Towards information processing by natural neural networks

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The brain's abilities to process parallel data streams are still unsurpassed by any modern computer technology. In particular the brain is good in pattern recognition and abstraction, which involve filtering and categorizing information. For years people are looking for computer architectures and algorithms that mimic this kind of potential. One answer might come from biohybrid computer designs based on natural neural networks cultured on high-density electrode arrays. Neurons from dissociated brain tissue tend to self-organize into networks which have features that resemble functional features of the intact brain. In the recent past, various research groups could show that such networks can be conditioned or trained to respond predictably and reproducibly to different external stimuli – a first step towards learning and memory formation. These experiments might lead to neurobionic computing systems for information processing and pattern recognition applications. This talk will present one approach into that direction based on a prototype of an integrated in-vitro platform for long-term recording from and stimulation of natural neural networks. It entails novel bidirectional CMOS-recording and stimulation devices, microfluidics for drug-delivery, and emerging cell biological techniques. First fundamental results on exploring pattern recognition abilities of neural networks cultured in-vitro are presented. The work is a multinational effort of four European research institutes and one company, namely ETHZ, Switzerland, SISSA, Italy, IMT, Switzerland, KTECH, Germany, and LEISTER, Switzerland.

The project is funded by the Future and Emerging Technologies arm of the IST Programme IST-2000-26463.