

CyberSurgeon

Virtual reality surgery: Has the future arrived?

by Karen Sandrick, Chicago, IL

As part of the typical surgical routine, surgeons slap X-ray films, computed tomography slices, and even three-dimensional image reconstructions on light boxes along the walls of the operating room so they can step away from the operating table whenever they need to review where a particular structure lies. Is it just beyond the curve of that vessel, just past that turn in the bone, just behind that bit of tissue?

But what if surgeons didn't have to walk away from the table? What if they could view anatomy in three dimensions through stereo video displays in a pair of goggles much like a pair of bifocals? Better yet, what if they could turn the display in any direction or orientation and look at actual three-dimensional images of anatomy superimposed over the operative field from their particular point of view?

Surgeons then would be able to save considerable amounts of time. They wouldn't have to spend an hour with an ultrasound probe double-checking the position of major vessels during liver resection. They would know exactly where to place their ports while performing living-related donor nephrectomy. They could spot a tumor in the adrenal gland without having to interrupt the operation at critical moments to check anatomic images.

"Surgeons would be able to see much more clearly and do things in more efficient and intelligent ways. Knowing exactly what they were going to find and exactly where they were going in and coming out, they would be better able to make all the small decisions of an operation," says Jonathan Silverstein, MD, FACS, assistant professor of surgery and health care informatics at the University of Illinois at Chicago (UIC).

This is the future of virtual reality surgery as Dr. Silverstein sees it, and it's not that far away. Indeed, some elements of virtual reality surgery already are in place at UIC:

Surgical residents are using virtual reality

technology to study the three-dimensional anatomy of the temporal bone, which often is difficult for students to conceptualize even after reviewing textbooks, illustrations, photographs, or cadaveric sections. With the virtual temporal bone, students can see not only the bone itself, they also can rotate it in different orientations and peel off layer after layer of bony

Tele-immersion technologies

Virtual reality technology is being developed in many clinical and industrial centers throughout the country. The tele-immersion approach, which combines teleconferencing with virtual reality, was invented at the University of Illinois at Chicago Electronic Visualization Laboratory. Researchers there created a portable four-by-six-foot screen called the ImmersaDesk™, which brings computer projections into a viewer's own world. The technology produces stereo vision in a viewer-centered perspective, which means the computer corrects the projected view of a three-dimensional object according to each viewer's position.

While wearing stereo glasses and using a magnetic hand-tracking device, viewers enter a virtual reality environment that surrounds them with three-dimensional, computerized graphics but does not eliminate their real world. Viewers consequently can see their own hands and talk with other people in the same virtual setting.

"It's not the same virtual environment you see in other areas where you walk into a virtual world and your eyes are covered to the real world. This actually combines the two," explained Jonathan Silverstein, MD, FACS, an assistant professor of surgery and health care informatics at UIC.

As a result, "Teleimmersion or augmented reality will give surgeons the ability to superimpose anatomic images right on their patients while they're operating," he said.

tissue to reveal the semicircular canals, carotid arteries, nerves, and other structures.

A computer model of the virtual pelvic floor is providing colorectal surgery residents with a panoramic view of the muscles of the rectum, coccyx, and anal sphincter from below, the lining of the anal canal, and the network of nerves innervating the pelvis. It is also allowing true three-dimen-



Temporal bone image

The image pictured above, which appears in color on the cover of this issue, demonstrates the three-dimensional complexity of the internal anatomy of a right temporal bone from the perspective of a person looking down the external auditory canal. The largest structures shown include the facial and trigeminal nerves in yellow, carotid artery in red, venous sinuses and semicircular canals in blue.

The image was created by a multidisciplinary team working with the Virtual Reality in Medicine Laboratory at the University of Illinois at Chicago. Digitized histologic sections were multiplanar reformatted to obtain voxel data at 0.038mm resolution. Each individual structure was then outlined by illustrators on hundreds of images. Finally the three-dimensional structures were regenerated and rendered. The model is used to teach head and neck surgeons.

