Lighting-Sensitive Displays Re-Create Setting

Because computer displays cannot respond to a wide spectrum of lighting conditions, their images tend to be flat and unrelated to their surroundings. Researchers have countered this with an innovative technology called lighting-sensitive displays. The method accounts for the illumination field surrounding the display, making virtual objects appear as if they were in the viewer's setting.

"In general, we were thinking that displays put out light, so it makes sense that they should measure light," said Shree K. Nayar of Columbia University's Computer Vision Laboratory, who developed the system with Peter Belhumeur of Yale University in New Haven, Conn., and Terry Boult of Lehigh University in Bethlehem, Pa. Their goal was to make reactive, intelligent displays that present content appropriate to the lighting conditions of the space where it is viewed. For instance, if you were buying furniture or fabric over the Internet, a laptop with a reactive display could show you what it would look like in your home by producing similar shadings and highlights appropriate to ambient conditions.

The developers have discovered a few ways to achieve this high degree of photorealism. The first method is called image-based rendering. In a still-life setting, 2000 images are collected off-line from different angles and with varying types of illumination. The images are heavily compressed into an 8-MB file. A camera on the display monitor senses actual illumination and compares it with the stored images to produce one that is appropriate for that lighting environment.

Another scenario involves a classic computer-rendering technique. Material properties, such as the brushstrokes of a painting or the reflective properties of the paint, are assigned to a three-dimensional model of a scene, and the computer program makes a ray tracing.

A tiny CCD camera with a hemispherical field of view is attached to the top of a computer monitor. The embedded camera provides a fish-eye view of the room so that it measures light from the ceiling and table lamps, as well as any light filtering in through the windows. When measuring illumination, you don't need very high precision, Nayar said. A low-resolution, full-video camera is adequate for the application because it measures only the direction of the light.

Another way to detect illumination and apply its effects to the images on the screen would be to embed sensing pixels among the emitting pixels of the display itself, which could take accurate measurements. Nayar and his collaborators are looking into this possibility. □

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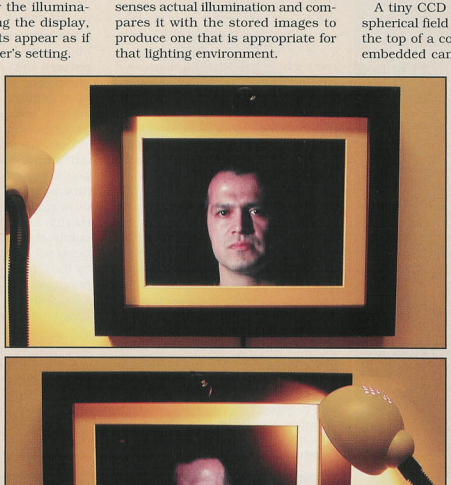

Lighting-sensitive display technology measures real-time illumination and produces images consistent with the viewer's environment. In the top photo, the human face appears to be lit by the table lamp to the left of the display. When the lamp is moved to the right, the highlights and shadows change correspondingly.

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