Real-Time Estimation and Prediction of Wave Excitation Forces for Wave Energy Control Applications

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Abstract

Wave energy is emerging as a new potential source for renewable energy generation. However, wave energy technology is not currently cost competitive with other more mature renewable energy sources such as wind and solar. One approach that researchers and developers are taking to reduce the cost of wave energy is to actively control wave energy converters (WECs) in such a way that the average power produced by the WEC is significantly increased. Most of the proposed control algorithms depend on having predictions of the future wave forces, as the optimal control actions depend on these future forces.

This thesis details a methodology that uses a Kalman filter to estimate the wave forces on a WEC from measured motions of a WEC in real-time. These estimated forces are then used to predict future forces with a recursive, autoregressive least squares prediction model. The methodology is tested on a generic, 3 degree of freedom, point absorbing WEC in simulations, using recorded water surface elevation time series data as input to the WEC model. The effect of different sea states on both estimation and prediction accuracies is investigated. Results show that both estimation and prediction accuracies depend on the hydrodynamic properties of the WEC. It is also observed that low energy sea states result in significantly reduced estimation and prediction accuracies compared to more energetic sea states.

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