—Jonathan Silverstein, MD, FACS

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sional, stereo surgical teleconferencing. In a virtual pelvic floor broadcast from the UIC Virtual Reality in Medicine Laboratory to two other locations, colorectal surgeons in Chicago, IL, and in Washington, DC, could see and discuss the pelvic floor model from their own perspective.

Ophthalmology residents are testing their ability to manipulate surgical instruments to execute interactive cutting, excision, suctioning, and elevation of tissue. They also learn to manage tearing, drainage, and adhesions while repairing retinal detachments on a virtual reality simulator.

Other applications will soon make virtual reality part of everyday patient care, Dr. Silverstein predicts. The virtual reality laboratory at UIC is working with the department of radiology to transfer three-dimensional radiology data sets to a virtual reality stereo environment for conducting presurgical planning. In a demonstration at the College's 1999 Clinical Congress, Dr. Silverstein's team showed that CT or magnetic resonance imaging data could be manipulated interactively in an immersive environment, instantaneously transforming the view of the data. Features demonstrated included windowing the data from bone to soft tissue and exposing internal structure through the use of cutting planes. With these techniques, the team could identify vessels surrounding a tumor and plot an unobstructed path to the surgical target past vital areas.

In about a year, Dr. Silverstein and his colleagues may start bringing virtual reality into the operating room—at least as a prototype. By then, current large-scale computerized stereo displays may become part of a network that links high-performance computing power with more manageable display units in an operating room; or the displays may be condensed into smaller devices that will not clutter an already crowded surgical suite. These networks and devices are being built in various sites around the country, and when they are integrated into clinical practice, they will add tremendous value and use, Dr. Silverstein says.

Virtual reality simulations will become a standard part of a surgeon's ongoing training, he pre-

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AWS issues call for grant applications

The Association of Women Surgeons (AWS) Foundation and Ethicon Endo-Surgery are accepting applications for a \$25,000 research grant for the year 2002.

Preference will be given to research topics in the following

two areas: minimal access approaches to treatment and/or diagnosis of cancer, bariatrics, and breast disease, as well as wound healing. Studies may be either clinical (human) or pre-clinical (animal/bench).

The grant will be awarded in

July 2001 for research to be conducted during the following 12 months.

The deadline for submission of grant applications is March 30, 2001. For more information and an application form, visit <http://www.womensurgeons.org>.

Surgical Research Clearinghouse available online

The Surgical Research Clearinghouse continues to be available online through the College's Web site (www.facs.org). The clearinghouse is a listing of research scholarships, fellowships, and awards that are available

from various surgical specialty societies. The names of current recipients of some of the awards are included. The clearinghouse link is located near the bottom of the ACS home page.

Societies seeking to publicize

their scholarships may contact Jan Fair, Surgical Education and Research Dept., American College of Surgeons, 633 N. Saint Clair St., Chicago, IL 60611-3211; tel. 312/202-5354, e-mail jfair@facs.org.

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dicted. While virtual reality will not replace current hands-on teaching about new surgical procedures, it will give surgeons a chance to learn complex anatomy inside-out and gain extra practice before their first patient is scheduled. "It will give them the time to do an advanced procedure in a completely free environment," Dr. Silverstein says.

The technology also will test surgical skills. The UIC virtual surgery laboratory is exploring the possibility of developing reliable simulation models for evaluating whether surgeons perform the steps of a procedure in the right order and in an appropriate length of time. Models one day may include challenging clinical scenarios that test whether surgeons choose the right surgical approach to a problem or adapt to changing patient dynamics.

Pretreatment planning will take virtual reality

simulations to a different plane. "It will allow us to create a distributed, collaborative environment to look at and manipulate radiologic data. It will simulate standing at this spot, looking at this patient, right under these vessels and seeing what the anatomy looks like around there," Dr. Silverstein explains.

Virtual reality in the operating room will augment the limited visualization surgeons have with minimally invasive techniques by providing patient-derived data to surgeons by means of a pair of glasses that project anatomical images to a tiny triangular space in each lens. "This will have tremendous impact on the crowded operating room by bringing all those monitors and screens down to where they belong—in front of the surgeons' eyes—without blocking the rest of their view," Dr. Silverstein says. 