MIDWEST MECHANIC SEMINAR

Dissecting the Causality of Pressure Forces in Vortex Dominated Flows - From Fish Schools to Noisy Drones

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3:30PM-4:20PM HAMP 1144

RAJAT MITTAL

Professor of Mechanical Engineering
Professor of Medicine
John Hopkins University

Abstract:
Pressure-induced drag and lift are key to the performance of wings, rotors and propellers; undulating fins and flapping wings generate forces that are key to locomotion in fish, birds and insects; time-varying fluid dynamic forces drive flutter and flow-induced vibrations of flexible structures in engineering and biology, and these same forces enable the extraction of energy from flow via devices such as wind-turbines. Pressure on a body immersed in a flow is however induced simultaneously by vortices, acceleration reaction (a.k.a. added mass) effects associated with body and/or flow acceleration, and viscous diffusion of momentum, and determining the relative contribution of these different mechanisms on surface pressure remains one of the most important and fundamental issues in fluid dynamics. I will describe the force partitioning method (FPM), a new data-enabled method that partitions pressure forces into components due to vorticity, acceleration reaction and viscous diffusion. FPM has been used to gain new insights into a variety of vortex dominated flows including dynamic stall in pitching foils, vortex-induced vibration of bluff-bodies, hydrodynamics of schooling fish and rough-wall boundary layers, and results from these analyses will be presented. Application of FPM to data generated from experiments will also be described. Finally, FPM has been extended to aeroacoustics, and applications of the aeroacoustic partitioning method (APM) to dissect aeroacoustic noise in engineering and biological flows will be presented.

Biography
Rajat Mittal is Professor of Mechanical Engineering at the Johns Hopkins University with a secondary appointment in the School of Medicine. He received the B. Tech. degree from the Indian Institute of Technology at Kanpur in 1989, the M.S degree in Aerospace Engineering from the University of Florida, and the Ph.D. degree in Applied Mechanics from The University of Illinois at Urbana-Champaign, in 1995. His research interests include computational fluid dynamics, vortex dominated flows, biomedical engineering, biological fluid dynamics, fluid-structure interaction, and flow control. He has published over 200 technical articles and multiple patents in these application areas. He is the recipient of the 1996 Francois Frenkiel and the 2022 Stanley Corrsin Awards from the Division of Fluid Dynamics of the American Physical Society, and the 2006 Lewis Moody as well as 2021 Freeman Scholar Awards from the American Society of Mechanical Engineers (ASME). He is a Fellow of ASME and the American Physical Society, and an Associate Fellow of the American Institute of Aeronautics and Astronautics. He is an associate editor of the Journal of Computational Physics, Frontiers of Computational Physiology and Medicine, and serves on the editorial boards of the International Journal for Numerical Methods in Biomedical Engineering, and Physics of Fluids.

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