Researchers get neurons and silicon talking

European researchers have created an interface between mammalian neurons and silicon chips. The development is a crucial first step in the development of advanced technologies that combine silicon circuits with a mammal's nervous system.

The ultimate applications are potentially limitless. In the long term it will possibly enable the creation of very sophisticated neural prostheses to combat neurological disorders. What's more, it could allow the creation of organic computers that use living neurons as their CPU.

Those applications are potentially decades away, but in the much nearer term the new technology could enable very advanced and sophisticated drug screening systems for the pharmaceutical industry.

"Pharmaceutical companies could use the chip to test the effect of drugs on neurons, to quickly discover promising avenues of research," says Professor Stefano Vassanelli, a molecular biologist with the University of Padua in Italy, and one of the partners in the NACHIP project, funded under the European Commission's Future and Emerging Technologies initiative of the IST programme.

NACHIP's core achievement was to develop a working interface between the living tissue of individual neurons and the inorganic compounds of silicon chips. It was a difficult task.

"We had a lot of problems to overcome," says Vassanelli. "And we attacked the problems using two major strategies, through the semiconductor technology and the biology."

With the help of German microchip company Infineon, NACHIP placed 16,384 transistors and hundreds of capacitors on a chip just 1mm squared in size. The group had to find appropriate materials and refine the topology of the chip to make the connection with neurons possible.

Biologically NACHIP uses special proteins found in the brain to essentially glue the neurons to the chip. These proteins act as more than a simple adhesive, however. "They also provided the link between ionic channels of the neurons and semiconductor material in a way that neural electrical signals could be passed to the silicon chip," says Vassanelli.

Once there, that signal can be recorded using the chip's transistors. What's more, the neurons can also be stimulated through the capacitors. This is what enables the two-way communications.

The project tested the device by stimulating the neurons and recording which ones fired using standard neuroscience techniques while tracking the signals coming from the chip.

The development of the interface and chip are crucial for this new technology, but problems remain. "Right now, we need to refine the way we stimulate the neurons, to avoid damaging them," says Vassanelli.

That's one of the problems the team hopes to tackle in a future project. Right now a proposal has been prepared which could tackle this and many other problems, including how to communicate with the neurons using genes.

"Genes are where memory come from, and without them you have no memory or computation. We want to explore a way to use genes to control the neuro-chip," says Vassanelli.

If NACHIP took the first crucial step towards a neuron-powered CPU, future work will pave the way for a genetically-powered hard disk.

Source: IST Results