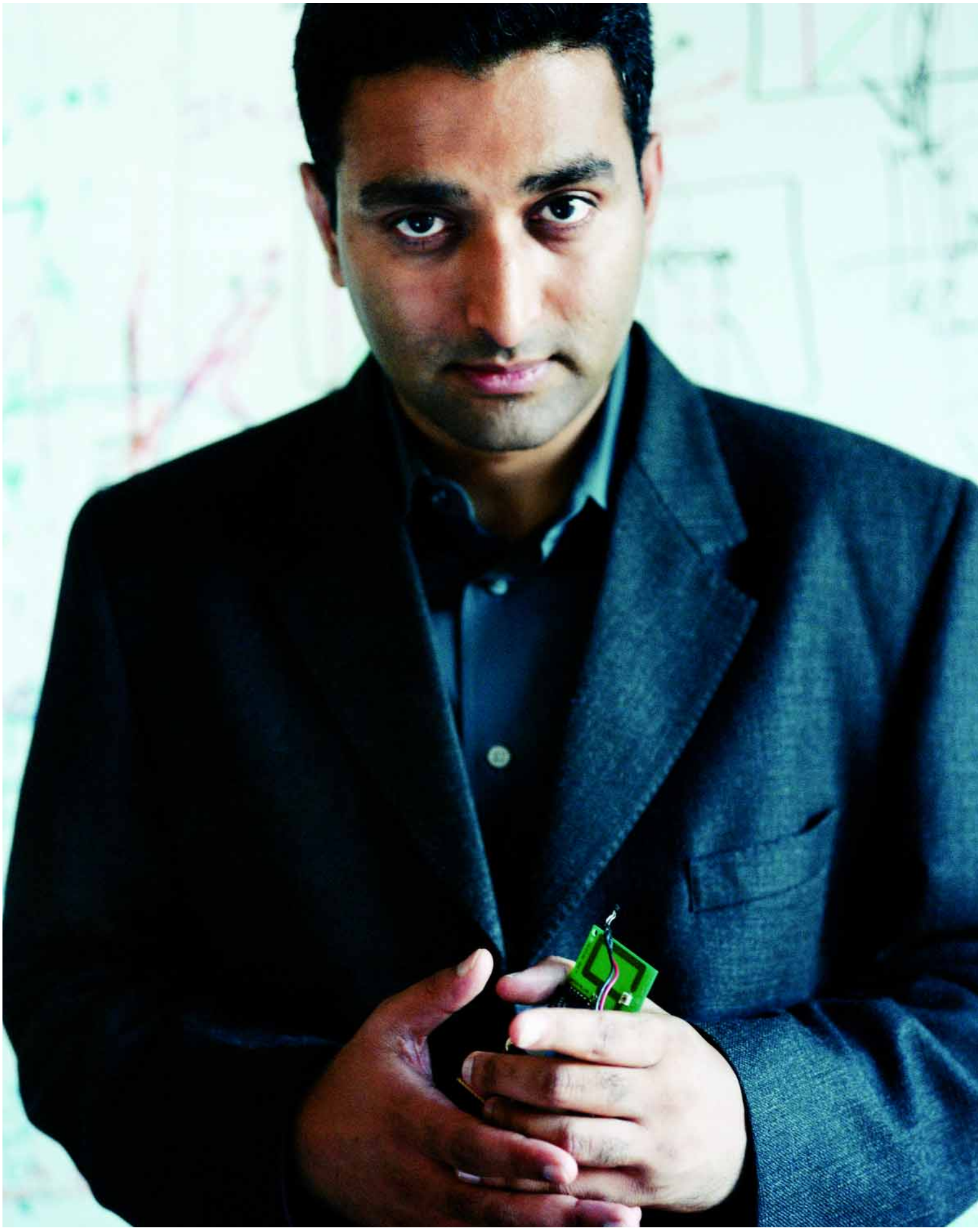


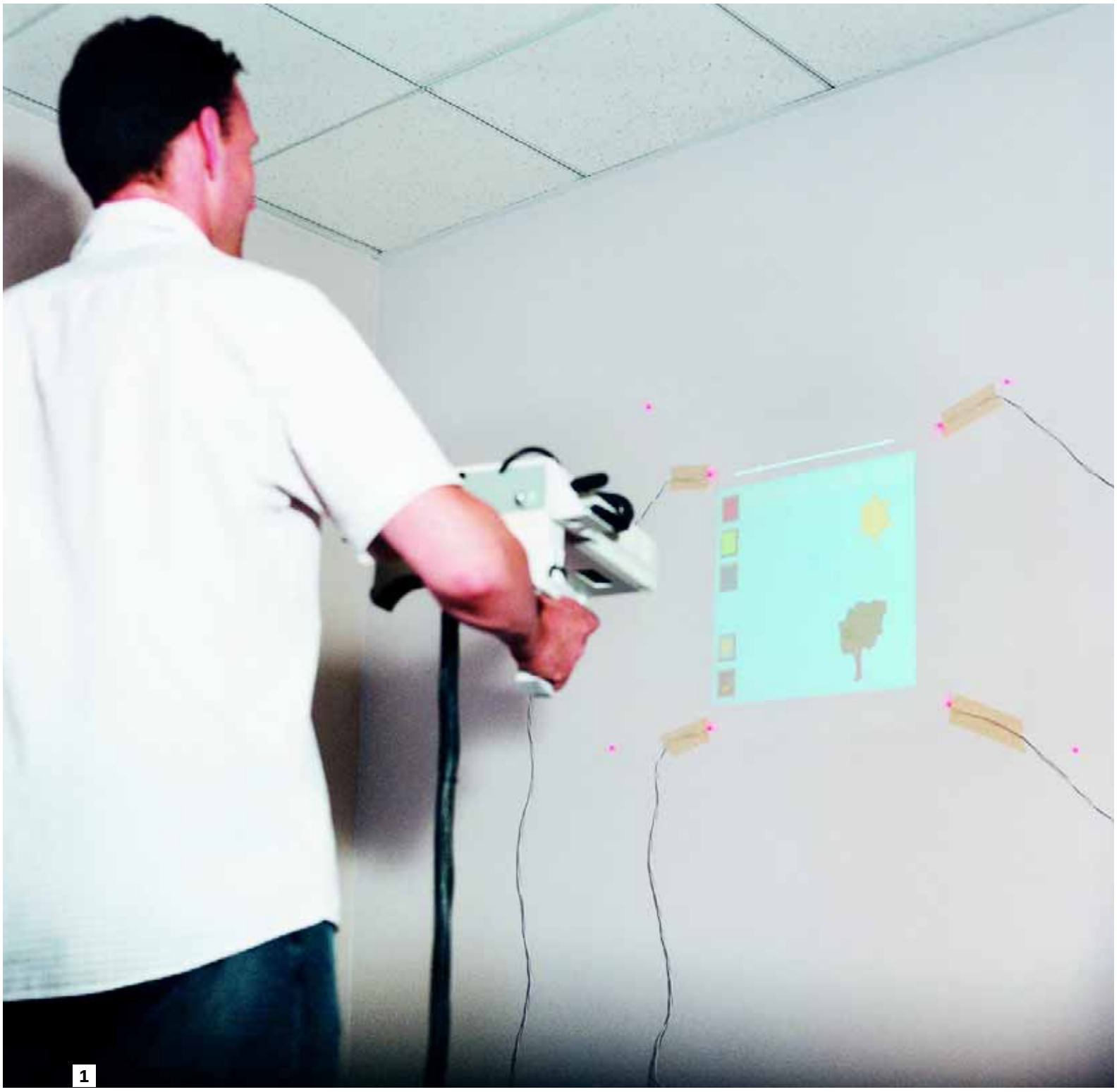
DEMO

PORTABLE PROJECTORS

Sick of squinting at the minuscule display on your cell phone or PDA? **Ramesh Raskar** might have a solution: tiny built-in projectors that turn virtually any handy surface into a display as big as you want it to be.

PHOTOGRAPHS BY KATHLEEN DOOHER

CHANCES ARE YOU can't remember the last time you hauled a projector out of the attic to look at slides or movies. But, says Ramesh Raskar, you may soon carry one with you everywhere you go. Raskar, a research scientist at Cambridge, MA's Mitsubishi Electric Research Laboratories, sees tiny projectors as the solution to one of the fundamental problems with our ever shrinking cell phones, PDAs, digital cameras, and other portable devices. The gizmos carry more and more of our data, but they are running out of room to display it to us. Build a tiny projector into each of those devices, though, and the world becomes your display. Raskar's team has developed hardware and software that can project digital images onto whatever surface is handy—the wall, say, or a desktop—and make them look good even if the impromptu screen isn't nice and smooth. And "once you buy into this notion that people would like to have this kind of an attachment," he asks, "what will they do beyond just looking at those images?" Raskar envisions projectors as the heart of a whole new way of interacting with the world, and he shared his vision with *Technology Review* senior editor Rebecca Zacks.



