Human eye a model for camera

Curved screen resembles retina

By Jeremy Manier
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Drawing inspiration from the simple design of the human eye, Illinois engineers have invented a new kind of eyelike camera that avoids some pitfalls of ordinary cameras and could lead to a host of novel devices based on flexible electronics.

The electronic eye made by researchers at the University of Illinois at Urbana-Champaign and Northwestern University collects light on a curved screen resembling a retina, in contrast to digital cameras that use lenses to focus images on a flat sheet of light detectors. A curved surface reduces the need for multiple lenses and cuts down on distortion that comes from projecting the light on a flat surface.

That allows for a compact camera with low distortion and a wide field of view, much like a natural eye, according to a study published in Thursday's edition of the journal Nature.

Making curved arrays of electronics is far tougher than it sounds, experts say. Until now, nearly all complex electronics have been etched on flat wafers, with even slight curves posing a steep engineering and production challenge.

"The whole technology is based on flat and rigid systems," said Max Lagally, a professor of materials science and engineering at the University of Wisconsin at Madison.

Bionic eyes based on the design are not yet on the horizon. But other teams are studying how to get digital signals into the brain's vision centers, and the new camera could be useful in such efforts. The camera may be most useful in military surveillance or space missions.

But the potential for a new era of flexible electronics sparks the imagination of engineers who have used stiff circuit boards for decades, said lead study author John Rogers, a professor of materials sciences and engineering at the U. of I.'s Beckman Institute.

Rogers is teaming with bioengineers at the University of Pennsylvania to make rubbery sheets of electronic components that could monitor or even correct neuron misfirings in the brains of epilepsy patients.

"These flexible electronics have tremendous capacity for making brain-computer interfaces," said Dr. Brian Litt, a professor of neurology and bioengineering at Penn who is collaborating with Rogers' group.

To make the curved array of electronics, Rogers' team started with a small amount of elastic material in the shape of a dome. They stretched the elastic until it was taut and flat, then transferred the mesh of photodetectors to that flat surface. When they released the elastic, it snapped back to its curved shape with the electronics in place.

Such bending often breaks the brittle semiconductors in circuits, but the group overcame that by using very small photodetectors connected by thin wires on flexible plastic strips. Those tiny plastic bridges absorbed the strain of the change in shape, said study co-author Yonggang Huang, a professor of engineering at Northwestern.

The curved camera design makes it easier to get a good image across a given field of view, experts said. A normal digital camera tends to have the best image quality at the center of an image, with more distortion at the edges.

But the new design makes it possible to get sharp focus all the way to the edge of the image, without the need for fancy optics.

Bendable electronics would free camera designers to mimic other kinds of natural inventions, including "insect-like compound eyes" and fisheyes with a 360-degree field of view, wrote University of Tokyo electronics researcher Takao Someya in an accompanying editorial in Nature.

Most experts doubted the new camera design would have immediate applications for consumers, in part because existing digital cameras are already relatively cheap and serve most people's needs. But Lagally of Wisconsin, who has collaborated with Rogers on other projects, said there may be other uses that require only another leap of imagination.

"I won't be surprised if [Rogers] comes up with something really magical in short order," Lagally said.

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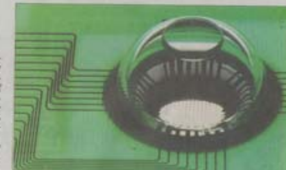

Photo courtesy of Beckman Institute, University of Illinois

Drawing inspiration from the simple design of the human eye, researchers have created a new eyelike camera.

Possible uses

A team of Illinois researchers has made an eyelike camera with electronics that are curved like the retina in a human eye. Some possible applications:

- The camera could aid military surveillance or space missions, which often need small cameras with wide fields of view.
- Engineers could use the bendable electronics to make insectlike compound eyes or fisheyes with a 360-degree perspective.
- The U. of I. team is working with bioengineers to make flexible sheets of sensors that could monitor the brains of epilepsy patients and potentially prevent seizures.
- Flexible circuit boards could allow for roll-up solar panels, pressure-sensitive skins for robot arms and wrap-around video displays.

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