Cell Phone Technology May Speed Up CT Scanning

UTILIZING the same multiplexing technology used in cell phone networks and other telecommunication systems, researchers at the University of North Carolina (UNC) at Chapel Hill are on their way to developing dramatically faster CT scanners.

Multiplexing—whereby multiple signals are combined into a single composite signal and then transmitted—allows cell networks and computer modems to operate at high speeds. In CT, multiplexing can instantaneously merge signals from 10 to 1,000 separate X-ray sources. Currently, one X-ray source is moved quickly around the patient and data are slowly collected in a serial or "single-file" manner.

Leading the UNC research team is Jian Zhang, Ph.D., of the Department of Radiation Oncology. Dr. Zhang explained that the research is really moving forward on two fronts: scanning and transmission. The first step is to develop CT scanners that simultaneously use up to 1,000 stationary X-ray pixels. Multiplexing will then be employed to quickly transmit the data.

The theory is that 1,000-view CT scanning could be 500 times faster, said Dr. Zhang. The researchers' ultimate goal is a multiplexed 1,000-pixel CT scanner that provides images clear enough for clinical use, but, he said, getting there "is going to take a while and take some considerable effort."

Breast Tomosynthesis is Focus

In the meantime, the UNC team is also working with the National Cancer Institute to develop a limited-angle, stationary CT scanner for use in 3D breast tomosynthesis. That scanner would only require 25 to 50 pixels and data would first be collected in the traditional sequential manner, rather than using multiplexing. "It's a little bit easier for us to create the system for tomosynthesis applications," said Dr. Zhang. "We're actually pretty close to that."

There are still hurdles to overcome, however. The first and most obvious, said Dr. Zhang, is working out the balance between speed and image quality. He pointed out that each time the number of X-ray sources is increased, the scattering effect of the rays also increases. His team is currently working with a 25-pixel prototype to study the scattering effect.

One of Dr. Zhang's colleagues on the project is Otto Zhou, Ph.D., a professor of materials sciences and physics and a member of UNC's Lineberger Comprehensive Cancer Center. "The other challenge is that once you have this multipixel X-ray source, are you going to do multiplexing imaging or sequential imaging, and what are the tradeoffs in multiplexing between imaging speed and the imaging quality?" asked Dr. Zhou. "What is the signal-to-noise ratio? At this point there's no clear answer to that—it's one of the things we want to find out with this project."

> *The reason we can do multipixel scanning where traditional technology cannot is nanotechnology.*
>
> **Otto Zhou, Ph.D.**

Dr. Zhou explained that when it comes to achieving a clear image, "It really depends on the reference point. The goal of this research is to provide a realistic comparison between the traditional method of doing breast tomosynthesis and the use of our process." He added that with their 25-pixel tomosynthesis scanner, "We're hoping to increase the scan speed by a factor of 10." Dr. Zhou is hopeful that such multipixel tomosynthesis scanners could be in clinical use in the near future. "I'm always optimistic, so I'd say less than five years," he said.

New Electron Source Identified

One of the biggest hurdles for multiple-source X-ray technology was the heat created by X-ray sources that use a metal filament to generate electrons. The need for insulation surrounding these high-heat sources also makes the machinery bulky. Therefore, the notion of multiplying those traditional electron sources by 1,000 made multipixel scanning seem impossible.

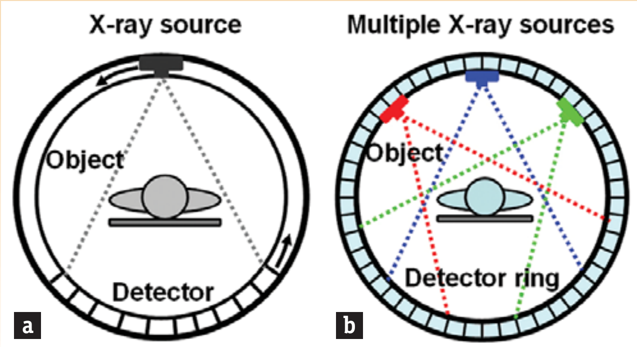
When they began their research eight years ago, the first thing Drs. Zhang and Zhou focused on was using carbon nanotubes as an electron source. As Dr. Zhang explained, nanotubes do not have to be heated in order to pull out an electron. Dr. Zhou added, "the reason we can do multipixel scanning where traditional technology cannot is nanotechnology." They spent more than five years developing a carbon-nanotube-based device, but it was only in the last two to three years that they started looking at multipixel capabilities and multiplexing, explained Dr. Zhou.

