Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Cause-and-effect relationships in tandem swimmer models using transfer entropy[1] SEAN PETERSON, Mechanical and Mechatronics Engineering, University of Waterloo and Department of Mechanical and Aerospace Engineering, New York University , MAXWELL ROSEN, Department of Applied Physics, New York University Tandon School of Engineering, ANTONIOS GEMENTZOPOULOS, PENG ZHANG, MAURIZIO PORFIRI, Department of Mechanical and Aerospace Engineering, New York University Tandon School of Engineering — Swimming in a group affords a number of advantages to fish, including an enhanced ability to escape from predators, search for food, and mate. To study coordinated movements of fish, principled approaches are needed to unravel cause-and-effect relationships from raw-time series of multiple bodies moving in an encompassing fluid. In this work, we aim at demonstrating the validity of transfer entropy to elucidate cause-and-effect relationships in a fluid-structure interaction problem. Specifically, we consider two tandem airfoils in a uniform flow, wherein the pitching angle of one airfoil is actively controlled while the other is allowed to passively rotate. The active control alternates the pitch angle based upon an underlying two-state ergodic Markov process. We monitor the pitch angle of both the active and passive airfoils in time and demonstrate that transfer entropy can detect causality independent of which airfoil is actuated. The influence estimated by transfer entropy is found to be modulated by the distance between the two airfoils. The proposed data-driven technique offers a model-free perspective on fluid-structure interactions that can help illuminate the mechanisms of swimming in coordination.

[1]This work was supported by the National Science Foundation under grant numbers CBET-1332204 and CMMI-1433670.

Peng Zhang
Department of Mechanical and Aerospace Engineering, New York University Tandon School of Engineering

Date submitted: 01 Aug 2017 Electronic form version 1.4