Project ID: **55052**

Project Title: **Advanced Sensing and Control Techniques to Facilitate Semi-Autonomous Decommissioning**

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Graduate Students:
The number of graduate students involved in this project to date (excluding any new hires in the remaining funding period) is 14. As of now, 8 MS degrees received or expected; 8 PhD expected. (Numbers do not sum to 14 since 2 are continuing from MS to PhD). Detailed information is available upon request. In addition, we employed one visiting researcher (post doctoral) during the Summer of 1998.

RESEARCH OBJECTIVE

This research is intended to advance the technology of semi-autonomous teleoperated robotics as applied to Decontamination and Decommissioning (D\&D) tasks. Specifically, research leading to a prototype dual-manipulator mobile work cell is underway. This cell is supported and enhanced by computer vision, virtual reality and advanced robotics technology.

RESEARCH PROGRESS AND IMPLICATIONS

This report summarizes work after 2.5 years of a 3-year project. A no-cost extension of the above-referenced project for a period of 12 months has been requested. This will make the revised expiration date of the project 9/00.

Major revisions in the surface characterization algorithms have been required in the

transition from a theoretical technique tested in a carefully controlled laboratory environment to a pre-prototype robotic system. Progress has been delayed somewhat by unanticipated numerical sensitivity in geometry recognition routines, by unanticipated errors in calibration of the robot 3-D environment, and by unanticipated difficulty in extrapolation of observed diffuse lighting. Fitting quadratic NURBS surfaces to highly accurate point estimates of surface geometry now appears to offer a numerically stable procedure for surface estimation, and an iterative approach to radiosity-based rendering is likely to provide the desired accuracy in diffuse lighting estimation.

Currently, the project is at the critical stage where the three subsystems (imaging, VR and robotics) are being integrated and tested.

PLANNED ACTIVITIES

Future research will focus on achieving the originally-stated project goals. This includes the synergistic integration of several emerging technologies. Specifically, we are combining fundamental manipulator control research with visual feedback/virtual reality research and applying the technologies to an industrial PUMA 560 robot manipulator.

The future goals include utilizing the visual feedback information from a camera tool mounted on the end of one manipulator to provide position measurements to the low-level controller of a cooperating manipulator. In addition, through the use of virtual reality technologies, we hope to use the camera information to virtualize the robots' environment to facilitate teleoperation (i.e., for the handling of hazardous payloads, to remove humans from hazardous environments, etc.).

INFORMATION ACCESS

Publications:

N. Costescu, M. Loffler, E. Zergeroglu, and D. Dawson, "QRobot – A Multitasking PC Based Robot Control System", Proc. of the IEEE Conference on Control Applications, Trieste, Italy, Sept., 1998, pp 892-896.

N. Costescu, M. Loffler, E. Zergeroglu, and D. Dawson, "QRobot - A Multitasking PC Based Robot Control System", Microcomputer Applications Journal Special Issue on Robotics, to appear.

Geist, R., Westall, J., Tregila, D., and Smotherman, M., “Real-time, 3-D Graphics for the Linux PC,” Proc. of the 24th Annual Int. Conf. of the Computer Measurement Group (CMG98), Anaheim, California, December, 1998, pp. 863 - 873.

Geist, R., Vernon, D., and Schalkoff, R., “Rendering Inversion in the Automated Construction of Virtual Environments,” Proc. 3rd ASCE Specialty Conf. on Robotics for Challenging Environments (ROBOTICS '98), Albuquerque, New Mexico, April, 1998, pp. 85 - 91.

Geist, R., Schalkoff, R., Stinson, T., and Gurbuz, S., “Autonomous Virtualization of Real Environments for Telepresence Applications,” PRESENCE: Teleoperators and Virtual Environments, 6:6(1997), MIT Press, pp. 645 - 657.

Van Pernis, A., “Surface Construction from within a Virtual Environment,” Proc. 37th Annual ACM Southeast Conf., Mobile, Alabama, April, 1999. NOTE: this was the winning paper in the ACM SE student paper competition.

Web Page(s):

Our web page coverage of this activity has been continually updated as results became available. The URL is **http://ece.clemson.edu/iaal/doeweb/doeweb.htm**.