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Moving brain implant seeks out signals

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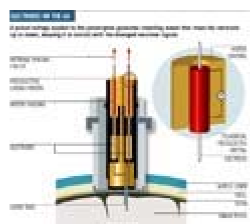
A device that automatically moves electrodes through the brain to seek out the strongest signals is taking the idea of neural implants to a new level. Scary as this sounds, its developers at the California Institute of Technology in Pasadena say devices like this will be essential if brain implants are ever going to work.

Implants could one day help people who are paralysed or unable to communicate because of spinal injury or conditions such as amyotrophic lateral sclerosis (Lou Gehrigâ€™s disease). Electrodes implanted in the brain could, in principle, pick up neural signals and convey them to a prosthetic arm or a computer cursor.

But there is a problem. Implanted electrodes are usually unable to sense consistent neuronal signals for more than a few months, according to Igor Fineman, a neurosurgeon at the Huntington Hospital, also in Pasadena.



Electrodes on the go. CLICK to enlarge

This loss of sensitivity has a number of causes: the electrodes may shift following a slight knock or because of small changes in blood pressure; tissue building up on the electrodes may mask the signal; or the neurons emitting the signals can die.

To get around these problems, Joel Burdick and Richard Andersen at Caltech have developed a device in which the electrodes sense where the strongest signal is coming from, and move towards it. Their prototype, which is mounted on the skull, uses piezoelectric motors to move four electrodes independently of each other in 1-micrometre increments.

Tuning in

It has successfully been used to decode motor signals in rats and intention signals in monkeys. When surgeons implant electrodes in the brain they normally have to â€œtuneâ€ individual electrodes by positioning them to pick up signals from a single brain cell.

With the new device, which the Caltech teams calls an autonomous microdrive, an fMRI scan is enough to locate the

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electrodes in the general area where the signals are coming from. Each electrode then homes in on the strongest nearby signal.

Piezoelectric motors were chosen for the microdrive because they are capable of moving the electrodes hundreds of micrometres with great accuracy, Burdick says.

Applying a voltage to the crystal causes it to expand momentarily, and because it has a roughened edge, feeding it a sequence of voltage pulses causes it to ratchet forward another surface in contact with it â€“ in this case an electrode.

Collision avoidance

To stop it damaging neurons, the microdrive has been given a collision avoidance capability. â€œIf the signal voltage starts rising very rapidly we know we are in danger of puncturing a neuron, so it backs off,â€ Burdick says.

While the animal tests have shown that the microdrive can home in on the strongest neural signals, it is still too bulky to be used for people. The team is working with Yu-Chong Tai of Caltech, an expert in microelectromechanical systems (MEMS), to make a smaller version with up to 100 electrodes.

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Joel Burdick, California Institute of Technology

The Andersen Lab, California Institute of Technology

The researchers say that within a year they expect to be able to fit a paralysed person with a microdrive implant that will allow them to control a computer cursor and navigate the web.

Autonomous microdrives could also eventually be used in other types of implant, such as the deep brain stimulators used to treat Parkinsonâ€™s disease. Fineman says the microdrives could help make them more effective by providing a feedback mechanism from single neurons.

Duncan Graham-Rowe

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