Invited Speaker

SpiNNaker – A Neural Simulation Engine

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Abstract:

SpiNNaker is a completely novel kind of computing architecture, which bears little or no resemblance to Turing's original concept of sixty years ago. It was intended, designed and optimised for the problem of neural simulation, but on a scale and at a speed unattainable with conventional machines. The headline goal is to be able to simulate the behaviour of a billion neurons in real time, using a million conventional cores. As neural ensembles become ever more complex, amongst the technical challenges facing the human experimenter is that of interpreting the output: a billion time histories is a formidable mass of data to mine. Received neuroscience wisdom says that the best way to study the high-level behaviour of a large neural ensemble is to embed it in a virtual reality environment, where complex emergent behaviour can be (relatively) easily identified and manipulated. To achieve this requires that the simulation is capable of reacting to stimuli in real time, and this is just what SpiNNaker is designed to do.

In this talk, we present a brief outline of the architecture of the machine, followed by a more detailed description of the specialised approach used within it to integrate (neural) differential equations - we go on to show how this produces biologically realistic behaviour.

A conventional metric for any simulation system is "How fast does it go?" The design intention for SpiNNaker is that it operates in real time; it will simulate the behaviour of one neuron in the same wallclock time as - we hope - a billion.

Whilst there is no way through Amdahls Law (The proportion of code that cannot be parallelised will ultimately limit the advantages accrued from more processors), the Gustafson-Barsis Law does permit a way around it: (If you can have an arbitrary number of processors, the total amount of work performed by the system may be increased arbitrarily at no extra cost).

This is a programming methodology of immense power, only today becoming a feasible research approach as the effective 'cost' of a core approaches zero.

Two research questions SpiNNaker is intended to illuminate:

• How can massively parallel computing resources accelerate our understanding of brain function?

• How can our growing understanding of brain function point the way to more efficient parallel, fault-tolerant computation?

Biography

Professor Brown holds an established chair in Electronics at Southampton, and was head of the ESD (Electronic System Design) research group in the Department of Electronics from 1995 to 2007, building it up from three academic staff (the smallest engineering group) to thirteen academic staff (the largest engineering group) in that period. He has worked as a Visiting Scientist at IBM Hursley Park (UK) and Siemens Munich (Germany), MAC Communications as part of the Senior Academics in Industry program, and has held Visiting Chair positions at the Universities of Trondheim (Norway), Cambridge (UK); and Ecole Polytechnique Federale de Lausanne (Switzerland).

He has been involved in three spin-outs, all as a founding director: Horus Systems Ltd (1985) - electronic system simulation, LME Design Automation (2000) - electronic system synthesis (where he
was awarded a two-year Royal Society Industrial Fellowship) and ECSPartners (2003) - a consultancy company set up to oversee and coordinate external consultancy activities in ECS.

He is a Fellow of the BCS and the IET, a Senior Member of the IEEE, a UK Chartered Engineer (CEng) and the EU equivalent (Eur Ing).