Learning Nugget

Educational Haptics

Haptic (force feedback) devices for education have been developed and applied to help students at all levels (from kindergartners to graduate students) understand science and engineering concepts. An intuitive understanding of physical systems is key to the success of many science and engineering students. While the tacit knowledge gained through physical interaction is not easily shared between individuals, it is thought to be valuable for the process of engineering innovation.

A rugged, single-axis force-feedback joystick called the haptic paddle (Figure 2) can be assembled for less than US $30 (assuming some surplus components) and is controllable by a standard personal computer. At Johns Hopkins University, this device has been used to provide engineering undergraduate students in a dynamic systems course with intuition of course concepts. Course evaluations and a systematic, four-year study involving pre- and post-laboratory assessment have revealed a significant contribution of haptics to learning. The haptic paddle design has been used or adapted at over a dozen other universities, and has also been used in graduate education. A course taught at Johns Hopkins University, "Haptic Systems for Teleoperation and Virtual Environments", involves interdisciplinary project teams, typically composed of Biomedical, Electrical, and Mechanical Engineering, as well as Computer Science, students. Many projects are related to robot-assisted surgery and surgical simulation, and approximately 50% of course projects have resulted in published papers that allowed young graduate students to experience international conferences. In September 2006, the IEEE-RAS/IFRR School of Robotics Science on Haptic Interaction (Paris, France) allowed students only 8 hours to develop and execute a hands-on haptics project. Seven teams successfully used haptic paddles in a fast-paced developmental and experimental setting (Figure 1).

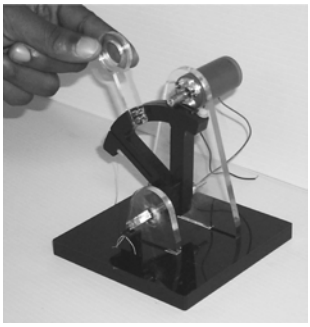

Figure 1

Figure 2

Haptic devices are also excellent mechanisms for encouraging excitement about engineering in K-12 students. Most children are familiar with haptics already, in the form of the "rumble pack", which is a hand-held video game controller that vibrates to reflect certain events in the virtual environment. But it is not until they feel high-fidelity force feedback during simulations of dynamic systems and 3-D shapes that they understand the potential of haptics and gain knowledge about physical principles. Several haptic devices have been used to create a set of demonstrations designed for elementary school students and teachers. In Figure 3, a student uses a haptic device to interact with a virtual ball.

Figure 3

Students are able bounce a ball while the strength of gravity is varied, and feel what it would be like to bounce a ball on Earth, the Moon, or Jupiter.