Weekly CEAFM Seminar: Fall 2016

JOHNS HOPKINS
Center for Environmental
& Applied Fluid Mechanics

Date: **Friday, November 4, 2016**

Time: 11:00 AM

Location: Gilman Hall # 50

Speaker: **Dr. Takao Suzuki** (The Boeing Company - Seattle)

Title: ***"Hybrid unsteady-flow simulation combining PIV/PTV and DNS: Family of data-assimilation algorithms and their capabilities"***

Abstract

Applications of state-of-the-art techniques integrating time-resolved particle image velocimetry (PIV) with unsteady computational fluid dynamics (CFD) are recently expanding. Techniques of this type can serve for purposes of data assimilation, filtering of measurement noise, extraction of reduced-order models, unsteady pressure estimation, compensation of missing/sparse data, and combination of some of these. We have developed a series of hybrid-unsteady-simulation techniques combining particle tracking velocimetry (PTV) and direct numerical simulation (DNS), and demonstrated their capability by solving unsteady laminar flows past an airfoil and planar-jet flows. Unsteady velocity fields on a laser sheet in a water tunnel are acquired with time-resolved PTV; subsequently, PTV velocity fields are rectified in a least-squared sense to satisfy the continuity, and they are transplanted to a two-dimensional incompressible Navier—Stokes solver by setting a multiple of the computational time-step equal to the frame rate of the PTV system. The hybrid velocity field is then assimilated into that of the measured one over time with the resolution equivalent to DNS and the noise level much lower than the original PTV data. Unsteady pressure fields can be simultaneously computed, and the set of the computed flow quantities essentially satisfies the governing equations. This presentation introduces hierarchy of hybrid simulations from a reduced-order approach consisting of proper orthogonal decomposition (POD) and the Galerkin projection to a high-fidelity approach adopting the extended Kalman filter, and compares the data-assimilation capabilities of these algorithms.