臺大 電機系 自動控制組
專 題 演 講

L1 Adaptive Control and Its Transition to Practice

Time: September 19 (Wed) 3:30pm

Room: 明達館 2F, MD-205

Speaker: Prof. Naira Hovakimyan
Department of Mechanical Science and Engineering
University of Illinois at Urbana-Champaign

Abstract：

The history of adaptive control systems dates back to early 50-s, when the aeronautical community was struggling to advance aircraft speeds to higher Mach numbers. In November of 1967, X-15 launched on what was planned to be a routine research flight to evaluate a boost guidance system, but it went into a spin and eventually broke up at 65,000 feet, killing the pilot Michael Adams. It was later found that the onboard adaptive control system was to be blamed for this incident. Exactly thirty years later, fueled by advances in the theory of nonlinear control, Air Force successfully flight tested the unmanned unstable tailless X-36 aircraft with an onboard adaptive flight control system. This was a landmark achievement that dispelled some of the misgivings that had arisen from the X-15 crash in 1967. Since then, numerous flight tests of Joint Direct Attack Munitions (JDAM) weapon retrofitted with adaptive element have met with great success and have proven the benefits of the adaptation in the presence of component failures and aerodynamic uncertainties. However, the major challenge related to stability/robustness assessment of adaptive systems is still being resolved based on testing the closed-loop system for all possible variations of uncertainties in Monte Carlo simulations, the cost of which increases with the growing complexity of the systems. This talk will give an overview of the limitations inherent to the conventional adaptive controllers and will introduce the audience to the L1 adaptive control theory, the architectures of which have guaranteed robustness in the presence of fast adaptation. Various applications, including flight tests of a subscale commercial jet, will be discussed during the presentation to demonstrate the tools and the concepts. With its key feature of decoupling adaptation from robustness L1 adaptive control theory has facilitated new developments in the areas of event-driven adaptation and networked control systems. It is currently being evaluated on Learjet for various failure modes with a flight test schedule being confirmed for early March 2015..

Biography：

Naira Hovakimyan received her MS degree in Theoretical Mechanics and Applied Mathematics in 1988 from Yerevan State University in Armenia. She got her Ph.D. in Physics and Mathematics in 1992 from the Institute of Applied Mathematics of Russian Academy of Sciences in Moscow, majoring in optimal control and differential games. Before joining the faculty of UIUC in 2008, she spent time as a research scientist at Stuttgart University in Germany, French Institute for Research in Computer Science and Automation (INRIA) in France, at the Georgia Institute of Technology, and she was on faculty of Aerospace and Ocean Engineering of Virginia Tech from 2003 to 2008. She is currently a W. Grafton and Lillian B. Wilkins Professor of Mechanical Science and Engineering at UIUC. In 2015 she was named inaugural director for Intelligent Robotics Lab of Coordinated Science Laboratory at UIUC. She has co-authored two books, six patents and more than 350 refereed publications. She was the recipient of the SICE International scholarship for the best paper of a young investigator in the VII ISDG Symposium (Japan, 1996), the 2011 recipient of AIAA Mechanics and Control of Flight award, the 2015 recipient of SWE Achievement Award, and the 2017 recipient of IEEE CSS Award for Technical Excellence in Aerospace Controls. In 2014 she was awarded the Humboldt prize for her lifetime achievements. In 2015, she was awarded the UIUC Engineering Council award for Excellence in Advising. She is Fellow and life member of AIAA, a Fellow of IEEE, and a member of SIAM, AMS, SWE, ASME and ISDG. She is cofounder and chief scientist of IntelinAir. Her work in robotics for elderly care was featured in the New York Times, on Fox TV and CNBC. Her research interests are in control and optimization, autonomous systems, neural networks, game theory and their applications in aerospace, robotics, mechanical, agricultural, electrical, petroleum, biomedical engineering and elderly care.