Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Integrating sensor data into reduced-order models with deep learning NIRMAL JAYAPRASAD NAIR, ANDRES GOZA, University of Illinois at Urbana-Champaign — Efficiently leveraging limited sensor data in reduced-order models (ROMs) is key to enabling real-time control of a range of fluid flows. Two primary challenges to achieving this goal are: i) while the ROM evolves on a low-dimensional space, sensor data is typically related to the ROM via an intermediate step that involves the high-dimensional fluid state, ii) although a physical interpretation of the ROM state space may be derived, it is rarely obvious how to directly relate physical measurements to this low-dimensional representation. To address both challenges, we propose a flow-field estimation methodology where the sensor data is directly mapped to the ROM state space without involving the high-dimensional flow state. The flow-field can be efficiently recovered via the ROM approximation, if desired. We employ a neural-network architecture that learns the nonlinear mapping between the sensors and state space. We emphasize that the proposed estimation framework is agnostic to the ROM employed, and can therefore be incorporated into ROMs derived by Galerkin projection, regression, etc. Our methodology is demonstrated on problems involving parametric 1D diffusion and 2D flow over an airfoil.

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Date submitted: 22 Jul 2019 Electronic form version 1.4