Modeling of oceanic processes such as water circulation and interaction with the seafloor terrain is immensely helpful for tasks such as tracking oil spills, harmful algae or temperature distributions to predict the oceans impact on global weather. The use of autonomous underwater vehicles (AUV) has recently seen increasing potential in gathering required data measurements to facilitate such models. The work presented gives an energy-optimal solution to the guidance problem of an AUV. The presented guidance methods are for lower level control of AUV paths, facilitating existing global planning methods to be carried out more efficiently. The underlying concept is to use the energy of fluid flow fields the AUVs are navigating to extend the duration of missions. This allows the gathering of more data with higher spatio-temporal resolution. The problem is formulated for a generalized two dimensional uniform flow field given a fixed final time and free end states. This allows the AUVs to navigate to certain spatial positions while maintaining the required temporal resolution of each segment of its mission. The simplistic way the problem is posed allows an analytical closed form solution of the Euler-Lagrange equations. Two dimensional thrust vectors are obtained as optimal control inputs. The control inputs are then incorporated into a feedback structure, allowing the particle to navigate in the presence of disturbance in the flow field. Further, the work also explores the effect of fluid-particle interaction on the control cost and behavior of the particle. The concept of changing the cost weights of the optimal cost formulation in situ has been introduced. Potential applications of the mentioned concept are explored through an obstacle avoidance scenario. The optimal guidance methods are then adapted to non-uniform flow fields with quadratic and discontinuous spatial variation being the primary focus.

Major: Mechanical Engineering

Educational Career:
Bachelor's of Mechanical Engineering, BS, 2009, University of Moratuwa
Master's of Mechanical Engineering, MS, 2014, University of Central Florida

Committee in Charge:
Tuhin Das, Chair, Mechanical & Aerospace Engineering
Ranganathan Kumar, Department of Mechanical & Aerospace Engineering, University of Central Florida
Tarek Elgohary, Department of Mechanical & Aerospace Engineering, University of Central Florida
Aman Behal, Department of Electrical& Computer Engineering, University of Central Florida

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The public is welcome to attend.