Graduate Student Research Seminar

Fall 2021

Koopman Operator Based Flow Parameter Estimation with Applications to Underwater Robotics

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3:00 pm (EST) – 132 Fluor Daniel Building

Abstract

One key area of research in autonomous control is the ability to identify parameters of the environment based on limited sensing data. Existing approaches are effective at this task where there is an accurate underlying model and there is sufficient data to assure observability, but it is difficult to apply these to complex systems such as an autonomous vehicle in a dynamic road environment or an aquatic robot submersed in high Reynolds number fluid. Finite-dimensional approximations of the infinite-dimensional Koopman operator have seen recent interest for their ability to lift the complex dynamics of observables to a linear approximation of the system. In this work we use a Koopman operator approximation derived from limited surface pressure and angular velocity data from a pinned airfoil with an angular spring in a water tunnel environment simulated in OpenFOAM to perform flowfield estimation, specifically estimating the position of an upstream obstacle and the free-stream velocity. Exploiting modern convolutional neural network estimation routines, we compare estimation based on the approximated Koopman operator to direct estimation based on the time-series data, and explore the effects of different methods of pre-processing the Koopman operator prior to classification.

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