Learning Fluid Dynamics from Animals: Changing Shape to Efficiently Generate Large Fluid Forces

Gabriel Weymouth

Associate Professor; Department of Engineering and Environment, University of Southampton

Many high performance applications demand large instantaneous fluid forces for high-speed maneuvering and improved power efficiency for sustained propulsion. Animals achieve remarkable feats of maneuvering and efficiency by changing their body shape to generate unsteady fluid forces. Inspired by this, we have studied a range of immersed bodies which drastically change their shape to produce fluid forces. These include relatively simple shape-changes, such as quickly changing the angle of attack of a foil to induce emergency stops and the use of tandem flapping foils to generate three times the average propulsive force of a single flapping foil. They also include more unconventional shape-changes such high-speed retracting foil sections to power roll and dive maneuvers and the use of soft robotics to rapidly shrink the frontal area of an ellipsoid to power 65% efficient fast-start maneuvers or even completely cancel the drag force on a bluff body with 91% efficiency. These systems have been investigated with both full-field experimental measurements and Cartesian-grid immersed-boundary numerical simulations.

Bio: Dr. Gabriel Weymouth is a Southampton Marine and Maritime lecturer in the Fluid Structure Interactions Research Group at the University of Southampton. He was previously a Lead Research Scientist at the Singapore MIT Alliance for Research and Technology in Singapore (2010-2013). His research focuses on the development of fast, accurate, and robust computational fluid dynamic predictions and application of those techniques to diverse elements of the marine and maritime environments - particularly in the domains of offshore and biologically inspired engineering. He leads three international research collaborations between the UK, US and Singapore, and created the open source project Lily Pad as a teaching and research platform for fluid/structure simulations which is being used in universities around the world.