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NEWS

RSNA Press Release

Image-guided Suite of the Future Brings Precision to Minimally Invasive Procedures

Released: June 19, 2003

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At A Glance

- A robot prototype will be assisting National Institutes of Health doctors with positioning needles starting in September.
- Mini-GPS can track catheters, needles and guidewires making their way through the body, and map out the optimal course.
- Image fusion, 3-D images and virtual reality-like headsets and goggles will provide real-time imaging of patients.

NEW YORK - Minimally invasive treatment of disease, a revolutionary alternative to larger surgical incisions and longer recovery times, is undergoing its own transformation. Interventional radiologists are fusing imaging technologies with the accuracy of robots and automated instruments to help physicians target cancerous tumors and diseases with exquisite precision.

Three major categories of technology are at the forefront: robotics, global positioning systems (GPS) and next-generation image displays, such as imaging fusion, 3-D imaging and virtual reality devices known as "augmented reality."

"Many of these technologies have already been used in medicine, but their integration with imaging technology in the therapeutic realm is new," said Brad Wood, M.D., an interventional radiologist in the imaging sciences program at the National Institutes of Health (NIH) Clinical Center in Bethesda, Md.

Dr. Wood described the image-guided suite of the future today at a Radiological Society of North America media briefing on image-guided therapies.

In treating serious illnesses such as cancer, precision is key, according to Dr. Wood. A fraction of a millimeter can determine whether a tumor grows back or disappears. Despite forward strides, minimally invasive procedures still involve some estimating, even those performed by the most experienced clinicians, Dr. Wood said. Computed tomography (CT), positron emission tomography (PET) and magnetic resonance (MR) imaging offer detailed information, but physicians still count on their clinical experience to actually reach a target.

"The 'multi-modality' suite of the future will eliminate much of the guesswork, reduce the risk of human error, and even minimize the impact of variations in physicians' clinical abilities by standardizing many procedures," Dr. Wood said. "These advances will improve success rates and patient outcomes and help facilitate emerging new procedures."

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Beyond its precision, the promise of the image-guided suite also lies in its cost-effectiveness and potential for use by community hospitals.

"The suite of the future will rely on relatively inexpensive, accessible modalities, such as CT and ultrasound," Dr. Wood said. "These technologies will allow physicians to treat more patients in their hospitals rather than having to send them to larger medical centers."

Robotics

Robots assist in everything from heart surgery to hip replacement, and now at the NIH Clinical Center, interventional radiologists and biomedical engineers have developed one of the first systems to seamlessly integrate robotics with imaging technology.

On its first attempt, the robot prototype quickly made contact with a BB buried deep in a model of the human body and later scored more precisely than the physician in a study on needle placement accuracy for tumor destruction. The system is scheduled for use on patients at the NIH Clinical Center beginning in September, initially to help with needle positioning.

"Physicians will insert the needle themselves, at first, but the device will eliminate the guesswork of deciding where the needle should go," Dr. Wood said.

Ultimately, physicians will view a CT scan on a computer screen, click on a tumor and instruct the robot to calculate the ideal angle and depth of needle entry and to insert the needle. The physician will then deliver the appropriate dose of radiofrequency energy or heat to destroy the tumor.

GPS-guided therapy

The principles of global positioning systems (GPS) used by the military and auto industry, where information from satellites helps to locate, track and direct actions on the ground, is being adapted for minimally invasive interventional treatments.

CT and ultrasound scans provide the information to locate, track and direct a needle or guidewire bearing an electromagnetic sensor. The instruments are inside a catheter that has been inserted into the patient. The positioning system will map the ideal route to the target and provide real-time CT or ultrasound displays of the sensor's position in relation to the target. The system's precision and real-time feedback will reduce the risk of damage to surrounding tissue and critical structures. This mini-GPS will also be used to fuse regular x-rays to CT scans for improvements to image-guided therapies like angiography, stenting, angioplasty and embolization.

Eventually, physicians will also use this technology to deliver "designer nanoparticles," such as proteins, gene therapy, chemotherapy, antibodies and other cargo that have been specifically designed to target a patient's tumor or a specific organ, and spare damage to non-cancerous tissue, according to Dr. Wood. Such molecular-based targeted therapeutics will rely upon advanced navigation systems like the mini-GPS for local or regional delivery to the targeted area.

Image display

Augmented reality will expand what doctors are able to see with the naked eye. Augmented

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reality devices, such as headsets with special goggles similar to virtual reality devices, will superimpose three-dimensional, computer-generated images of anatomy onto the patient during therapy. Augmented reality technology will show physicians where a needle or other instrument needs to go and supply real-time information about the areas they have reached, or missed.

Additionally, image-fusion technology links PET and CT, two cornerstones of contemporary imaging, and brings PET into the treatment area for the first time. Combining the structural information of CT with the metabolic information of PET provides updated, fused images during treatment. The fused images take advantage of each imaging technique by highlighting treated versus untreated regions and areas of malignancy.

Another method highlighting treated and untreated areas during therapy will be computer-generated, 3-D CT images of organs or other anatomy. These images will be displayed on an orb or globe so the physician can look over and around them, instead of looking on an x-ray or wall, or rotating them on a screen with a mouse.

"Three-dimensional displays generated by CT scans to plan treatment are not new, but they have never been used to provide an ongoing source of information during these procedures," Dr. Wood said.

He said while some components of the image-guided suite of the future have already been used in treatment, including real-time imaging fusion, others have yet to be applied to patients, but hold enormous potential. "We are excited to see significant improvements as these methods come into clinical use," he said.

The RSNA is an association of more than 33,000 radiologists, radiation oncologists and related scientists committed to promoting excellence through education and by fostering research, with the ultimate goal of improving patient care. The Society's headquarters are located at 820 Jorie Blvd., Oak Brook, Ill. 60523-2251. (http://www.rsna.org)

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The National Institutes of Health is an agency of the United States Department of Health and Human Services.

Disclosure: Dr. Wood holds a provisional patent on magnetic tracking for tumor ablation and needle placement.

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