Magnetic levitation gives computer users sense of touch

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Computers, long used as tools to design and manipulate three-dimensional objects, may soon provide people with a way to sense the texture of those objects or feel how they fit together, thanks to a haptic, or touch-based, interface developed at Carnegie Mellon University.

Unlike most other haptic interfaces that rely on motors and mechanical linkages to provide some sense of touch or force feedback, the device developed by Ralph Hollis, research professor in Carnegie Mellon's Robotics Institute, uses magnetic levitation and a single moving part to give users a highly realistic experience. Users can perceive textures, feel hard contacts and notice even slight changes in position while using an interface that responds rapidly to movements.

"We believe this device provides the most realistic sense of touch of any haptic interface in the world today," said Hollis, whose research group built a working version of the device in 1997. With the help of a $300,000 National Science Foundation grant, however, he and his colleagues have improved its performance, enhanced its ergonomics and lowered its cost. The grant also enabled them to build 10 copies, six of which are being distributed to haptic researchers across the U.S. and Canada.

"We have gone from the prototype to a much more advanced system that other researchers can use," Hollis said. Putting the instrument in the hands of other researchers is critical in a young, developing field such as haptic technology, he emphasized. Though haptic interfaces have uses in engineering design, entertainment, assembly, remote operation of robots, and in medical and dental training, their full potential has yet to be explored. That's particularly the case for magnetic levitation haptic interfaces because so few have been available for use by researchers, he added.

"This is an affordable device that's also practical," said Hollis, who has started a spinoff company to build additional devices. "Now other people can have this technology, and this represents technology transfer in the very real sense."

Six devices will be delivered to researchers at Harvard, Stanford, Purdue and Cornell, as well as to the universities of Utah and British Columbia. All are members of the Magnetic Levitation Haptic Consortium, an international group dedicated to fostering increased use of this technology.

Hong Tan, associate professor of electrical and computer engineering at Purdue University and a consortium member, studies human perception of fine surface textures — work that requires simulation resolution at the micron level. "This is beyond the capability of most commercially available haptic devices, but the maglev device developed by Dr. Hollis will make it possible for us to continue this research," she said.

"The field of haptic research and development is expanding rapidly," said Rob Conway, project manager in Carnegie Mellon's Center for Technology Transfer. "Carnegie Mellon's research opens new possibilities by joining the world of haptic feedback with a comfortable magnetic levitation interface. The magnetic levitation decouples the interface device from the mechanical world, eliminating friction, backlash, jump, sticking and other interfering effects, so that the user feels only the artificial environment in complete accuracy down to the micro scale."

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 device called a flotor that is embedded with six coils of wire. Electric current flowing through the coils interacts with powerful permanent magnets underneath, causing the flotor to levitate. A control 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 virtual object on the computer display. As this virtual object encounters other virtual surfaces and objects, corresponding signals are transmitted to the flotor's electrical coils, resulting in haptic feedback to the user.

Hollis and his colleagues will demonstrate the new maglev haptic interfaces at the IEEE 16th Symposium on Haptic Interfaces for Virtual Environments and Teleoperator Systems, March 13-14 in Reno, Nevada.

More information: www.msl.ri.cmu.edu/projects/haptic_consortium/

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