MITMECHE

Colloquium

Mechanical Engineering Lecture in Ocean Science and Engineering

Marine Science of Autonomy: *From Theory to Practice*

Pierre F.J Lermusiaux

Associate Professor of Mechanical Engineering, Massachusetts Institute of Technology

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The science of autonomy is the systematic development of fundamental knowledge about autonomous decision making and task completing in the form of testable autonomous methods, models, and systems. Marine autonomy applications are rapidly growing, both in numbers and in complexity. For systematic advances, we integrate varied disciplines and provide fundamental results in minimum-time path planning, energy-optimal path planning, and optimal adaptive sampling based on mutual information fields, all in complex dynamic flows. The aim is to set a theoretical basis for a large number of vehicles forming heterogeneous and collaborative underwater swarms that are smart, i.e. knowledgeable about the predicted environment and their uncertainties, and about the predicted effects of autonomous sensing on future operations. Results are thus extended to coordinated groups of vehicles that maintain swarm formations and avoid dynamic obstacles, and to three-dimensional paths, anisotropic motion constraints, onboard adaptive routing, and path planning under uncertainty. Examples are provided for varied nonlinear fluid and ocean conditions. We also highlight some of our recent related results, including: Bayesian nonlinear data assimilation and inference of model equations; multiresolution high-order modeling; multiscale ocean dynamics; and, stochastic Lagrangian Coherent Structures.