Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Probabilistic cluster-based feedback control of fluid flow dynamics[1] VEDASRI GODAVARTHI, CHI-AN YEH, Department of Mechanical and Aerospace Engineering, University of California, Los Angeles, CA 90095, USA, EURIKA KAISER, Department of Mechanical Engineering, University of Washington, Seattle, WA 98115, USA, KUNIHIKO TAIRA, Department of Mechanical and Aerospace Engineering, University of California, Los Angeles, CA 90095, USA — We develop a cluster-based feedback control strategy to modify the evolution of flow states to a desired dynamics using limited temporal measurements capturing the flows attractor. The flow state is encoded into a low-dimensional feature space, which is partitioned into a small number of clusters and where each flow state is represented by a cluster probability vector. The evolution of the cluster probability vector is given based on the transition probability matrix, which encodes the transitions among the clusters. We formulate an LQR problem to control the cluster probability vector to a desired distribution. The control gain matrix is translated to an optimal feedback control law in the physical space using an estimated scaling function. We first demonstrate this probabilistic control approach on two canonical oscillators: a Lorenz-63 system with bistability and a coupled Fitz-Hugh Nagumo oscillator system that exhibit extreme events. Using DNS, we also employ this control strategy to reduce the pressure fluctuations over a 2D cavity using limited sensor measurements on the cavity wall. The present approach is developed for real-time characterization and control of complex flow dynamics.

[1]We acknowledge the support from AFOSR (FA9550-16-1-0650 and FA9550-17-1-0380)

Vedasri Godavarthi
Department of Mechanical and Aerospace Engineering, University of California, Los Angeles, CA 90095, USA

Date submitted: 10 Aug 2020 Electronic form version 1.4