Dear Colleague,

We are writing to bring to your attention the following one-day workshop:

**Annual Summer Systems & Control Workshop**

**Topic:** Dynamics and Control of Micro, Nano and Quantum Systems  
**Date:** Friday 15 February 2008  
**Venue:** University of Newcastle, Lecture Theatre ES 203 (Building ES)

**Speakers:**  
Professor Antoine Ferreira, ENSI Bourges, France  
Professor Ian Petersen, UNSW@ADFA  
Professor Minyue Fu, University of Newcastle  
Dr. Elanor Huntington, UNSW@ADFA  
Dr. Andrew Fleming, University of Newcastle

The workshop is **free but registration** is required by **Wednesday 13 February 2008** by email to Ms. Jayne Disney: Karen.Disney@newcastle.edu.au

Current details of the workshop can be found on the following web address:  
**http://scrg.ee.unsw.edu.au**

We would appreciate your posting this notice in a prominent place.

Sincerely,

Victor Solo  
Professor of Electrical Engineering  
University of New South Wales

Reza Moheimani  
Professor of Electrical and Computer Engineering  
University of Newcastle
Annual Summer Systems & Control Workshop
Dynamics and Control of Micro, Nano and Quantum Systems
Final Program

9:00   Registration
9:20   Opening

Session I:
Chair:   Professor Victor Solo
9:30 – 10:20  Professor Antoine Ferreira
Teleoperation at Micro, Nano and Atomic Scales: Current Prospects and
Future Challenges in Control
10:20 – 10:30   Floor discussion
10:30 – 11:00   Morning Tea

Session II:
Chair:    Dr. Jose De Dona
11:00 – 11:50  Professor Ian Petersen
$H_{\infty}$ Control of Linear Quantum Systems
11:50 – 12:00  Floor discussion
12:00 – 14:00   Lunch

Session III:
Chair:    Dr. Julio Braslavski
14:00 – 14:20  Dr. Elanor Huntington
Frequency locking of an optical cavity using LQC Integral Control
14:20 -14:30  Floor discussion
14:30 – 14:50  Dr. Andrew Fleming
Optimal Scan Trajectories for Micro- and Nano-Positioning Systems
14:50 – 15:00  Floor discussion
15:00 – 15:30   Afternoon Tea

Session IV:
Chair:   Professor Reza Moheimani
15:30 – 16:20  Professor Minyue Fu
Nonlinear Tracking Control for Dual-Stage Actuator Systems
16:20 – 16:30  Floor discussion
16:30   Close
Invited Speakers, Titles, Abstracts and Bios

Speaker: Professor Antoine Ferreira, ENSI Bourges, France

Title: Teleoperation at Micro, Nano and Atomic Scales: Current Prospects and Future Challenges in Control

Abstract: Recent advances in the field of nanotechnology have enabled widespread opportunities to investigate and manipulate matter at the micro and nanoscale with future developments at the atomistic scale. Atomic Force Microscopy (AFM) probes can be used to push, pull, cut, indent, and lithographically deposit nanoscale objects. Considering the micro/nano-specific problems related to task application, tools and the interconnection technologies leads to many flexible micro/nano/quantum manipulation concepts. They can range from direct teleoperation to full automatic manipulation with great challenging problems in dynamic modelling, control and teleoperation. In this talk, the current challenges and future prospects related to teleoperation control are discussed. First, open control challenges for teleoperated micro/nanorobotic manipulation are reported in this talk. We show that advanced robust control (such as, $H_\infty$, predictive control-, sliding mode-based controllers) increases greatly the robustness/stability of micro/nanomanipulation tasks while passivity-based controllers allows the improvement of transparency. Then, visual-servoing and virtual reality control architectures are proposed for the automation of micro/nanomanipulation with different levels of autonomy. Finally, new paradigms in advanced control techniques for atomistic manipulation will be reported for cell surgery, DNA and protein manipulation.

Bio: Antoine Ferreira is a Professor of Robotics Engineering at the Laboratoire Vision et Robotique, University of Orléans (France). He received the MS, PhD in Electrical and Electronics Engineering from the University of Franche-Comté (France) in 1993, 1996 respectively. In 1997 he was a Visiting Researcher at the ElectroTechnical Laboratory (ETL), in Tsukuba (Japan). He is a full Professor with the PRISME Institute, Ecole Nationale Supérieure d’Ingénieurs de Bourges (France). His main research interests are focused on the dynamic modeling and control of micro and nanorobotic systems using active materials, micro-nano-manipulation systems, biological nanosystems, bio-nanorobotics. He is an author of more than 100 journal and conference papers and book contributions.

