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Restoring sight with wireless implants

A combination of video goggles and photovoltaic retinal implants could make vision restoration more practicable.

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The development of retinal implants has been dogged by problems of unwieldiness since the first implantable stimulator for vision restoration was developed in 1968. Sticking a mess of electronics, with wires, cables and inductive coils, into the human visual system was always going to be a tricky business.

James Loudin and his colleagues at Stanford University in California have developed a solution that overcomes many of these problems by the use of special glasses that fire infrared signals into the eye and onto an implanted array of silicon photodiodes. The system simplifies what needs to be implanted and both transmits visual data and power directly to the implants, eliminating the need for any bulky external power source. Their work is published today in *Nature Photonics*[1].

In order to explain how the set-up would work, Loudin regularly uses the Star Trek character Geordi LaForge as an analogy. “I'm not well versed in Star Trek any more, and I don't think Geordi had implants,” he says. “However, like his visor, our patients cannot see without the goggles.”

Anna Omelchenko / Shutterstock

Retinal implants could help restore vision to damaged eyes.

Loudin and his colleagues demonstrated the plausibility of their system by using near-infrared light to stimulate rat retinas into which the photodioides had been implanted. A pocket computer processes images captured by a miniature camera set into a pair of glasses similar to existing video goggles, and a near-to-eye projection system casts these images into the eye and onto the photodiode array using pulsed near-infrared flashes. The array in turn stimulates inner retinal neurons.

Electronic sight

Recent clinical trials with multielectrode-array implants — interfaces that connect neurons to electronic circuitry — have restored some clarity of vision. But the surgery is complex and the implantation produces a range of unwanted side effects, including inflammation, loss of neurons, and an accumulation of astrocytes and microglia that form a sheath around the array. This increases the space between the electrode probes and also insulates the electrodes, reducing functionality.

Data transfer is also difficult to scale to large numbers of densely packed microelectrodes and, a major disadvantage in restoring a normal experience of vision, such systems are dependent on an external camera for retinal stimulation, so patients cannot use natural eye movements.

Loudin's system reduces these problems because the photovoltaic implants are much thinner, and they are wireless. And the pulses deliver both visual information to the photovoltaic array and power it, reducing the number of components that need to be implanted. “Surgeons should be much happier with us. We’ve just got the one implant,” says Loudin. “Other approaches require pretty big pieces of hardware to be stuck in the body: 1–2 centimetres in size.”

The photovoltaic system also enables patients to scan the visual scene with their own eyes, within the visual field of the goggles.

Eberhart Zrenner at Tübingen University in Germany, a leader in the field and the co-inventor of the subretinal electronic chip, takes his hat off to the solution. “It’s an elegant approach,” he says. “It also allows for a high density of pixels, which means better resolution with many hundreds of pixels. The array is flexible, which allows larger arrays to be implanted.”

He adds that while the current demonstration is a convincing proof-of-concept, more work will be required on issues of biocompatibility, stability of the material and the development of safe surgical procedures.

Nevertheless, 66 patients in Europe and the United States have already received existing retinal-implant systems during clinical trials. Zrenner reckons that such implants will be available on the market within one or two years. “There will be regulatory issues of course, but it’s coming soon.”

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Corrections

Corrected: This article originally stated that Eberhart Zrenner believed that Loudin's implants will be available on the market within one or two years; in fact, he was referring to implants that he has helped to develop, and which are already in clinical trials.

References

1. Loudin, J. *et al*. *Nature Photonics* http://dx.doi.org/10.1038/NPHOTON.2012.104 (2012).