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Entitled

Neural Network Based Reactive Control of Point Absorber Wave Energy Converters

by

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Abstract

The main objective of this work is to develop a neural-network-based Reactive Control (RC) system for wave energy converters. The ability to maximize the power output of WEC while maintaining operation constraints, which can be physical or thermal, is crucial to the development of deployable control strategies. Having a control method that is robust, which means it handles uncertainty and noise very well, is one of the main performance criteria in evaluating the method. Therefore, this work starts by deriving an averaged WEC model to be simulated in MATLAB/Simulink. Additionally, the concepts of resistive loading control and reactive control (approximate conjugate control) are discussed. A solution to sea state estimation is developed and explained which poses a contribution the current WEC research. This novel technique uses recurrent neural networks (RNNs) with time-series data input to estimate the sea state in real-time. The technique fills the gap of estimating forces based on peak frequencies and also the problem of calculating sea states based on periodical averaged statistical analysis. To complete the methodology, an optimization technique using feed forward neural networks is improved to perform optimization that is proposed to optimize the power output with respect to the sea states. This is done by using the neural network as a cost function while using the physical limitations of the system as a constraint. The neural networks in this work are developed, trained and tested using MATLAB's Deep Network Designer and Deep Learning Toolbox then imported as a Simulink block to complete the simulation. The results are evaluated for each of the section. First, initial logging of the performance metrics, such as mean power, is done prior to the addition of any neural networks. The accuracy and robustness of the sea state estimation RNN is then discussed. Finally, a comparison between traditional reactive Control optimized and reactive Control is conducted. To summarize the outcome, after experimenting with different datasets and architectures, the RNN is able to estimate sea states in real-time under different initial conditions.

Keywords: neural network, recurrent neural networks, reactive control, wave energy converters, deep learning, approximate conjugate control, sea state estimation