Picturing the World in New Ways

SHREE K. NAYAR

T. C. Chang Professor of Computer Science

Professor Shree K. Nayar's work is all about seeing things differently. "The basic principles of photography have remained unchanged since the earliest camera obscura," Nayar explained. "Cameras use an aperture to capture light, a lens to focus it, and some medium to capture the familiar linear perspective image. In the 1990's, I started asking whether we could use new optics and a computational processing to produce new types of images."

One of Nayar's first inventions was the Omnicam. Its combination of lenses and mirrors captures panoramic 360 degree images in a single click. "The image is distorted, since you can't map a sphere to a flat surface without distortion, but we corrected that with mapping software. In fact, a single 360 degree image could be used to generate any number of traditional views of the scene.

"Placed in the middle of a table of people, it gives the illusion of multiple cameras pointed at individuals during a video conference, although it is one camera with no moving parts," Nayar said. The camera is also used for surveillance.

Nayar's next invention, a high dynamic range camera, takes better photographs of scenes that mix dark and light areas. "Let's say you try to take a picture of a scene with shadows and a bright sky. Today's digital cameras cannot reveal details within the shadows and the sky. If the sky comes out well, the shadows do not, and vice-versa," Nayar said.

Nayar's solution is to use an image sensor with a patterned optical mask on it. The mask ensures that neighboring pixels on the sensor have different sensitivities to light. His software decodes the captured photo to produce one that captures the shaded clouds in the sky and the objects in the shadows. Sony has prototyped the technology for use in its digital cameras.

A third camera enables photographers focus on close-up details without blurring background features. Nayar does this by physically sweeping the image sensor of the camera through an entire focal range, during the exposure of a single photo. The captured photo is again processed by software to obtain one where everything appears in focus.

Nayar has also launched a project to help children around the world learn science, art and culture by assembling and using a digital camera. His Bigshot Camera has panoramic and stereo imaging capabilities, and makes it easy to post photos on the Web.

"Each picture is a window on another culture, and youngsters can learn about those cultures from their peers," he said. To Nayar, it is just another way of seeing things differently.

B.S., Birla Institute of Technology (India), 1984; M.S., North Carolina State, 1986; Ph.D., Carnegie Mellon University, 1990