Maglev Haptics: Butterfly Haptic's New User Interface Technology

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1 Introduction

There is an increasing interest in haptic (sense of touch) interaction with computers. A new kind of haptic system has recently been developed at Carnegie Mellon University and commercialized by Butterfly Haptics. The system eliminates the bulky links, cables and general mechanical complexity of other haptic devices on the market today in favor of a single lightweight moving part that floats on magnetic fields.

At the heart of the maglev haptic interface is a bowl-shaped assembly called a flotor that has six embedded coils of wire. Electric current flowing through the coils interacts with powerful permanent magnets, causing the flotor to levitate. A handle is attached to the flotor. A user moves the handle much like a computer mouse, but in three dimensions with six degrees of freedom – up/down, side to side, back/forth, yaw, pitch, and roll. Optical sensors measure the position and orientation of the flotor, and this information is used to control the position and orientation of a 3D virtual object. As this virtual object encounters other virtual surfaces and objects, currents are sent to the flotor's coils, resulting in haptic feedback to the user. The new system provides extremely high performance levels resulting in a very "high fidelity" user experience.

2 Exposition

Several of the new maglev haptic systems at SIGGRAPH 2008 New Tech Demos feature demonstrations of one- and two-handed haptic interaction with simple 3D visual/haptic virtual environments. These include moving a box within a box, moving a probe over sinewave and dithered textures, touching and navigating around a large (70,000 triangle) object, and the enjoyment of a haptic playground populated with balls, cubes, and a teeter-totter.

3 Conclusion

The new systems were developed under NSF Major Research Instrumentation grant EIA-0321057, and represent dramatic improvements and lower costs compared to an earlier prototype system, also developed with NSF funding. Ten of the new systems were produced, with six systems going to leading haptics researchers at Purdue, Harvard, Stanford, Cornell and the universities of Utah and British Columbia. The Magnetic Levitation Haptic Consortium was formed to help foster research and collaboration with this new form of interaction.

Current magnetic levitation haptic research at Carnegie Mellon includes psychophysical studies of hard contact, texture and deformable object perception; teleoperation, micromanipulation of biological materials, and control of a six-legged running robot.

Potential future applications of maglev haptics include character animation, visualization of complex multi-dimensional data sets, virtual surgery and virtual dentistry, computer augmented design, micro- and nano-manipulation, and teleoperation of remote robot arms and vehicles.

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