Oscillating Energy Harvester for UUV Applications

by

Lucas Kistner Stone

Submitted to the Department of Mechanical Engineering
on April 11, 2023, in partial fulfillment of the
requirements for the degrees of
Naval Engineer
and
Master of Science in Mechanical Engineering

Abstract

This thesis presents the design, modeling, and optimization of a novel oscillating energy harvester for use in a Bluefin-21 UUV. Real-world vessel acceleration data was used to optimize the harvester for four different potential energy profile configurations: free-floating, linear monostable, nonlinear monostable, and bistable. Active control was desired and two strategies were explored but deemed to be too costly to implement. The performance of each configuration was evaluated and it was found that the linear monostable model performed the best, although, due to detuning concerns, the free-floating configuration is expected to out perform the linear model across a range of sea state spectra. While the calculated power collection rate was insufficient for supplementing or recharging the main batteries, the harvester was found to be a promising alternative power source for an emergency location beacon, enabling continuous transmission as long as the UUV remained adrift. The findings of this thesis demonstrate the potential of oscillating energy harvesters in UUV applications and suggest avenues for further research into control strategies and experimental validation.

Keywords: oscillating energy harvester, UUV, floating, linear, nonlinear, monostable, bistable, control strategy

Thesis Supervisor: Paul D. Sclavounos
Title: Professor of Mechanical Engineering and Naval Architecture