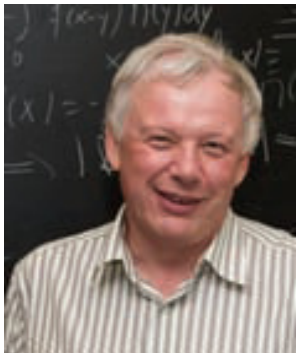
MANCHESTER 1824

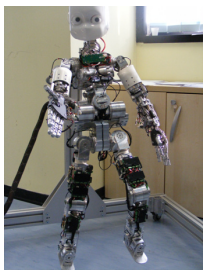
The University of Manchester

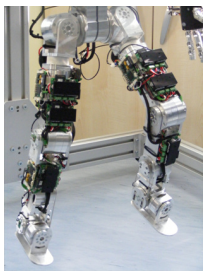
Newsletter 2,
September 2009

CICADA

Centre for Interdisciplinary Computational and Dynamical Analysis







Welcome

Welcome to the 2nd CICADA newsletter. The project started in November 2007 and the last 6 months have been quite productive. Four workshops have been organized and researchers in the 4 research themes have been making interesting progress. In addition, the centre has hosted 12 international visitors. In this newsletter, you'll find more information about these activities, as well as a profiled researcher, and details of future events. As always, full and up-to-date information can be found at our website: http://www.cicada.manchester.ac.uk/

Best wishes,

Prof David Broomhead

Meet Dr Piotr Kowalczyk

Piotr joined the CICADA project in February 2008, after having studied at Bristol and worked at Exeter. His work brings a dynamical systems theory approach to hybrid systems. He has been studying grazing-sliding bifurcations in continuous time, non-smooth dynamical systems. Together with Paul Glendinning he has been studying the effects of digitisation on the dynamics of these systems and has developed a theory of the kinds of instability and new dynamical behaviour that can arise.

Visit or Work With Us

If you are interested in any of this work, please get in touch. We're always interested in inviting people either to give seminars or to spend a longer time at the centre as a visitor.

Research Progress

Significant progress in the various research themes has been made in the past 6 months. Particular highlights include:

• Margarita Korovina's continued study of Pffafian hybrid systems, which are a subclass of hybrid systems which although include continuous dynamics, can be modelled with finite bisimulations. She has developed tools and algorithms for reachability analysis, and elucidated the satisfiability of viability constraints and invariants. This allows verification of some classes of safety critical systems.

• Marianne Johnson, Dave Broomhead, Steve Furber and Mark Kambites have shown how tropical geometric and max-plus algebra can be used to increase efficiency use of "clock stealing" in clocked systems of asychronous processors. This problem has been studied in a heuristic way, but the new insight developed here puts the technique on a firm footing and allows for a scalable algorithm to increase the efficient use of clock cycles. Prototype software has been written which proves the concept.

• Younes Chahlaoui has developed model reduction methods for linear time invariant systems. He has developed new rigorous error bounds and two approximation algorithms for balanced truncation.

These and other researches have resulted in 40 publications this year.

Research Directions

Current research is investigating:

• The use of linear switched systems stability theory to underpin hybrid model reduction.

• Example applications which draw together the dynamical systems and computational formalisms of hybrid systems.

• Application of ergodic theory and iterated function systems theory to digital control and machine learning.

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Workshops

In the past 6 months, four successful workshops/ symposia have been held at Manchester:

• Humanoid Robotics, Feb 2009

• Hybrid Systems & Model Reduction, March 2009

• Numerics for Control & Simulation, June 2009

• Computation & Dynamics of Continuous and

Discrete Processes, June 2009

The symposium on **Humanoid Robotics**, and the evening lecture attracted a total audience of ~200 people and was widely reported in the local and national media. The symposium was strongly supported by the Italian Institute of Technology (IIT) who, under Prof Darwin Caldwell, are responsible for manufacturing and further developing the iCub. The iCub is being used on the CICADA project as an exemplar complex control test bed.

The workshop on **Hybrid Systems & Model Reduction** discussed recent developments in the area of dynamical systems and model reduction, and identified these tools used in each field, that could be applied for effective investigations of hybrid systems. To this aim we looked at different formalisms used to tackle hybrid systems, the role of singular perturbations in dynamical systems as a model reduction tool, and at the recent developments in the model reduction theory.

The workshop on **Numerics for Control & Simulation** discussed the feasibility of using low-rank solutions in systems and control applications, discussed recent developments in algorithms for computing them, and reviewed applications in model reduction and simulation of large scale systems.

The conference on **Computation & Dynamics of Continuous and Discrete Processes** was held to celebrate the first anniversary of the official start of the project. Researchers on the CICADA project gave four presentations, in addition, Professor John Leigh (Case Western Reserve University, Ohio) spoke, encouraging us to use ideas from hybrid control to model how the cerebellum controls eye siccades; Professor Gabor Stepan (Budapest University of Technology & Economics) spoke about balance control in robots.

More information about the individual conferences can be found on the web site.

Industrial Applications

We have held two workshops exploring the applications of the work of CICADA. Our 1st Industrial Workshop was held in February. At these workshops we give representatives from industry the opportunity to describe some significant problems they would like to see us help address, and to influence our research directions. This workshop was attended by Airbus, AstraZeneca, BT, Google, IBM, NPL, Perceptive Engineering, Unilever and the Smith Institute. Keynote address was given by Professor John Ockendon FRS, Research Director of the Oxford Centre for Industrial and Applied Mathematics. This workshop led to further collaborations with some of the participants. Our next industrial workshop will take place towards the end of 2009. Please contact Helen Harper if you are interested in taking part.

We also held a workshop in May to meet with academic colleagues who work closely with applications or industry, in order to bring the tools and techniques being developed by CICADA into wider use. Problems considered included prediction problems in energy distribution networks, hybrid systems models in systems biology, and applications of computational finance to mining. CICADA is keen to work in partnership on interesting industrial problems which highlight interesting theoretical challenges and which would benefit from the tools and techniques being developed.

Forthcoming Events

• Industrial Workshop, winter 2009, dates TBA.

• Presentation of iCub robot in the Manchester Science Festival, October, 2009.

Contact Us

For more information about the CICADA project, please contact Mrs Helen Harper at:

School of Mathematics, Alan Turing Building, Manchester, M13 9PL

T: +44 (0)161 275 5856

E: helen.harper@manchester.ac.uk

or visit the website. The website contains full contact information for the academics and researchers working on the project as well as details about seminars, workshops and publications.