Extreme Ship Motion Estimation using Neural Network Correction

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ABSTRACT

A key factor in ship design is the survivability of the ship in extreme conditions. Furthermore, in the chaotic and non-linear ocean space, design events may not always be the result of rogue waves or 1,000 year storms, but perhaps moderate combinations of waves that result in extreme responses. That being said, searching the parameter space for these less rare but dangerous wave sets is far too computationally expensive when considering Monte Carlo simulations in a higher-fidelity solver. The work presented seeks to use a multi-fidelity method with aid from a Long Short-Term Memory (LSTM) neural network (Hochreiter and Schmidhuber, 1997) to estimate short-term extreme events. The two simulation tools used in this study are a low-fidelity, volume-based solver known as SimpleCode and a higher-fidelity potential flow simulation tool known as Large Amplitude Motion Program (LAMP). While SimpleCode is much more computationally efficient than LAMP (about 2,000-5,000x faster) and provides a qualitative representation of the ship response (Smith, 2019), it fails to capture the non-linearities that are crucial in estimating extreme events quantitatively. To take advantage of both code's strengths, an LSTM network is trained to correct time series "snippets" surrounding time series extrema from SimpleCode to the corresponding time series snippets from LAMP. The fully trained network can then be used in conjunction with SimpleCode to generate many extreme examples that showcase accuracy that is representative of LAMP but in a much more computationally efficient manner. In this study, the seakeeping simulation results from the proposed multi-fidelity method are compared with the results from 10,000 hours of LAMP Monte Carlo simulations.

REFERENCES

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