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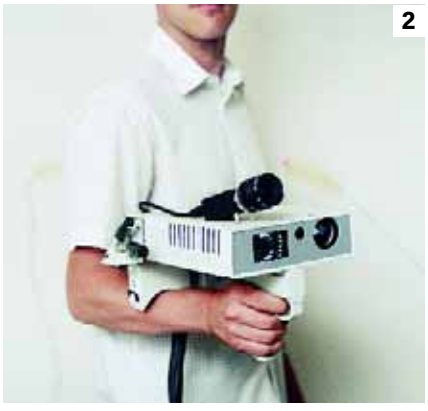

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1-2. AIMING AT PORTABILITY. In a dimly lit lab, Raskar describes his vision of pencil-size projectors that are standard components in mobile devices. Then Jeroen van Baar, who along with Paul Deitz and Paul Beardsley works with Raskar on the project, picks up one of the team's prototypes. It's bigger than a pencil, to be sure, but the researchers are confident they will be able to shrink it down. Van Baar takes aim at a spot in the middle of four red lights taped to the wall. As the projector beams out a video game, four lasers, two on each side of the device, shine red dots onto the wall just beyond each corner of the projected image. A camera atop the device, Raskar explains, "is looking at all eight lights and finding the relationship between the wall and the projector." That way, the computer can adjust the image on the fly to keep it stable even as van Baar moves his hand to point and click. In the future, Beardsley believes, the system will use landmarks such as cracks or grout lines for reference, eliminating the need for the taped-on markers.

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3. SHARED VISION. Projecting an image on a blank white wall is one thing, Raskar says, but if people are using projectors all the time, "it might be on a nonplanar surface; it might be on a curved surface; it might be on a surface that's part red and part white, and you want to compensate for all those issues." What's more, people might want to combine the power of their small individual projectors to make bigger, brighter images. As he talks, van Baar powers up a computer attached to four projectors, all aimed at a curved screen a meter and a half across. Say, for instance, that four friends want to use their projector-equipped mobile devices to watch a baseball game, Raskar says. They'd simply aim them roughly at whatever surface is handy, he says, "just click one button, and they all start talking to each other and figure out their geometric configuration, and you see a nice big display." To illustrate, van Baar turns on the projectors one by one. As they beam out a test pattern, attached cameras and sophisticated algorithms enable the computer to figure out which projector is aimed where and which piece of the picture it should project; the computer also corrects for the curvature and color of the surface so that the image doesn't look distorted.

4-6. GREAT COMPENSATION. The last step is to compensate for the fact that the projectors' images overlap, making some areas brighter and some dimmer. "We can find exactly which two or three or four pixels overlap with each other," van Baar says, "and we can adjust correspondingly."

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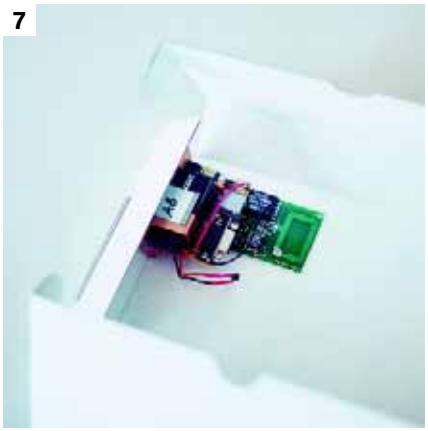

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7. PLAYING TAG. While bringing projectors, cameras, and wireless communication tools together could enable a host of consumer applications beyond game playing and video watching, Raskar says, even more interesting applications become possible if you throw in one more technology: radio frequency identification. RFID is now being adopted in a number of industries; in retail it's used to track products from manufacturers to stockrooms to store shelves. Raskar leads the way to a nearby conference room, where a metal bookcase has been stacked with boxes to imitate a storeroom. Each box is outfitted with a souped-up RFID tag attached via wires to a tiny photosensor that pokes through the front.

8-9. SUPER SCANNER. The photosensor, Raskar says, allows a user—a stock manager, say—to scan all the boxes at once and get an instant visual depiction of information associated with their RFID tags. (As in other RFID systems, that information is stored in an online database accessed wirelessly by the reader.) With a conventional RFID reader, finding out, say, which of a group of products have expired is difficult. That's because the reader isn't able to give specific location information; you can get the IDs off all the tags in a one- to two-meter radius, Raskar says, but if you want to know something about a specific one, "you don't know where exactly it is." Raskar's scanner—an RFID reader equipped with a projector—starts by projecting a series of vertical and horizontal lines of various thicknesses onto the shelf. By interpreting the pattern of illumination and darkness registered by its photosensor, each tag can determine its precise location. It then radios that information back to the reader.

10. AT A GLANCE. Once it knows where all the tags are, the reader looks up product information in the online database, then projects the relevant data right onto the boxes. In this case, Raskar says, a stock manager could see at a glance which products had expired and which were still okay. Or a consumer might use the system to find just what he wanted in a supermarket aisle. "Say I'm allergic to nuts, and I want low calorie, and I want something with fruits," Raskar says. "It would take me forever to search through the whole cereal aisle, but I can just aim my projector at this rack." Of course, he admits, it might take time before broad retail industries are willing to invest the extra penny per tag that it costs to add photosensors to regular RFID tags. "More-critical applications would use them first," he says. One example: hospitals hoping to avoid the medication errors that happen when busy staffers grab the wrong bottles out of cabinets. A projector-based system, Raskar says, could instantly light up just the right bottle.

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