The University Of Sheffield.

Automatic Control and Systems Engineering

The Department of Automatic Control & Systems Engineering
is pleased to announce the following seminar:

Bio-inspired Heterotic Computing Hardware

Dr Martin A. Trefzer
Electronic Engineering
University of York

Wednesday, 09 October 2019 at 14:00
Pam Liversidge Building, LT02

Abstract

State-of-the-art electronic design allows the integration of complex systems comprising thousands of high-level functions made from billions of components working in concert on a single chip. This has become possible because of the combination of semiconductor technology providing atomic-scale devices and electronic design automation (EDA) tools following a strictly hierarchical design methodology breaking down a system into blocks, sub-blocks or cells. The result is the ubiquitous "classical" computer combining Boolean logic with silicon.

However, the ever-increasing transistor density and design complexity makes modern systems brittle and inefficient. As we start to meet fundamental device scaling limits when touching the atomic scale, design challenges arise including the thermal/power constrained Dark Silicon and other deep sub-micron silicon fabrication issues such as intrinsic variability and electrical wear out (ageing). As we approach the miniaturisation limits of conventional electronics, alternatives to silicon transistors – the basic building block for conventional electronic devices – are being hotly pursued.

This raises questions of whether Boolean logic and silicon are actually a good match or whether current design methodology and system management approaches are appropriate; and gives rise to the ideas of biologically-inspired hardware and unconventional computing. Inspired by the way living organisms have evolved in nature to perform complex tasks with remarkable ease, in particular the way the brain outperforms classical computing paradigms, we will explore a combination of "evolution" as the design tool and reconfigurable hardware and nano materials as the substrates to create novel, self-organising information processing devices.

I will motivate how four seemingly random words like "Bio-inspired", "Computation", "Heterotic" and "Hardware" fit together and present examples how methodologies developed in this context will lead to the next-generation unconventional computer with a perfect match of computational model and physical substrate. Examples will range from fault-tolerant evolutionary hardware over social insects managing many-core processors to carbon nanotube-based material computers and how to characterise them.

Biography

Dr. Martin Trefzer is a Senior Lecturer in Electronic Engineering (University of York). His research interests include variability-aware analogue and digital hardware design, biologically motivated models of hardware design, evolutionary computation, and autonomous fault-tolerance. His vision is to create novel architectures and autonomous systems, which are dynamically self-optimising and inherently fault-tolerant, by porting key enabling features and mechanisms from nature to hardware. He is/has been co-investigator on EPSRC grants, SpInspired, eFutures Network, Bio-inspired Adaptive Architectures and Systems, Graceful and PAnDA, a DSTL grant on unconventional computing and Innovate UK KTPs in High-speed Embedded Vision Systems and Adaptive Networks for Spacecraft. Recent EPSRC awards are highly cross-disciplinary projects investigating computational properties and creating novel architectures underpinned by principles from Biology, Physics and Electronics. He is SMIEEE, co-chair of the International Conference on Evolvable Systems (ICES), member of York Cross-disciplinary Centre for Systems Analysis (YCCSA), and Chair of IEEE Task Force on Evolvable Hardware.