Cyber-Physical Systems Workshop, May 16th 2013

Arranged under the auspices of the SICSA Modelling and Abstraction theme, the Cyber-Physical Systems Workshop took place in Edinburgh on Thursday, May 16th. There were 25 participants including people from Glasgow, Heriot-Watt, Stirling, St Andrews, Aberdeen and Edinburgh Universities, in addition to several people from outside SICSA. There was a varied programme of talks, and plenty of opportunities for networking, and it is almost certainly a sign of the success of the workshop that people lingered chatting for at least an hour after the formal programme was over.

The keynote presentation at the meeting came from Boudewijn Haverkort of the University of Twente who spoke about model-checking hybrid Petri nets with applications to critical fluid infrastructures such as water, gas and oil networks. The modelling questions of interest included the probability that water tanks overflow or the probability that a city runs out of water and generally other survivability questions. Stochastic hybrid models are needed to answer these questions and have the advantages that they naturally represent the continuous physical dynamics of such systems. These allow the modeller to pose questions in Stochastic Time Logic (STL) and answer questions such as whether particular continuous variables of interest lie within prescribed bounds using Stochastic Time Diagrams which partition the state-space into regions.

Many of the speakers posed the question of "What is a cyber-physical system?" and a variety of answers were given. Most seemed to agree that such systems share characteristics with hybrid systems, and some talks presented formalisms which focused on modelling and analysis techniques for hybrid systems. For example, Vashti Galpin of the University Edinburgh described the HYPE modelling language, which is a process algebra capable of capturing discrete, continuous and stochastic actions, whilst Andrew Sogokon, also of the University of Edinburgh presented a tool which allows functions involving transcendentals to be manipulated in the analysis of hybrid programs. Eva Navarro, an RCUK Academic Fellow at the University of Manchester reported on DYVERSE, a novel framework for complex hybrid dynamical systems. This supports discrete abstractions of dynamical behaviours expressed as hybrid automata, investigated through formal verification, and used to achieve supervisory control of systems. Verification challenges of interest included stability-related and liveness properties. Leslie Smith from the University of Stirling gave a brief position statement on cyber-physical systems relating these to embedded systems and characterising these as collections of embedded systems that network with each other. He listed unpredictable timing, power consumption, security, reliability and robustness as some of the central problems of cyber-physical systems.

Michele Sevegnani, who has recently completed his PhD at the University of Glasgow, spoke about runtime verification of domestic wireless network management with bigraphs with sharing. Examples such as WLANs were encoded in bigraphs.

Rob Arthan from Queen Mary, University of London, spoke about Hoare logics for continuous systems, in particular providing an algebraic semantics for linear control systems where signals are elements of vector spaces over the real numbers and blocks are linear transformations between spaces. This novel semantic account of such systems allows unstructured signal flow graphs to be transformed into structured block diagrams for analysis.

Michael Harrison from Newcastle University and Queen Mary, University of London, spoke about a particular instance of a cyber-physical system, a smart environment for hospital out-patients. The underlying concept is that cyber elements such as sensors, situated displays and personal electronic devices could be used to enhance patient experience. He reported on his work with rheumatology out-patients in Sheffield and oncology out-patients in London and considered models of patient journeys. A goal of the work is to complement traditional operations research using analysis supported by model-checking tools such as Promela and SPIN.