with state of the art force-reflecting manipulators and television viewing, remote task performance execution is five to ten times slower than equivalent direct contact work. Thus the requirement to work remotely is a major cost driver in many projects. Modest improvements in the work efficiency of remote systems can have high payoffs by reducing the completion time for projects. Additional benefits will accrue from improved work quality and enhanced safety.

A promising way to achieve increased remote worksystem efficiency is to layer telerobotic technologies onto teleoperated remote systems. Best available remote worksystems use pure teleoperation in which a single human operator performs all operations through remote control and viewing interfaces. The research being reported here supplements the teleoperation baseline with selective technologies that allow automatic performance of subtasks that are either repetitive, require high precision, or involve extreme patience. Before subtask automation can be exploited, however, it is necessary to explicitly represent the 3-D geometry of the task space scene surrounding the remote worksystem. And since this information is rarely available *a priori*, it must be generated *in situ*, under the supervision of the operator, by perception systems associated with the robot.

Description. The RTSA is a tool for remote equipment operators that combines laser and stereo imaging, human-interactive modeling and semi-automatic object recognition to build a 3-D model of the work zone in which a robot system is operating. This model is accessed by automatic collision checking and motion planning routines so that some aspects of the remote task can be

performed robotically and with fewer demands of human operator. By interweaving automation with teleoperation, overall task execution is faster and less stressful on the operator which ultimately reduces costs.

Robot Task Space Analyzer will provide operators of remote worksystems the complete set of capabilities needed to create task space models for telerobotic control. It will combine scene data acquisition and processing modules, 2-D and 3-D display modules, and interactive analysis capabilities to help the operator build a task space model that is sufficient and appropriate to automate some or all of the tasks at hand for environmental restoration applications such as decontamination and decommissioning, and tank waste remediation. Operationally, *Robot Task Space Analyzer* will be a collection of software processes running on a computer in the operator's console and linked to physical devices on the remote worksystem. It will be organized into modules that provide a full spectrum of options to the operator for the timely development of task space models.

Results. The RTSA project has just begun this September. At this point, the initial work on refining functional and performance requirements has been started. By December, the conceptual design of a fully integrated task space scene analysis capability will be complete. In addition, the hardware and software systems used in earlier DOE feasibility assessments in this area will be recovered and evaluated for application to the project.