Center for Environmental & Applied Fluid Mechanics

Change to Tuesdays

"Stochastic Estimation and Reinforcement Learning Control of Disturbed Aerodynamic Flows"

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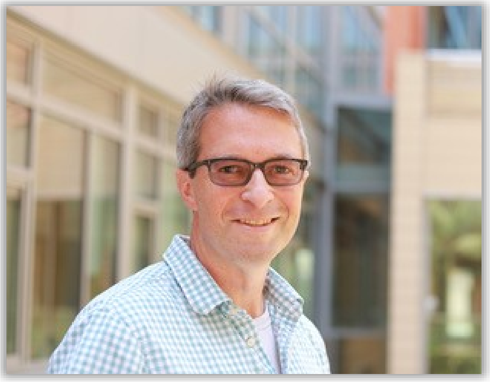

Abstract: There is a wide variety of applications in which we may need knowledge of a transient fluid flow, but we only have information from a few noisy sensors. For example, small flight vehicles, targeted for many emerging applications, are more agile but also more strongly affected by unexpected disturbances ('gusts') than larger vehicles. The nonlinear aerodynamics of these gust encounters remains a principal challenge in controlling the vehicle's flight. In particular, any flight control strategy is generally more effective if it can rely on an estimation of the vehicle's current flow state from available sensors. In this talk, I will discuss the dynamic estimation of flows from limited sensor data, and the control of the flow with deep learning strategies. In the first part, I will discuss aspects of the flow estimation problem within the context of Bayesian inference and ensemble Kalman filters, which allow us to easily combine physics-based and/or data-driven models of the flow with measurement data from sensors. The assimilation of these measurements can compensate for the physics that are unrepresented in the model. In the examples I will show, we use the estimation framework to predict the fluid dynamics of a separated aerodynamic flow subjected to a gust, relying on the surface pressure measurements to inform the model of the gust. Then, I will discuss the use of deep reinforcement learning to develop strategies for the mitigation of gust encounters, based on available sensor data.

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February 4, 2025 ⌘ 3:00 PM ⌘ Hodson 210