Announcing the Final Examination of Steven Helkin for the degree of Master of Science

Time & Location: October 31, 2011 at 2:00 PM in ENGR 1381J
Title: Design and Optimization of a Wave Energy Harvester Utilizing a Flywheel Energy Storage System

A point absorber is a form of a wave energy harvester involving a floating buoy device that transforms the kinetic energy of the vertical heaving motion of surface waves into electrical energy. This study details the mechanical design of a proposed point absorber that utilizes a flywheel energy storage system to improve power output. By using a flywheel to store energy, a steadier power output could be achieved with the system, even with the intermittent motion from the surface waves acting on the buoy.

This thesis focuses largely on the optimization of the buoy design. The vertical motion of the buoy is coupled with the rotational velocity of the flywheel—adjusting parameters to increase the flywheel velocity may inhibit the motion of the buoy, thereby reducing the overall power output from the system. For instance, increasing the flywheel size allows for improved energy storage; however, the larger flywheel requires greater torque to turn the rotor, resulting in lower rotational velocity for the generator rotor. Likewise, the back-torque produced by the generator as the rotor is spun is transmitted to higher tension in the mooring cable of the buoy, resulting in less vertical velocity for the buoy. Thus the design may be improved by applying a load control that disengages the electrical load from the generator based on the flywheel rotational velocity. By sacrificing time for which power is produced by the generator, the buoy is able to move more freely, resulting in greater overall power output.

A laboratory prototype was constructed to analyze the mechanical design and to determine methods to improve the conceptual design. To test the prototype, a motion platform was employed that could heave the system vertically in a sinusoidal fashion. However, this prescribed motion would not realistically mimic the motion of the buoy on an ocean wave; as such, a hydrodynamic simulation was developed to predict the response of the buoy to a surface wave input. The simulation allows for system parameters to be varied in order to observe the effect on the overall power output from the wave energy harvester. The simulation was run with parameters for four different-sized generators to observe the effects of optimization for each generator. It is shown herein that by optimizing the flywheel size, as well as using a load control that disengages electrical load from the generator when the rotor velocity falls below some lower threshold value and reengages the load when the velocity increases beyond an upper threshold value, the overall power output by the system can be improved drastically when compared to results without using load control.

Major: Mechanical Engineering

Educational Career:
Bachelor's of Mechanical Engineering, BS, 2009, University of Central Florida

Committee in Charge:
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Approved for distribution by Dr. Kuo-Chi Lin, Committee Chair, on October 11, 2011.

The public is welcome to attend.