The 32nd Chinese Control Conference

Pre-conference Workshop 2

Speaker: Zhang Youmin, Concordia University, Canada

Title: Research and Development on Fault Diagnosis, Fault-Tolerant and Cooperative Control with Applications to Manned and Unmanned Aircraft Systems

Biography

Zhang Youmin is an Associate Professor in the Department of Mechanical and Industrial Engineering and also with the Concordia Institute of Aerospace Design and Innovation (CIADI) & Concordia Institute for Water, Energy and Sustainable Systems (CIWESS) at Concordia University, Canada. Prof. Zhang received his Ph.D. degree in 1995 from the Department of Automatic Control, Northwestern Polytechnical University (NPU), Xi'an, China. He was early promoted as an Associate Professor in 1992 while he worked at NPU. Before joining in Concordia University, he held several teaching and research positions previously in NPU, University of New Orleans, Louisiana State University, State University of New York at Binghamton, The University of Western Ontario, and Aalborg University, respectively.

His main research interests and experience are in the areas of condition monitoring, fault diagnosis and fault-tolerant (flight) control systems; cooperative guidance, navigation and control of unmanned aerial/ground/surface/underwater vehicles; dynamic systems modeling, estimation, identification and control; and advanced signal processing techniques for diagnosis, prognosis and health management of safety-critical systems, renewable energy generation and distribution systems, water distribution systems, and manufacturing processes. He has published 4 books with co-authors (including a book on "Active Fault Tolerant Control Systems: Stochastic Analysis and Synthesis" (2003) and a book on "Fault Diagnosis and Fault Accommodation for Control Systems" (2009)), over 250 journal and conference papers. His comprehensive review paper published at Annual Reviews in Control on "Bibliographical Review on Reconfigurable Fault-tolerant Control Systems" has gained significant impact in the field worldwide. The paper has been ranked No. 1 in the "Most Cited Articles" published since 2007 and the highest citation ever in the journal after the paper published in Dec. 2008. Prof. Zhang has been invited to give international

conference plenary talks, research seminars, and tutorials/workshops worldwide for more than 40 times since 2005. He is a senior member of AIAA, a senior member of IEEE, a member of the IFAC Technical Committee on Fault Detection, Supervision and Safety for Technical Processes, a member of the AIAA Infotech@Aerospace Program Committee (PC) on Unmanned Systems, a member of the IEEE Robotics and Automation Society Technical Committee (TC) on Aerial Robotics and Unmanned Aerial Vehicles, and a member of the ASME/IEEE TC on Mechatronics and Embedded Systems and Applications (MESA). He is an Editorial Board Member and/or (Associate) Editor of several international journals (including the two new journals of Unmanned Systems and International Journal of Intelligent Unmanned Systems) and IPC member of many international conferences.

Abstract:

Unmanned Aerial Vehicles (UAVs)/Unmanned Aircraft Systems (UASs) are gaining more and more attention during the last few years due to their important contributions and cost-effective applications in several tasks such as sense, surveillance, reconnaissance, border patrol, search and rescue, flood, earthquake and other natural disasters aids, and forest fire, power line and pipeline monitoring, military and security missions, or under circumstances where it is highly risky for human pilots to be physically involved. On the other hand, health management, fault detection and diagnosis, and fault-tolerant control of manned aerial vehicles have a long history since the initial research on self-repairing flight control systems in US Air Force and NASA begun in mid-1980s. However, due to safety concern of manned aerial vehicles to the pilot, experimental tests and further practical research and development have been limited. Benefited from the recent and significant advance and development of UAVs, development and application of autonomous, fault-tolerant, as well as cooperative control techniques have been emerged and developed quickly in recent years, since UAVs provide a cheap and operative experimental testbed for development, implementation, testing and validation of the newly developed autonomous, fault-tolerant, as well as cooperative guidance, navigation and control techniques. Such an active research and development was also mainly motivated by the new or emerging applications of UAVs to the above-mentioned applications with lower cost.

In this tutorial, a brief and historical review on the research and development of Fault Detection and Diagnosis (FDD) and Fault-Tolerant Control (FTC) techniques in manned aircraft systems will be presented firstly; then the challenges and opportunities on autonomy, fault-tolerant control, and cooperative control of single and multiple unmanned aircraft systems will be given secondly; and finally the latest developments and current research works in this active research and development area with applications examples to manned/unmanned fixed-wing and quadrotor helicopter UAV testbeds developed at the

Diagnosis, Flight Control and Simulation Lab (DFCSL) and Networked Autonomous Vehicles Lab (NAVL) of Concordia University will be introduced. Linear and nonlinear techniques for modeling, FDD, FTC, path and trajectory planning/re-planning, cooperative/formation flight guidance, navigation and control, based on a set of quadrotor helicopter UAVs and fixed-wing aircraft/UAV testbeds, will be presented in the tutorial. Furthermore, fault diagnosis, fault-tolerant control, and cooperative control strategies development with practical application scenarios on surveillance and coverage control with multiple unmanned systems will also be presented, together with demonstration of the experimental flight-testing videos.