Augmented Haptics for Low-Cost Teleoperation

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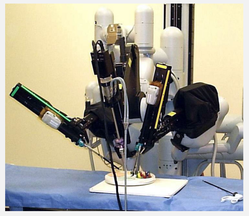
Background

- Teleoperation is often used in medical, space, and defense environments, but has not found wide adoption outside of these fields.



- Low-cost interface devices might enable wider adoption, but these devices are too simple to support complex activities

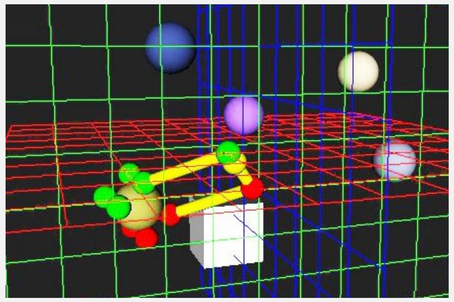
- By adding low cost Force Sensor/Vibrotactile Actuator (FS/VA) modules to simple haptic systems, sophisticated activities such as manufacturing may be supportable.

Research Challenges

- Designing and effective, low-cost module
- Integrating force and motion input with haptic and tactile output
- Determining best configuration of modalities for performance and error reduction.

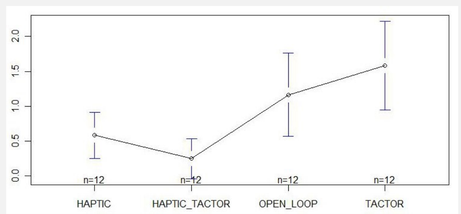
Interface Design

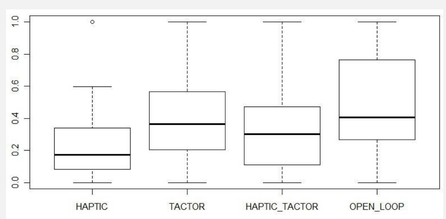
- Developed using force-sensing and audio actuator running custom software to provide the interaction environment.
- Can interact with up to 8 FS/VA units, USB mouse and two Phantom devices.
- After multiple prototypes (hand, mouse, two-finger gripper) a testbed was developed that used one Phantom Omni with two FS/VA units.
- Application runs all interaction combinations (open loop, haptic, tactile, haptic+tactile) in randomized sequences.
- Application records task completion times and errors per task per modality



Initial Results

- Initial study was with 10 total subjects, 8 male and two females, ages 21 to 54
- Task consisted of grasping and placing randomly placed spheres in a goal using a virtual environment.
- Haptic + Vibrotactile provided fewest errors
- Haptic provided fastest performance





Future Work

- Extend initial study with more subjects to determine if preliminary results hold.
- Develop and test use of more sophisticated vibrotactile waveforms for collision, contact, and release.
- Configure a test robotic workcell to evaluate more realistic conditions.