Noting there are different ways to do multiplexing, Dr. Zhang said binary multiplexing is the most efficient way to encode the X-ray beam. He has some preliminary results on binary multiplexing and said he hopes to publish his findings soon.

Today Drs. Zhang and Zhou work with a fairly large and diverse group of researchers. "We have about 20 to 30 people from different backgrounds, including engineering, physics, medicine, radiology and oncology," said Dr. Zhou. "There's certainly a high level of interest from different corners of the imaging community."

One area that may benefit from the research sooner rather than later is airport security scanning, where speed is definitely desired but imaging standards are not as high as in medical use.

The team's first prototype, developed in 2005, used five pixels. Now they are using a 25-pixel prototype and a 100-pixel scanner is in the works. Building the hardware presents some engineering challenges, said Dr. Zhou, adding, however, "We're making a lot of progress and there are now commercial vendors working together with us. We hope that a lot of these issues will be solved in the near future."



How Multiplexing Works

(a) Configuration of a conventional CT scanner. *(b)* The multiplexing CT scanner enables simultaneous collection of multiple images due to the multiplexing principle.

Courtesy of Jian Zhang, Ph.D., University of North Carolina at Chapel Hill, et. al.

As for the 1,000-pixel scanner, that remains a bit further out. "It's going to be a long way to go, probably 10 years or even longer," said Dr. Zhang when asked about the possibility of a multiplexing CT scanner for clinical radiology use.

Still, both professors were confident there will be more immediate uses for their research. "Obviously a multi-pixel X-ray is very useful and can be applied in different areas," said Dr. Zhou.

Learn More

- The abstract for "Multiplexing Radiography for Ultra-Fast Computed Tomography: A Feasibility Study" is available online at *www.aapm.org/meetings/amos2/pdf/29-7279-59073-381.pdf.*

iPhone™ is Next Step in Remote Reading Revolution

While engineers focus on improving radiology practice by taking advantage of cell phone transmission technology, radiologists are seizing the opportunities offered by the latest generation of handset, the Apple iPhone™.

Whereas other phones' browsers often rearrange Web pages to adjust to a smaller interface, the iPhone's display is more like that of a small laptop, allowing users to view content much like they would on a desktop computer using Safari, the Web browser developed by Apple. The iPhone's 3½ inch screen displays images with a resolution of 480 x 320 pixels—good by mobile phone standards, but not quite the 512 x 512 matrix required for CT studies.

The advent of the iPhone has had medical software companies scrambling to boast iPhone compatibility, appealing to consumers with scenarios in which a physician swiftly attends to a patient's emergency situation from a table in a restaurant or a lounge chair on the beach.

For example, the Mac-based WebPAX VS, developed by Durham, N.C.-based Heart Imaging Technologies (HeartIT), is an iPhone-compatible secure remote picture archiving and communication (PACS) system that converts MR and CT images into animated GIF files that display simultaneously with the patient's heart rate. A sample on HeartIT's Web site features detailed miniature movies of a beating heart from 12 angles. Using WebPAX, a physician with access privileges can click on a Web link sent via e-mail by a colleague, enter a password and view images on the iPhone. The iPhone also allows for putting the colleague on speakerphone and conducting a medical consultation while viewing the images.

Physicians can also use iPhone with programs like Life Record™, a Web-based application that enables viewing of updated patient records, including recorded images, and even writing and transferring of prescriptions online. Representatives from the Bloomfield, N.M.-based company posted a video of how it works on YouTube.

Ever since they discovered in 2004 that the extensive storage space offered by the iPod® could be used to transport medical images, radiologists have awaited new developments and, specifically, technology practical enough to use in real-life situations on a regular basis. (See *RSNA News,* December 2004)

Courtesy of Apple

Eliot L. Siegel, M.D., of RSNA's Radiology Informatics Committee, said he has high hopes for the iPhone's multi-touch interface, which he said is "intuitive and offers intriguing possibilities for navigation and display of images and related patient information." He said he hopes that other displays and devices will offer this feature.

Dr. Siegel said that he hopes the iPhone will evolve into a device that takes advantage of a faster Internet connection, has improved battery life over its current five hours for talk/video/Web browsing and utilizes an open system that will support downloading of applications directly to the phone without the need to run them on Safari.