Oceanography Seminar

Michael Krieg

ASSISTANT PROFESSOR
DEPARTMENT OF OCEAN & RESOURCES ENGINEERING
UNIVERSITY OF HAWAII AT MANOA

"Bioinspired Propulsion and Sensing Systems Enabling Next Generation Underwater Vehicles"

Even the most robust and sophisticated underwater robots pale in comparison to the performance of the ocean's natural inhabitants, as many of which seem to traverse turbulent environments with ease and also demonstrate effective long range migration patterns. This talk analyzes a novel propulsion mechanism inspired by the locomotion of squid and jellyfish; whereby, finite fluid jets are ejected from a flexible internal cavity in a periodic fashion. Vortex ring formation, which is associated with expelled jets starting from rest, causes the thrust associated with this novel locomotion to be fundamentally different from that of continuous propulsive jets. As a result unsteady jets can nearly double hydrodynamic impulse relative to steady jets with equivalent mass flux. Furthermore, models for unsteady pressure in the thruster derived from the vorticity dynamics are used to explain recent observations of propulsive efficiency in live squid that are higher than previously thought possible. Similarly, a sensory system inspired by the lateral line in fish was designed to fit over the surface of a prototype autonomous underwater vehicle (AUV). Much like the actual lateral line, this system consists of hydrodynamic (pressure) sensors strategically distributed over the surface of the vehicle, and allows the AUV to sense its hydrodynamic surroundings. By using this system to directly measure complex hydrodynamic disturbance forces in real time for controller compensation, a prototype AUV shows a reduction in position tracking error of more than 70% compared to traditional state feedback controllers. Biological systems have had millions of years to evolve an optimal morphology; they have lessons to teach if we work hard enough to find them.

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