

Pitch Resonance Tuning Tanks: a novel technology for more efficient wave energy harvesting

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Abstract

The purpose of this thesis work is the development of a novel technology for a more efficient wave energy harvesting. IOwec, Inertial Ocean wave energy converter (WEC), is a floating pitching WEC based on the ISWEC technology (Inertial Sea Wave Energy Converter) developed by the Renewable Energy group of Politecnico di Torino (Italy). The novelty consists on the the integration of the water sloshing tank (U-Tank) technology derived from the naval field. The variation of the dynamic properties of the U-Tank, allows the shifting of the resonance condition of the device with a consequent improvement of the energy harvesting from ocean waves.

The result is a novel device able to adapt itself in different wave-climates through the dynamic tuning of the U-Tank with the incoming sea-state. The adaptability and flexibility of this new technology is advantageous for the future industrialization, because able to work in various installation sites avoiding a site-dependant design.

A numerical model is developed in order to assess the dynamics and performance of the device, and a numerical design tool is implemented in Matlab to design and optimize the device. A sea-state based control is proposed for the tuning of the device with the incoming wave. The performances of the novel technology are evaluated in regular and irregular wave condition and complex measured sea states with promising results.

A multi-objective optimization algorithm is implemented in order to optimize the performance of the IOwec device in two chosen installation sites, one in Humboldt Bay in California and the second one in Hawaii islands, at the Wave Energy Test Site (WETS). The optimization result show interesting techno-economic trends for the future design of the system and an improvement of the performance index of 20 \% compared with the first draft of IOwec. Moreover, the preliminary results show an energy extraction improvement of 20 \% due to the active control of the U-Tank. Nevertheless, the resulting device is optimal in both sites, demonstrating the adaptability of the technology for different wave-climates.