Technology Review
PUBLISHED BY MIT

Tuesday, April 24, 2007

Practical Holographic Video

Researchers have designed a cheap and small holography system that will work with PCs and gaming consoles.

By Kate Greene

The tyranny of two-dimensional computer and TV displays could soon be over. A team of MIT researchers has proposed a way to make a holographic video system that works with computer hardware for consumers, such as PCs with graphics cards and gaming consoles. The display, the researchers say, will be small enough to add to an entertainment center, provide resolution as good as a standard analog television, and cost only a couple hundred dollars.

A holographic video display could provide another way to view medical images such as MRIs and CT scans, as well as sets of complex, multidimensional data and designs for furniture and cars, says V. Michael Bove Jr., director of the consumer electronics program, CELab, at MIT. And the system would be a natural fit for displaying video games and virtual worlds. Most games now have sophisticated three-dimensional models sitting deep within their software, "but you don't see them because [the images are] rendered as a two-dimensional picture," Bove says.

The new system, called Mark III, is the third generation (following Mark I and Mark II) of MIT-designed holographic video displays that date back to the late 1980s. These earlier systems were "loud, finicky, required specialized computing hardware to generate a video signal, and were a general pain in the neck to work with," says Bove. A few years ago, he wondered if he could turn a laboratory-based holographic display system that cost tens of thousands of dollars into an affordable consumer product.

Thus, Bove and his team have developed Mark III--expected to be completed within a couple of months--which is based on the earlier systems but has three major differences. First, explains Bove, the new system processes three-dimensional images on a standard graphics processor rather than on specialized hardware. It turns out, he says, that the graphics cards that are found in high-end PCs and gaming consoles are a good fit for the type of image processing required to create a hologram. Second, his team has redesigned a gadget called an acousto-optic modulator, commonly found in telecommunications systems, to direct light from lasers to form the hologram. The new modulator has a higher bandwidth, which makes for a high-resolution hologram, and is less expensive than the ones used in Mark II. Third, the researchers have eliminated some of the clunky optical components that made the Marks I and II as large as a dining-room table.

To create a holographic video, Bove says, software produces a real-time, three-dimensional model of the objects within a scene. So, for an MRI of a beating heart, the software uses a collection of numbers that describe the position of all points on the surface of the heart, in all three dimensions. With such a model in place, software calculates how lasers need to project the light to create a hologram. In essence, the software creates a blueprint for the lasers to follow that consists of the basis of all holograms: a diffraction pattern, which occurs when light waves interfere with one another.

For a hologram consisting of a single color, only one diffraction pattern is calculated, Bove says, but to create a full-color image, three different patterns need to be created, one for each of the additive primary colors: red, blue, and green. The computation consists of rendering a three-dimensional model, generating the diffraction patterns, and producing a video signal, all of which can be done using off-the-shelf hardware.

Then, Bove says, the holographic video signal is sent into a light modulator, which consists of a waveguide--made of a material called lithium niobate--where light travels, covered by a piezoelectric material that converts the video signal into vibrations. The video signal changes the shape of the piezoelectric material, which changes the properties of the light moving through the waveguide. The emitted light wave is thus composed of various intensities and frequencies that, when projected onto a foggy piece of glass, recreate a three-dimensional scene. Because this novel modulator can emit light in the vertical direction as well as in the horizontal direction, it can also help eliminate some mirrors and lenses that made previous generations of displays bulky.

While the project is in its final stages of completion, it has the potential to help make holographic video more accessible. "I'm entranced by the possibilities that [the researchers] show," says Harold Garner, professor of biochemistry and internal medicine at the University of Texas Southwestern Medical Center at Dallas. Garner has developed a holographic system for looking specifically at medical images such as MRIs. "I really look forward to a real device demonstration."

While his expertise is in holographic images for medicine, Garner believes that people will start to demand more than just high-definition displays from their televisions and computer monitors, and will eventually want three-dimensional videos as well. "It's only a matter of time," he says. But what makes it challenging, Garner adds, is that consumers demand bigger and brighter images, and researchers are a long way from delivering 60-inch, high-definition holograms. Because of consumer tastes, "you may have to pick and choose" the commercial applications for this technology, Garner says.

Bove and his team currently have a fourth generation of system lined up, which will be able to display an image as large as a desktop PC monitor; in contrast, the current system's displays are only about the size of a Rubik's Cube. Also, the current display is only capable of monochromatic holograms, but the fourth generation will have a full range of colors, Bove says.