FROM THE LABS

INFORMATION TECHNOLOGY

Better Face Recognition

A NEW ALGORITHM IMPROVES AUTOMATED RECOGNITION OF FACES IN LOW-RESOLUTION IMAGES

SOURCE: "RECOGNITION OF LOW-RESOLUTION FACES USING MULTIPLE STILL IMAGES AND MULTIPLE CAMERAS"
Pablo Hennings-Yeomans et al.
IEEE International Conference on Biometrics: Theory, Applications, and Systems, September 29–October 1, 2008, Crystal City, VA

Results: Researchers at Carnegie Mellon University and Microsoft Research have built a system that improves automated recognition of faces in low-resolution images.

Why it matters: Low-resolution images from surveillance and traffic cameras, cell-phone cameras, and webcams aren't much use for automatic face recognition, because they lack fine detail. The new system, however, can yield accurate matches from low-quality images. It could be used to search for specific faces on websites, and law-enforcement officials could use it to find suspects in surveillance videos.

Methods: Face recognition systems are usually trained on databases that include many high-resolution images of faces. That teaches them a technique called feature extraction: they learn to associate patterns of pixels with physical traits, such as a particular slant of the eyes. This training, however, doesn't equip the systems to handle low-resolution images very well. Existing algorithms can increase images' resolution—adding pixels to smooth out curves, for example. But while the results look better to human beings, the process can cause distortions that lead to errors in automated face recognition. The researchers developed algorithms that improve resolution in ways that take into account the requirements of feature extraction, increasing the accuracy of face identification.

Next steps: Face recognition systems need further improvements to correctly identify images taken from unusual angles. The researchers will also investigate other applications of image recognition—in biomedical imaging, for instance.

Electronic Eye

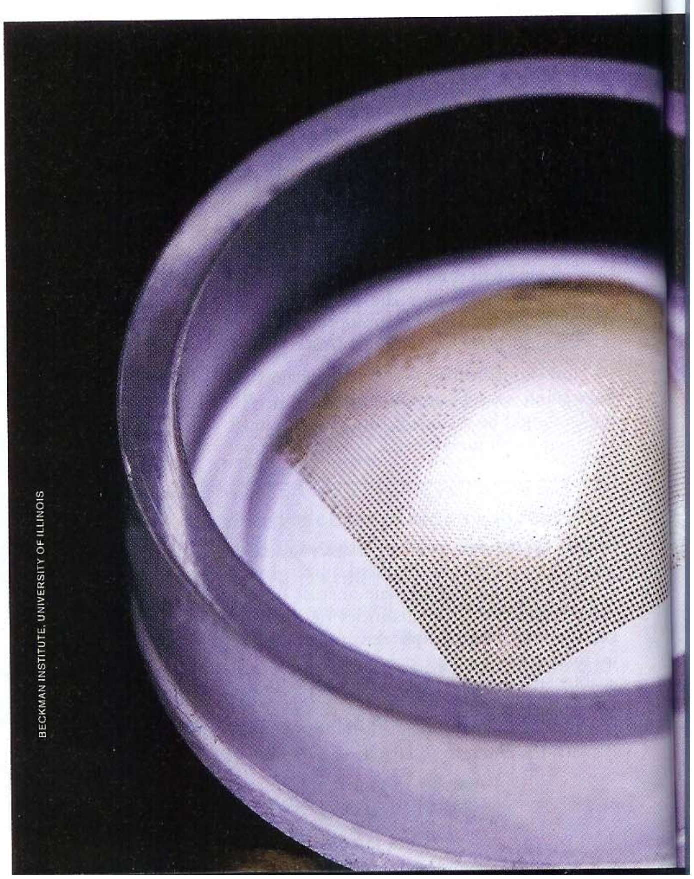
STRETCHABLE CIRCUITS ENABLE A HIGH-QUALITY SPHERICAL CAMERA

SOURCE: "A HEMISPHERICAL ELECTRONIC EYE CAMERA BASED ON COMPRESSIBLE SILICON OPTOELECTRONICS"
John Rogers et al.
Nature 454: 748–753

Results: Using a stretchable electronic circuit, researchers at the University of Illinois at Urbana-Champaign have designed a curved, 256-pixel camera sensor that produces small but high-quality images using a simple lens.

Why it matters: Unlike the human eye, with its single lens, camera lenses require multiple components to correct for distortions and aberrations that result from focusing light onto a flat surface, such as a strip of film or a conventional digital light sensor. A curved sensor doesn't require as many lens components to capture high-quality images, so lenses can be simpler and lighter.

