

## Newsletter 3, March 2010

# CICADA

Centre for Interdisciplinary Computational and Dynamical Analysis

### Welcome

Welcome to the 3rd CICADA newsletter. Since our last Newsletter in September 2009, researchers at CICADA have presented results at several major conferences, organised workshops and have continued to explore opportunities for interdisciplinary research. Our featured CICADA researcher this edition is Manuela Bujorianu. As ever, more detailed information can be found at:

<http://www.cicada.manchester.ac.uk>

Best wishes,  
Prof David Broomhead

### Research Progress

Particular highlights from the last 6 months include:

- **Piotr Kowalczyk** has been working on understanding the mechanism leading to the onset of complex (chaotic) dynamics in hybrid control systems with digital sampling. In addition, he has been extending his work on the theory of singularly perturbed systems to a class of slow-fast switched systems.

- **Pablo Shmerkin** has continued collaborating with M.Hochman and by integrating ideas in ergodic theory and fractal geometry they solved an open problem in dynamics due to H. Furstenberg. The techniques developed are now being applied to a wide variety of other problems. Pablo has also continued his research on the connections between fractal geometry and additive combinatorics, resulting amongst other things in a publication with J. Schmeling. He has developed his mathematical theory of iterated function systems further. In particular, he has made progress on understanding the geometric properties of self-affine sets, which are made up of smaller stretched copies of itself.

- **Younes Chahlaoui** has been looking at model reduction techniques for biology systems with CICADA colleagues and researchers at the Manchester Interdisciplinary Biocentre (MIB) in Manchester. Younes has also started some recent developments in the area of switched dynamical systems. He has introduced two new Gramians, solutions of special Linear Matrix Inequalities to come up with a balanced truncated like reduced model. With this approach the stability for the reduced model will be preserved. It should be said that it was implicitly supposed that each subsystem is stable. In addition, Younes is also considering the model reduction methods for structured systems, particularly second order systems and interconnected systems.

- **Margarita Korovina** is working on developing formal methods for safety analysis of dynamical and hybrid systems. Margarita and colleagues are considering construction of simulations and bisimulations based on encoding trajectories by words, approximate solving continuous constraints, inner and outer approximations of reachable sets. They have recently developed an algorithm for approximate solving of  $\sum_k$  - constraints which can be used for formalisation of switched controlled systems. They are also currently working on algorithms for optimal control of Pfaffian dynamical systems based on cylindrical cell decomposition and differential geometry tools with application to robot motion planning.



*In the CICADA Room: (From left to right): Piotr Kowalczyk, Manuela Bujorianu, Pablo Shmerkin, Margarita Korovina, Younes Chahlaoui and Jon Shapiro.*

### Research Directions

Current research is investigating:

- Several members of the group including Pablo Smerkin, Dave Broomhead, Martin Brown, Houman Dallali and Jon Shapiro have been exploring novel ways of applying iterated function system models to machine learning, digital control and models of walking robots.

- Dave Broomhead, Jon Shapiro, Younes Chahlaoui and Margarita Korovina have started the CICADA Collection – a collection of benchmark data sets, models and algorithms.

- Martin Brown, Paul Glendinning, Jon Shapiro and Houman Dallali have been looking at "falling robots" and are now developing links with psychologists at Manchester University.

- Steve Furber, also of CICADA, is providing insight into the building of "artificial brains".

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## Events

In the past 6 months, three successful workshops have been held at Manchester and one in London:

- CICADA and Social Sciences: An Afternoon of Problems.
- CICADA/Faculty of Life Sciences: Decoding the Brain: Open Questions in Neuroscience with Potential for Biology-Mathematics Collaboration.
- IET/IIT/CICADA Symposium on Humanoid Robotics and Evening Lecture by Prof Darwin Caldwell, Savoy Place, London.
- Network Dynamics" CoSyDy (Complex Systems Dynamics) Meeting, funded by CICADA and the LMS.

More information about the individual workshops can be found on the CICADA website and in our next newsletter.

## Forthcoming Events

**April 2010**, Workshop with MIB and researchers at the University of Aberdeen on "Dynamics of ribosome traffic on mRNAs"

**17-19 May 2010**, "Network Dynamics and Synchronization", International Workshop – confirmed speakers include – Prof Mike Field (Univ. of Houston), Prof Ian Stewart (Warwick), Prof Pete Ashwin (Exeter), Prof Celso Grebogi (Aberdeen)

**14 July 2010**, CICADA one-day conference on "Mathematics and Industry". Confirmed speakers include: Prof Peter Grindrod CBE, Dr Robert Leese (Smith Institute)

## Conference Highlights

Younes Chahlaoui was awarded a Royal Society Travel Award to attend the SIAM Conference on Applied Linear Algebra in Monterey, USA in October 2009. Nick Higham and Francoise Tisseur from CICADA also attended the conference.

Manuela Bujorianu and Martin Brown both gave papers at the IEEE Conference on Decision and Control in Shanghai, China in December 2009.

Margarita Korovina was given a travel award by the hosts to attend and present a paper at the Logical Approach to Barriers in Computing and Complexity last month in Greifswald, Germany.

## Contact Us

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## Industrial Applications

In our next edition we hope to introduce our new Knowledge Transfer Translator. A successful grant application for KTA funding means that we expect to appoint a person to this vital role shortly. Once in post the KTT will act as an interface between CICADA and industrialists. This will ensure that we have a dedicated resource focussed on the needs of industry and the business world.

We hope you will attend our one-day conference on "Mathematics and Industry" and meet the newest member of CICADA. The post will be advertised shortly at: <http://www.manchester.ac.uk/aboutus/jobs/>

## Meet Dr Manuela Bujorianu

Manuela was born in Romania, but came to the UK to carry out postgraduate studies at the University of Stirling. Manuela's activities at CICADA combine both teaching and research. In 2009 she lectured Vector Calculus and Laplace Transforms to a group of 150 students from Electrical Engineering. She has also taught Mathematics students Calculus and Mechanics. In order to promote interdisciplinary research, Manuela has organised a reading group in hybrid systems. Research-wise, Manuela has made presentations at some prestigious conferences (NFM'09, ADHS09, CDC'09, ICINCO'09) and she has reviewed many submissions in the areas of hybrid control systems and formal methods. She co-organised the Formal Methods for Aerospace workshop, a satellite event of FM'09. Manuela's future plans concern continuing and promoting interdisciplinary research in hybrid and cyber-physical systems and developing application of cyber-physical modelling in various areas, like aerospace and nano-engineering.

