New method of using nanotube x-rays creates CT images faster than traditional scanners

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Scientists at the University of North Carolina at Chapel Hill have developed a new method to create computed tomography (CT) images using carbon nanotube x-rays that works much faster than traditional scanners and uses less peak power.

The work is another step toward developing scanners for medical imaging and homeland security that are smaller, faster, and less expensive to operate, said Dr. Otto Zhou, Lyle Jones Distinguished Professor of Materials Science, in the curriculum in applied and materials sciences and the department of physics and astronomy, both in UNC's College of Arts and Sciences.

"The current CT scanners take images sequentially, which is slow and inefficient. Using the nanotube x-ray technology, we show in this paper the feasibility of multiplexing - taking multiple images at the same time," Zhou said.

Carbon nanotubes, made of layers of carbon atoms, can be as small as one nanometer - one billionth of a meter - in diameter. The UNC team uses them in this work because they can emit electrons without high heat.

The new development is published in the current edition of the journal *Applied Physics Letters*. The lead author of the paper is Dr. Jian Zhang, a postdoctoral research associate in the UNC School of Medicine's department of radiation oncology. In addition to Zhou, other authors - all

from UNC - are Dr. Sha Chang, associate professor of radiation oncology; doctoral candidate Guan Yang and Dr. Jianping Lu, professor of condensed matter physics, both of the department of physics and astronomy; and Dr. Yueh Lee, an intern at the medical school and an adjunct assistant professor in physics and astronomy.

Traditional CT scanners use a single x-ray source that takes approximately 1,000 images from multiple angles by mechanically rotating either the x-ray source or the object being scanned at high speed.

In 2005, Zhou and colleagues created a scanner with multiple x-ray sources, called a multipixel scanner. The machine required no mechanical motion but switched rapidly among many x-ray sources, each taking an image of the object from a different angle in fast succession.

The team's newest innovation combines this multiple-x-ray-source innovation with a principle called multiplexing, in which all the x-ray sources are turned on simultaneously to capture images from multiple views at the same time.

"Let's take a simple case where suppose you need 10 images," Zhou said. "Let's say each view take one second. In the conventional step-and-shoot method used for the current CT scanners, you take one shot, and the first pixel stays on for one second. Then we turn on the second pixel, and that stays on for one second." The whole process would take 10 seconds.

"With multiplexing, we can have all the x-ray pixels on at the same time for maybe 2 seconds. You still get all the images, only faster, and we need only about half of the original x-ray peak power," Zhou said.

Multiplexing is a known concept used by, for instance, cellular phones.

Millions of cell phone signals travel along the same frequency band, then are separated into coherent messages at their destinations.

"What makes the multiplexing CT scanning possible is the novel multi-pixel x-ray source we developed and the ability to program each x-ray pixel electronically," Zhou said.

In this study, Zhou and colleagues took images of a computer circuit board using a prototype multiplexing scanner, then compared the images to those generated by a traditional x-ray scanner. The images showed little difference in resolution or clarity, but the prototype multiplexing scanner got the job done faster.

"For this paper we built a prototype or demonstration scanner that gives a limited number of views, to image a simple object," Zhou said. "Our next step is to develop a small CT scanner for small animal imaging."

Source: University of North Carolina at Chapel Hill