Department of Manufacturing Engineering and Engineering Management

Seminar Series

Online Learning Design of Optimal Control Systems

by

Prof. F. L. Lewis

Fellow IEEE, Fellow IFAC, Fellow U.K. Inst. MC
Head, Advanced Controls & Sensors Group
Automation & Robotics Research Institute
The University of Texas at Arlington, USA

Jointly organized by Centre for Chaos and Complex Networks

Date: **Jan. 13**, 2010 (Wednesday)
Time: 11:00am (Tea Reception at 10:45am)
Venue: B6619, MEEM Conference Room

ABSTRACT

Optimal Control Design has been responsible for much of the successful performance of aircraft control systems since the 1960s. Linear Quadratic Regulator or Linear Quadratic Gaussian design has been used in stability augmentation systems, control augmentation systems, and autopilots to yield guaranteed performance. H-infinity robust control has been used for stabilization of systems with disturbances. LQR/LQG/H-infinity design is performed offline by solving optimal design equations including the algebraic Riccati equation and the Game ARE. It is difficult to perform optimal designs for nonlinear systems since they rely on solutions to complicated Hamilton-Jacobi or HJI equations.

Online Learning of LQR and H-Infinity Solutions. In this talk we discuss online algorithms for learning continuous-time optimal control solutions for nonlinear systems with known dynamics. This is a novel class of adaptive control algorithms that converge to optimal control solutions by online learning in real-time. In the linear quadratic (LQ) case, the algorithms learn the solution to the ARE by adaptation along the system motion trajectories. In the case of nonlinear systems with general

performance measures, the algorithms learn the (approximate smooth) solutions of HJ or HJI equations. The algorithms are based on reinforcement learning techniques.

Online Gaming. For 2-player zero-sum games, this is an Online Gaming method that can learn in real-time suitable approximations of the optimal value, and the saddle point control policy and disturbance policy, while also guaranteeing closed-loop stability. The adaptive algorithm is implemented as a reinforcement learning actor/critic structure which involves simultaneous continuous-time adaptation of critic, control action, and disturbance approximator networks.

BIOGRAPHY

Prof. F.L. Lewis, Fellow IEEE, Fellow IFAC, Fellow U.K. Institute of Measurement & Control, PE Texas, U.K. Chartered Engineer, is Distinguished Scholar Professor and Moncrief-O'Donnell Chair at University of Texas at Arlington's Automation & Robotics Research Institute. He obtained the Bachelor's Degree in Physics/EE and the MSEE at Rice University, the MS in Aeronautical Engineering from Univ. W. Florida, and the Ph.D. at Ga. Tech. He works in feedback control, intelligent systems, distributed control systems, and sensor networks. He is author of 6 U.S. patents, 216 journal papers, 330 conference papers, 14 books, 44 chapters, and 11 journal special issues. He received the Fulbright Research Award, NSF Research Initiation Grant, ASEE *Terman Award*, Int. Neural Network Soc. *Gabor Award* 2009, U.K. Inst Measurement & Control *Honeywell Field Engineering Medal* 2009. Received Outstanding Service Award from Dallas IEEE Section, selected as Engineer of the year by Ft. Worth IEEE Section. Listed in Ft. Worth Business Press Top 200 Leaders in Manufacturing. He served on the NAE Committee on Space Station in 1995. He is an elected Guest Consulting Professor at South China University of Technology and Shanghai Jiao Tong University. Founding Member of the Board of Governors of the Mediterranean Control Association.

Enquiry: 2788 8420

All are welcome!

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