INL research engineer Corrie Nichol is building a system that lets users feel the same objects as a faraway robot.

Engineer simulates a robot's sense of touch

by Roberta Kwok, *Research Communications Fellow*

Clunk. That's the sensation Corrie Nichol feels against his hand when he moves a video game controller on his desk.

The odd thing? The controller isn't actually touching anything. The clunk is coming from a robotic arm in a glass cube, five feet away, as it bangs on a piece of metal.

Nichol, a research engineer at Idaho National Laboratory, has programmed the arm to transmit tactile sensations, or force feedback, to his game controller. That means that he can "feel" what the robotic arm feels, even though he's not physically touching the same object.

Nichol's project is part of the growing field of haptic technology, or devices that mimic the sense of touch. Using components from industrial robots and video games, Nichol is building a system that puts the user into a robot's body, so to speak, to create a more immersive experience. The technology, funded through INL's Instrumentation, Control and Intelligent Systems Distinctive Signature, could one day allow people to perform dangerous tasks such as bomb disposal or nuclear plant inspection from a remote location.

"There are lots of environments where people can't be present," says Nichol, who has been working on the project for about a year. "You don't want to be a piece of glass away from the bomb you're dealing with."

A sensor transmits force feedback from the tip of the robot's arm to a video game controller held by the user.

Haptic devices already are used in computer games to simulate the recoil of a gun or the smack of a golf ball. In the nonvirtual world, remote surgery systems can deliver tactile feedback from a patient's organs to a doctor at a nearby console.

Nichol assembled a collection of commercial parts to create his own haptic system. First, he hooked up a robotic arm normally used in chemical processing plants to a sensor that detects external force. Next, he connected two video game controllers, each of which had only limited movement, to create a more powerful device that could maneuver freely in three-dimensional space. Finally, he wrote software to translate data between the robotic arm's sensor and the controllers, allowing the user to move the arm and receive force feedback in return.

When the arm hits an object, the sensor electronically relays the amount of force to the controller. The controller then jolts to a stop, giving the user the feeling that he has bumped into something.

Nichol describes his haptics project.

To make the experience even more realistic, Nichol incorporated a visor that receives video footage from a camera above the robotic arm. The user can view the same environment as the robot, and the camera automatically tracks the user's head movements by swivelling back and forth.

"We're trying to immerse the operators in the remote environment, so they can feel as if they're there," Nichol says.

So far, Nichol has used the system to perform simple welding operations. He envisions the technology could one day be mounted on a mobile platform and used for other purposes, such as defusing a bomb or inspecting a nuclear reactor.

While INL operators already use mechanical arms to handle radioactive materials from behind a glass shield, the person is restricted to the same area as the arms. Mobile haptic devices could be deployed to handle hazardous materials in a variety of locations, such as the area near a nuclear reactor's core, while transmitting data wirelessly to an operator in another room or even another building.

Nichol says a fully remote system could be ready in a couple of years, and he hopes to have a stationary prototype with two arms, video and audio

working by the end of 2009. But first, he needs to smooth out a few issues. The prototype controller feels jittery, he says, "like you're being bucked off." That's due to a time delay between the arm and the controller, a common problem in haptic systems which creates a bounce effect. Nichol plans to refine the software so that the movement is more natural.

"It still feels a little wild," he says.

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