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SIMULATED BILATERAL TELEOPERATION OF ROBONAUT

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ABSTRACT

Robonaut is a humanoid robot designed by the Robotic Systems Technology Branch at NASA's Johnson Space Center in a collaborative effort with DARPA. With dexterous hands and arms, Robonaut is designed to function as an EVA astronaut equivalent. Robosim, a software simulation of Robonaut, is a separate platform for developing and refining telepresence interfaces before use on Robonaut. This research effort succeeded in implementing some limited force feedback to a teleoperator during a simulated handrail grasp task. The necessary architecture for communication between the force feedback hardware, Robosim, and force calculation algorithms was developed and tested. In an experimental study, the effects of varying feedback to a teleoperator during a handrail grasp task were measured. Peak forces between the Robonaut palm and handrails were calculated for three cases: no feedback, visual feedback of collision state, and force feedback of the interaction forces. Visual feedback was the most effective modality for minimizing contact forces in the handrail task. Force feedback was not shown to be any more effective than no feedback for the same task. Recommendations for improvements to the force contact model, experimental methodologies, and system capabilities are discussed at length.

INTRODUCTION

The Dexterous Robotics Lab at NASA JSC has developed a humanoid robot astronaut assistant called Robonaut.[1] Robonaut is intended to be an assistant to astronauts during extra-vehicular activity (EVA) tasks, and is teleoperated by a remote human operator. Robonaut is intended to decrease the number of risks associated with EVA and may improve the quantity of on-orbit experimentation that can be completed by lessening the burden of human astronaut interaction required by a fixed crew size.

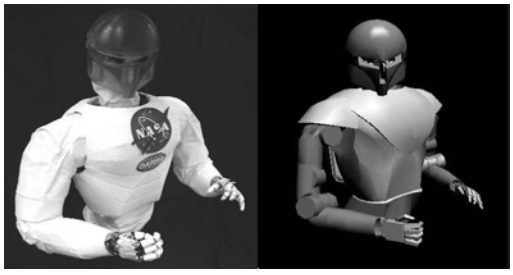

Figure 1. Robonaut and Robosim

One of the primary differences between Robonaut and Robosim, the software equivalent of Robonaut, is the lack of availability of contact force information in the simulated environment. Robonaut and Robosim are pictured side by side in Figure 1. For the experiments described here, simulated contact forces were calculated based on a collision detection and force model algorithm implemented in Visual C++ for the purpose of force

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