

Model-guided, Data-driven, AI-enhanced Flight Intelligence in Autonomy

Professor Hugh H.T. Liu
Institute for Aerospace Studies
University of Toronto

Abstract

This talk presents three case studies on intelligent flight control for autonomous aerial systems. First, time-optimal trajectory planning for drone racing exploits bang-singular-bang control structure, with Model Predictive Contouring Control enabling high-speed tracking. Second, Physics-Informed Neural Networks are used to learn Control Contraction Metrics for nonlinear control synthesis, applied to cooperative slung-load transport and multi-agent swarm coordination. Third, a quantitative, multidimensional trust measurement framework is introduced for Human – Multi-Agent Systems in Advanced Air Mobility. Together, these studies demonstrate a unified approach combining model-based optimization, deep learning, and AI-enhanced human – autonomy teaming.



Hugh H.T. Liu is a Professor of the University of Toronto Institute for Aerospace Studies, where he has been on the faculty since 2000. He currently also serves as the Director of Natural Science and Engineering Research Council of Canada (NSERC) Collaborative Research and Training Experience (CREATE) Program on Unmanned Aerial Vehicles and Centre for Aerial Robotics Research and Education. In 2022, he was named as the fellow of Canadian Academy of Engineering. The Canadian Aeronautics and Space Institute (CASI) Senior Awards recognizes Canadians for their outstanding achievement in aeronautics, space and related technologies. For the 2021 Senior Awards, Professor Hugh H.T. Liu was awarded the CASI McCurdy Award, presented for his outstanding achievement in the science and creative aspects of engineering relating to aeronautics and space research. His research interests in the area of aircraft systems and control include autonomous unmanned systems, cooperative and formation control, fault tolerant control, active control on advanced aircraft systems, as well as integrated modeling and simulations. He currently serves as the Associate Editor of AIAA Journal of Guidance, Control and Dynamics. He is also an Associate Editor of the Canadian Aeronautics and Space Journal. Dr. Liu is a fellow of Engineering Institute of Canada, an Associate Fellow of AIAA, a Fellow of Canadian Society of Mechanical Engineers, and a registered Professional Engineer in Ontario, Canada.