3D breakthrough with updatable holographic displays

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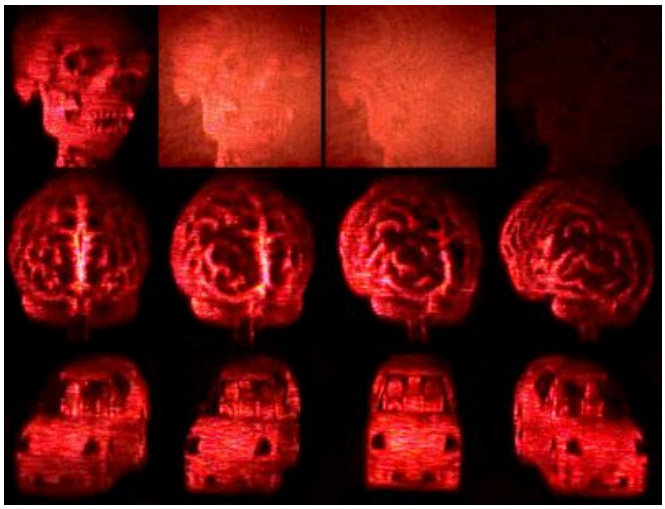

Top row: Erasing of the hologram; Mid and bottom rows: 3D images shown from different angles, demonstrating horizontal parallax. Credit: UA

University of Arizona optical scientists have broken a technological barrier by making three-dimensional holographic displays that can be erased and rewritten in a matter of minutes.

The holographic displays – which are viewed without special eyewear – are the first updatable three-dimensional displays with memory ever to be developed, making them ideal tools for medical, industrial and military applications that require "situational awareness."

"This is a new type of device, nothing like the tiny hologram of a dove on your credit card," UA optical sciences professor Nasser Peyghambarian said. "The hologram on your credit card is printed permanently. You cannot erase the image and replace it with an entirely new three-dimensional picture."

Watch Holographic Display Video: Mp4 (9Mb)

"Holography has been around for decades, but holographic displays are really one of the first practical applications of the technique," UA optical scientist Savas Tay said.

Dynamic hologram displays could be made into devices that help surgeons track progress during lengthy and complex brain surgeries, show airline or fighter pilots any hazards within their entire surrounding airspace, or give emergency response teams nearly real-time views of fast-changing flood situations or traffic problems, for example.

And no one yet knows where the advertising and entertainment industries will go with possible applications, Peyghambarian said. "Imagine that when you walk into the supermarket or department store, you could see a large, dynamic, three-dimensional product display," he said.

Tay, Peyghambarian, their colleagues from the UA College of Optical Sciences and collaborators from Nitto Denko Technical Corp., of Oceanside, Calif., report on the research in the Feb. 7 issue of the journal Nature.

Their device basically consists of a special plastic film sandwiched between two pieces of glass, each coated with a transparent electrode. The images are "written" into the light-sensitive plastic, called a photorefractive polymer, using laser beams and an externally applied electric field. The scientists take pictures of an object or scene from many two-dimensional perspectives as they scan their object, and the holographic display assembles the two-dimensional perspectives into a three-dimensional picture.

The Air Force Office of Scientific Research, which has funded Peyghambarian's team to develop updatable holographic displays, has used holographic displays in the past. But those displays have been static. They did not allow erasing and updating of the images. The new holographic

display can show a new image every few minutes.

The 4-inch-by-4-inch prototype display that Peyghambarian, Tay and their colleagues created now comes only in red, but the researchers believe much larger displays in full color could be developed. They next will make 1-foot-by-1-foot displays, then 3-foot-by-3-foot displays.

"We use highly efficient, low-cost recording materials capable of very large sizes, which is very important for life-size, realistic 3-D displays," Peyghambarian said. "We can record complete scenes or objects within three minutes and can store them for three hours."

The researchers also are working to write images even faster using pulsed lasers.

"If you can write faster with a pulsed laser, then you can write larger holograms in the same amount of time it now takes to write smaller ones," Tay said. "We envision this to be a life-size hologram. We could, for example, display an image of a whole human that would be the same size as the actual person."

Tay emphasized how important updatable holographic displays could be for medicine.

"Three-dimensional imaging techniques are already commonly used in medicine, for example, in MRI (magnetic resonance imaging) or CT scan (computerized tomography) techniques," Tay said. "However, the huge amount of data that is created in three dimensions is still being displayed on two-dimensional devices, either on a computer screen or on a piece of paper. A great amount of data is lost by displaying it this way. So I think when we develop larger, full-color 3-D holograms, every hospital in the world will want one."

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