Neural computers a step closer

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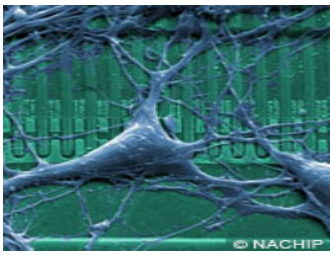

The development of organic computers, which use mammalian neurons to process or store information or neurological prosthetics for overcoming disorders of the central nervous system, might sound like the background plot for Terminator 4. However, breakthroughs achieved within the NACHIP project, funded under the Sixth Framework Programme (FP6) and developed by researchers in Germany, Italy and Switzerland, could contribute to the development of precisely these kinds of technology.

The team, made up of Peter Fromherz from the Max-Planck-Institute for Biochemistry in Munich , Stefano Vassanelli from the Department of Membrane and Neurophysics at the University of Padua and Nikolaus Greeff from the University of Zurich's Institute of Physiology, is investigating ways for silicone chips to communicate with rat nerve cells. While organic computers may be decades away from being a reality, in the short term the technology could help in the development of screening methods for the pharmaceutical industry, especially relevant in the light of recent events during a drug trial in the UK.

'Pharmaceutical companies could use the chip to test the effect of drugs on neurons, to quickly discover promising avenues of research,' Professor Vassanelli told IST Results.

But in order to 'hear' what these neurons are 'saying', they must first be connected to microchips. The team had to find ways of attaching neurons to individual silicone chips, then develop an interface between the two. The team attacked the problem from both the biological and the semiconductor perspectives. German semiconductor

company Infineon supplied advanced chips with thousands of transistors and hundreds of capacitors on a 1mm chip. The team then had to develop ways for nerve cells to make connections with it.

The team used special proteins found in the brain to glue the neurons to the chip. These proteins served a dual use: '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,' explained Professor Vassanelli.

Two-way communication was thus made possible. The chip's transistors recorded signals from the neuron, while the chip's capacitors send signals back to the neuron. 'Right now, we need to refine the way we stimulate the neurons, to avoid damaging them,' added the Professor.

The team envisage a genetic solution to the problem of communication between chip and neuron. 'Genes are where memory comes from, and without them you have no memory or computation. We want to explore a way to use genes to control the neuro-chip,' continued Professor Vassanelli. Assuming this can be done, and the researchers think it could be possible in a few decades, this could lead to interfaces between human nervous systems and computers. But for what purpose?

Devices controlled in this way would represent not simply prosthetics, but replacements. Prosthetic legs would be under direct control from the brain and be responsive. In theory, highly sophisticated prosthetics could enable a person to feel the road beneath the sole while walking. You could even stub your prosthetic toe and feel pain.

Organic computers could lead to an exponential growth in computational power. The most sophisticated supercomputers yet devised are still no match for the most primitive animal. If the human brain is compared to a computer, the number of computations per second required to simply interpret the world around us from sight alone is already enough to defeat any computer, never mind any interaction between the computer and outside world.

However, in the push to develop high speed and sophisticated organic computers, the EU starts with an advantage. 'Europe is very well placed in this field of research, because it is essentially a multidisciplinary field, and we have multidisciplinary teams working on it. [...] Europe should be very proud of these resources. It gives us access to equipment and expertise that would be very hard to replicate elsewhere.'

Countries

Switzerland, Germany, Italy

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