On the Modeling and Control of Horizontal Pendulum Wave Energy Converters

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Abstract

Presented is an investigation into the modeling, active control design, and simulation of a generic horizontal pendulum wave energy converter, known as a PWEC. A description is provided of the dominant attributes PWECs have, showcasing their promising potential as wave energy converters. Seeking to further promote this potential, an active control strategy for the PWEC dynamics is sought such that net electric power production is increased. Constrained equations of motion for a generic PWEC archetype are developed. Equations describing an irregular wave environment reminiscent of Oregon State's oceans are derived. Wave forces and moments acting on the PWEC model are then obtained through use of potential flow theory and paneling methods. Finally, developments of an active control strategy enforced by a controller based on techniques relating to optimal and model predictive control theory are given. Simulation of the generic PWEC occurs within the modeled irregular wave environment both with and without the active control engaged. Comparisons of the simulations indicate strong increases—up to 60 percent—in net PWEC electric power generation by use of active control. Future pathways for active control development and PWEC advancement are then proposed.

Wednesday, June 5, 2013
12:00 PM, Covell Hall Library (Rm. 117)