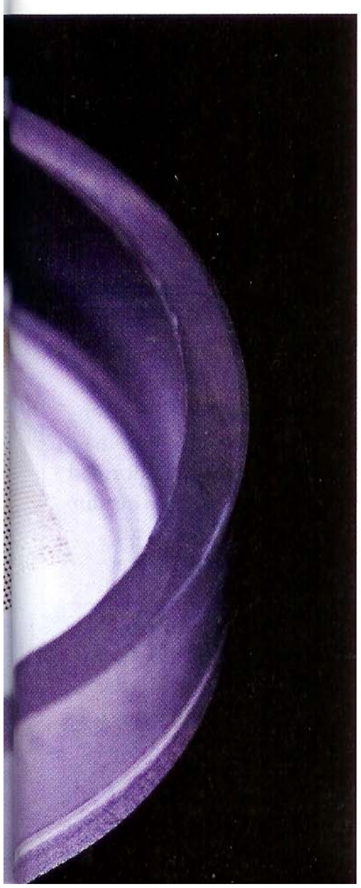
Methods: On a silicon wafer, the researchers used conventional lithography to fabricate an array of 500-by-500-micrometer silicon light sensors connected by metal ribbons. They removed the array from its silicon substrate by means of a chemical process. Next, the research-



SILICON EYE A network of 256 tiny image sensors has been stretched over a silicone hemisphere that measures about two centimeters across.

ers used a mold to fabricate a film of flexible silicone in the shape of a bowl. Then they stretched the film flat and applied the sensor array. When they released the silicone, it returned to its bowl-like shape, curving the sensor array in the process. The metal ribbons, which are thin enough to be flexible, allow the array to bend without breaking. Finally, the researchers incorporated the array into a camera with a simple lens and electronics.

Next steps: The researchers are trying to make higher-resolution cameras that have more sensors, and they hope to use different types of curved surfaces to optimize the imaging.



MATERIALS

Cool Fuel Cells

A NEW ELECTROLYTE WORKS AT ROOM TEMPERATURE

SOURCE: "COLOSSAL IONIC CONDUCTIVITY AT INTERFACES OF EPITAXIAL $ZRO_2:Y_2O_3/SRTIO_3$ HETEROSTRUCTURES"
Jacobo Santamaria et al.
Science 321: 676–680

Results: A new electrolyte developed for use in solid-oxide fuel cells has 100 million times the ionic conductivity of conventional electrolytes at room temperature.

Why it matters: Solid-oxide fuel cells show promise for power generation because they convert a wide variety of fuels—including gasoline, hydrogen, and natural gas—into electricity more efficiently than conventional generators do. But they have been very expensive, and limited in their applications, because they require electrolytes that function only at temperatures above 600 °C. The new electrolyte works at temperatures hundreds of degrees cooler.

Methods: A solid-oxide fuel cell consists of two electrodes separated by an electrolyte. Fuel is fed to one electrode and oxygen to the other. The electrolyte transfers oxygen ions from one electrode to the other, where they combine with the fuel in a chemical reaction that releases electrons, producing an electric current. Conventional electrolytes require high temperatures because they don't conduct ions well at room temperature.

To make the new material, the researchers combined nanometer-thick layers of the electrolyte, an yttria-stabilized zirconia, with 10-nanometer-thick layers of strontium titanate. The difference between the crystal structures of these two materials leads to gaps in the electrolyte that allow oxygen ions to move freely at relatively low temperatures.

Next steps: Ionic conductivity is difficult to measure in extremely thin films like the one tested, so the improvement requires verification. What's more, creating low-temperature fuel cells will also require new electrodes that operate at low temperatures.

Metamaterial Prism

A NEW MATERIAL FOR ULTRAHIGH-RESOLUTION MICROSCOPES

SOURCE: "THREE-DIMENSIONAL OPTICAL METAMATERIAL WITH A NEGATIVE REFRACTIVE INDEX"
Xiang Zhang et al.
Nature 455: 376–379

Results: Researchers have fabricated a material that interacts with near-infrared light in a way that no naturally occurring material does. A prism made from the material has a negative refractive index: that is, it bends light in the direction opposite the one in which ordinary materials bend it.

Why it matters: The prism is the first practical device for redirecting near-infrared light in this way. Devices made from the material could be used in microscopes to produce much sharper images. They could also be used to route light on a microchip or even to render objects invisible to near-infrared wavelengths by directing light around them. Some previous negative-index materials worked only with microwaves; others, which did work with visible or infrared wavelengths, transmitted little light and were so thin that they were difficult to use. The new material is thicker and transmits more light, making it potentially more useful.

LIGHT BENDING An image produced by a scanning electron microscope shows a wedge-shaped prism. The device was carved from layers of metal and insulating material (inset) punched with rectilinear holes.

Methods: The material is made up of alternating layers of a metal, which conducts electricity, and an insulating material; both are punched with a grid of square holes. This structure gives the mate-