

Bug-eye lens gives a broader view

IMAGINE if you could see the world through the eyes of an insect, able to spot a bite to eat or a potential predator even when it is almost behind you.

That may soon be possible, using an artificial, ultra-wide angle "eye", about 2.5 millimetres across and developed by researchers at the University of California, Berkeley.

The compound eyes of insects such as bees and dragonflies are made up of tens of thousands of tiny separate lenses, called ommatidia. These all point in different directions to give the insect a wide field of vision. Inspired by these eyes, Luke Lee and colleagues have created a three-dimensional eye based on a polymer resin dome spiked with



thousands of light-guiding channels, each topped with its own lens. The eye could be used to give a much wider field of vision to surveillance cameras, cellphone cameras, and surgical endoscopes.

The artificial eye is made up of 8700 microlenses. To create it, epoxy resin was poured into a hemispherical mould pocked with lens-shaped indentations. The resin was allowed to harden slightly, so the eye could be

popped out of its mould.

The team used a resin that acts like a lens when you shine light on it, and hardens completely when exposed to UV light. The eye was heated gently to harden the lens-shaped bumps, while the rest of the resin remained soft.

"The eye could give a much wider field of vision to cameras and endoscopes"

When a beam of UV light is shone on one of these bumps it focuses the beam, like a lens. The light then burns through the resin like a welder's torch into metal and creates a waveguide, or light-conducting channel (*Science*, vol 312, p 557).

Using a spoke-like pattern of UV light beams to pierce the resin at angles pointing towards the centre of the dome, the team was able to create waveguides that mimic the way an insect's ommatidia make light converge on the centre of the eye. "These devices are the first to integrate microlens arrays with self-aligned, self-written waveguides," Lee says.

The beauty of the technique is that because the microlenses create the waveguides, they are perfectly aligned with them, so that it will be relatively easy to hook the ommatidia up to a photodiode detector. "It's really lovely work," says Julian Vincent, director of the Centre for Biomimetic and Natural Technologies at the University of Bath, UK.

The artificial eye will have a 180-degree field of view, far wider than the best available fisheye lens. **Rowan Hooper** ●

The rotor that spins on a bubble

WHAT do you get if you take a set of miniature silicon helicopter blades, drop them into a beaker of water and blast them with sound waves? A remote-controlled underwater "bubble rotor" that could be used to manipulate individual cells.

The rotor, developed by Daniel Attinger of Columbia University in New York, consists of a piece of silicon, 60 micrometres wide, cut into two crossed blades. It can be made to spin by placing it near a bubble of air in water and hitting the bubble with ultrasound waves.

Although the bubble rotor itself is 100 times bigger than ordinary cells, if you attach a carbon nanotube shaft to drill into individual cells, you can learn more about how they respond to stimuli, Attinger says. The rotor could also be used in microfabrication: hundreds of spinning shafts could be assembled to form a moving "carpet" that guides tiny mechanical parts around a surface.

Attinger and his colleagues discovered the bubble rotor by accident in 2004 while using ultrasound waves to make an underwater air bubble expand and contract. The team was attempting to recreate a 2003 experiment by Philippe Marmottant at CNRS-Université Joseph Fourier in France, in which he showed that the process produces a doughnut-shaped whirlpool above the bubble. By creating this whirlpool near cells suspended in water it is possible to trap and stretch the cells so that the pores in their surface are wide enough to absorb certain drugs.

When Attinger repeated the experiment, he threw in tiny crushed plastic pieces to help him see the

vortex more easily. One of these pieces, a round plastic disk, was much larger than the rest. He found that the creation of the whirlpool sucked this plastic disk towards the 18-micrometre wide bubble, where it stuck to the top and started rotating along with the whirlpool, just like a spinning dish balancing on the end of a stick.

He has since built a helicopter rotor with four prongs, which he has spun on the surface of a bubble. By varying the frequency of the ultrasound, he can control the speed at which the rotor turns, up to a maximum of 600 rotations per minute. Attinger will present his bubble rotor on 8 May at Nanotech 2006 in Boston. **Celeste Biever** ●

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