MECHANICAL & MATERIAL COLLOQUIUM

Extreme Aerodynamics: Flying in Highly Gusty Conditions

by Kunihiko Taira (University of California, Los Angeles)

An air vehicle attempting to operate in adverse weather conditions or in the wakes of urban canyons and mountainous terrains would be affected by strong atmospheric disturbances. In such extreme aerodynamic conditions, flight control becomes a great challenge, if not impossible, due to the enormous transient forces that the vehicle experiences. Currently, encounters with these extreme flow phenomena limit the operations of fixed and rotating wing aircraft, especially those that are small to medium in size. The present study focuses on the analysis, modeling, and control of extreme aerodynamic flows, characterized by unsteadiness with amplitudes far larger than those considered in traditional aerodynamics, on a time scale comparable to that of flow instabilities. The high dimensionality, strong nonlinearity, and multi-scale properties of these extreme flows make systematic analysis and control a tremendous challenge. Without the reduction of the state variable dimension and extraction of dominant dynamics, the application of dynamical systems and control theory for flight/flow control remains difficult. This talk will present our research group's recent efforts to model and control such complex fluid flows by leveraging data-driven techniques. We will discuss the use of unsupervised and supervised machine learning techniques and how they can be incorporated into existing flow analysis techniques. Equipped with these modern toolsets, we extract the manifolds of extreme aerodynamics to facilitate the development of sparse and reduced-order models to design flow control techniques. Some of the successes in characterizing, modeling, and controlling extreme aerodynamic flows will be presented, followed by discussions on open problems and outlooks.

****

Dr. Kunihiko Taira is a Professor of Mechanical and Aerospace Engineering at UCLA, working in the areas of unsteady aerodynamics and flow control through computational and data-driven approaches. Prior to joining his current institution, he was a faculty member at Florida State University. He received his B.S. from the University of Tennessee, Knoxville, and his M.S. and Ph.D. from the California Institute of Technology. He is a recipient of the 2013 AFOSR Young Investigator Award, the 2017 ONR Young Investigator Award, and the 2022 Department of Defense Vannevar Bush Faculty Fellowship. He is a Fellow of APS and an Associate Fellow of AIAA. He currently serves as an Associate Editor for Physical Review Fluids and has served as an Associate Editor for the AIAA Journal and Theoretical and Computational Fluid Dynamics.

Place: Virtually
Time: 2:00-2:55PM
Jan. 27, 2026

Zoom ID: 862 6129 4870 Passcode: z4SkM2

For questions, comments and suggestions, contact Colloquium Organizers Dr. Saja AL Rifai (salrifai@fiu.edu) or Dr. Jiuhua Chen (chenj@fiu.edu)