

2008-2009

Graduate Seminar Series

The Department of Mechanical Engineering – Engineering Mechanics

Proudly Presents

Professor Bin Yao
Purdue University

Dr. Yao received his Ph.D. in Mechanical Engineering from the University of California at Berkeley in 1996. He obtained the M.Eng. degree in Electrical Engineering from the Nanyang Technological University, Singapore, and the B.Eng. in Applied Mechanics from the Beijing University of Aeronautics and Astronautics, P.R.China. Since 1996, he has been with the School of Mechanical Engineering at Purdue University, becoming a full Professor in 2007. He is honored as a [Kuang-piu Professor](#) at the [Zhejiang University](#) in China.



Dr. Yao was awarded a [Faculty Early Career Development \(CAREER\) Award](#) from the National Science Foundation (NSF) in 1998 and a [Joint Research Fund for Outstanding Overseas Chinese Young Scholars](#) from the [National Natural Science Foundation of China \(NSFC\)](#) in 2005. His research interests include the design and control of intelligent high performance coordinated control of electro-mechanical/hydraulic systems, optimal adaptive and robust control, nonlinear observer design and neural networks for virtual sensing, modeling, fault detection, diagnostics, and adaptive fault-tolerant control, and data fusion. He has published over 150 technical papers while enjoying the theory application via industrial consulting. He is the recipient of the [O. Hugo Schuck Best Paper \(Theory\) Award](#)

from the [American Automatic Control Council](#) and the [Outstanding Young Investigator Award](#) of the [ASME Dynamic Systems and Control Division](#) (DSCD). He is a member of ASME and IEEE and has chaired numerous sessions and served in a number of International Program Committee of various IEEE, ASME, and IFAC conferences. He has been Chair of the Adaptive and Optimal Control Panel and the Chair of the Fluid Control Panel of the ASME Dynamic Systems and Control Division (DSCD). He is currently the Vice-Chair of the ASME DSCD Mechatronics Technical Committee, which he initiated in 2005. He has been a Technical Editor of [the IEEE/ASME Transactions on Mechatronics](#) and since 2006 an Associate Editor of [the ASME Journal of Dynamic Systems, Measurement, and Control](#).

Thursday, Apr. 23, 2009 3:00 – 4:00 p.m. Room 112, ME-EM Bldg.

Nonlinear Adaptive Robust Control – Theory and Applications

Control of nonlinear systems with uncertainties has been one of the mainstream areas of focus in control community for the past twenty years. Two approaches have been popular: robust adaptive control and deterministic robust control (DRC). This talk will present a theoretically solid nonlinear adaptive robust control (ARC) approach that well reflects what a human brain normally does -- seamless integration of the fast reaction to immediate feedback information and the slow learning utilizing large amount of stored past information that is available in the computer based control systems -- to synthesize *performance oriented controllers with built-in intelligences* under practical constraints.

The first half of the seminar focuses on the basic ideas of ARC strategy and touches some specific design issues. The issues include: (i) means to achieve fast robust feedback; (ii) learning techniques (e.g., parameter adaptation) to reduce model uncertainties for an improved performance; (iii) desired compensation structure to alleviate the effect of measurement noises, (iv) direct and indirect ARC designs, and (v) integrated direct/indirect ARC design. The constructed ARC controllers range from the full-state feedback ARC for MIMO nonlinear systems in semi-strict feedback forms and the nonlinear observer based ARC for a class of nonlinear systems with partial state feedback to the output feedback ARC for uncertain linear systems with bounded disturbances.

The second half the seminar focuses on the applications of the proposed ARC approach to the intelligent and precision control of several electro-mechanical/hydraulic systems. The applications include the precision motion control of linear motor driven high-speed/high-acceleration electro-mechanical devices (e.g., machine tools) for precision manufacturing, the ultra precision motion control of piezo-actuator driven devices for nano-positioning, the motion and pressure control of electro-hydraulic systems (e.g., industrial hydraulic excavators), the energy-saving control of electro-hydraulic systems via novel programmable valves, and the coordinated motion and force tracking control of robot manipulators in contact with various contacting surfaces. In particular, experimental results on the precision motion control of a linear motor driven industrial gantry system will be shown to illustrate the high performance nature of the proposed ARC approach.

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