Speaker: Professor Ian Petersen

Title: $H_\infty$ Control of Linear Quantum Systems

Abstract: The purpose of this talk is to formulate and solve a $H_\infty$ controller synthesis problem for a class of non-commutative linear stochastic systems which includes many examples of interest in quantum technology. The paper includes results on the class of such systems for which the quantum commutation relations are preserved (such a requirement must be satisfied in a physical quantum system). A quantum version of standard (classical) dissipativity results are presented and from this a quantum version of the Strict Bounded Real Lemma is derived. This enables a quantum version of the two Riccati solution to the $SH^\infty$ control problem to be presented. This result leads to controllers which may be realized using purely quantum, purely classical or a mixture of quantum and classical elements.

Bio: Ian R. Petersen was born in Victoria, Australia in 1956. He received a Ph.D in Electrical Engineering in 1984 from the University of Rochester. From 1983 to 1985 he was a Postdoctoral Fellow at the Australian National University. In 1985 he joined the University of New South Wales at the Australian Defence Force Academy where he is currently Scientia Professor and an Australian Research Council Federation Fellow in the School of Information Technology and Electrical Engineering. He has served as an Associate Editor for the IEEE Transactions on Automatic Control, Systems and Control Letters, Automatica, and SIAM Journal on Control and Optimization. Currently he is an Editor for Automatica. He was made a Fellow of the IEEE in 1999. His main research interests are in robust control theory, quantum control theory and stochastic control theory.
Speaker: Professor Minyue Fu

Title: Nonlinear Tracking Control for Dual-Stage Actuator Systems

Abstract: This talk discusses a nonlinear control method for dual-stage actuator (DSA) systems to track a step command input fast and accurately. Conventional tracking controllers for DSA systems were generally designed to enable the primary actuator to approach the setpoint without overshoot. However, we observe that this strategy is unable to achieve the minimal settling time when the setpoints are beyond the secondary actuator travel limit. To further reduce the settling time, we design the primary actuator controller to yield a closed-loop system with a small damping ratio for a fast rise time and certain allowable overshoot. Then, a composite nonlinear control law is designed for the secondary actuator to reduce the overshoot caused by the primary actuator as the system output approaches the setpoint. The proposed control method was applied to an actual DSA positioning system, which consists of a linear motor and a piezo actuator.

Minyue Fu received his Bachelor's Degree in Electrical Engineering from the University of Science and Technology of China, Hefei, China, in 1982, and M.S. and Ph.D. degrees in Electrical Engineering from the University of Wisconsin-Madison in 1983 and 1987, respectively.

From 1987 to 1989, he served as an Assistant Professor in the Department of Electrical and Computer Engineering, Wayne State University, Detroit, Michigan. He joined the Department of Electrical and Computer Engineering, the University of Newcastle, Australia, in 1989. Currently, he is a Chair Professor in Electrical Engineering. In addition, he was a Visiting Associate Professor at University of Iowa in 1995-1996, a Visiting Professor at Nanyang Technological University, Singapore, 2002 and at Tokyo University, Japan, 2003.

He is a Fellow of IEEE. His main research interests include control systems, signal processing and communications. He has been an Associate Editor for the IEEE Transactions on Automatic Control, Automatica and Journal of Optimization and Engineering.

Title: Frequency locking of an optical cavity using LQC Integral Control

Speaker: Dr. Elanor Huntington, UNSW@ADFA

Abstract: This presentation will discuss the application of LQG integral control theory to a problem of cavity locking in quantum optics. The objective in cavity locking is to controlling the error between the laser frequency and the cavity frequency. A model for the cavity system, which comprises a piezoelectric transducer and an optical cavity is determined in the frequency domain using a subspace identification method. An LQG controller which includes integral action is synthesized to stabilize the frequency of the cavity at the laser frequency and to reject low frequency disturbances inherent in quantum optical systems. The controller is discretised and successfully tested in the laser laboratory.

Bio: Elanor Huntington is an experimentalist working in the field of quantum electronics. Elanor's expertise lies in high-precision measurement and signal processing techniques, quantum optical control engineering, and the application of continuous variable quantum optical techniques to discrete variable quantum optical systems. She completed her PhD in experimental quantum optics at the Australian National University in 2000. After a brief stint at the Australian Defence Science and Technology Organisation, Elanor joined the University of New South Wales at the Australian Defence Force Academy campus in Canberra. She is currently a Senior Lecturer, has over 30 refereed experimental journal papers and is a Program and Node Manager in the ARC Centre for Quantum Computer Technology.