Collaborative Teleoperation of Manipulation Tasks over the Internet using an Open, Component-based Architecture*

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Abstract

The technological developments in distributed systems have led to new telerobotic applications, such as virtual laboratories and remote maintenance of complex equipment, built on top of Internet and distributed computing system infrastructures. These applications must satisfy both the general requirements of distributed computing, e.g. location transparency and interoperability, and the domain-specific requirements of reconfigurability, guaranteed performance, real-time operation, and cooperation among robots and sensory systems. Moreover, these applications must often support multiple participants, who require not only to monitor the system but also to collaborate and communicate each other to accomplish their goals. While sharing general requirements, software infrastructures for internet-based telerobotic systems – collaborative or not – are often strictly tuned to specific applications, thus preventing reuse of design and coding efforts.

We have developed a CORBA-based software framework for telerobotic applications that takes advantage of Real-Time CORBA features to satisfy

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performance and functional requirements recurring in many telerobotic applications. Several CORBA services are exploited in the framework to enable geographic-scale, secure, and collaborative access for robot teleprogramming. The full portability and object-oriented nature of the framework are among its major virtues, in view of the inherent heterogeneity of telerobotic systems. Capitalizing upon the framework, we have configured and put into operation a telerobotic application including a Puma 560 manipulator along with several cameras and sensory subsystems.

In this paper, we describe experiments in collaborative manipulation tasks over the Internet where several operators can take turns in guiding a robot manipulator or hand over the controlling role to each other. Simple part manipulation and insertion tasks are performed using geographic-scale, Internet-based access to the system, exploiting either a textual interface or a VR dataglove. An arbitration system designed upon the CORBA Concurrency Service enables both collaborative and competing multi-user execution scenarios to be investigated. Limitations and potentials in system usability comparing geographic and local access are also discussed. The prototype described in this paper shows that cost-effective and portable collaborative telerobotic applications can be designed using commercial off-the-shelf components, without compromising system safety and efficiency.