Hybrid Method Simulation of Slender Marine Structures

This present thesis consists of an extended summary and five appended papers concerning various aspects of the implementation of a hybrid method which combines classical simulation methods and artificial neural networks. The thesis covers three main topics. Common for all these topics is that they deal with time domain simulation of slender marine structures such as mooring lines and flexible risers used in deep sea offshore installations. The first part of the thesis describes how neural networks can be designed and trained to cover a large number of different sea states. Neural networks can only recognize patterns similar to those comprised in the data used to train the network. Fatigue life evaluation of marine structures often considers simulations of more than a hundred different sea states. Hence, in order for this method to be useful, the training data must be arranged so that a single neural network can cover all relevant sea states. The applicability and performance of the present hybrid method is demonstrated on a numerical model of a mooring line attached to a floating offshore platform. The second part of the thesis demonstrates how sequential neural networks can be used to simulate dynamic response of specific critical hot spots on a flexible riser. In the design of mooring lines only top tension forces are considered. These forces can easily be determined by a single neural network. Riser design, depending on the applied configuration, requires detailed analysis of several critical hot spots along the structure. This means that the relation between external loading and corresponding structural response not necessarily is as direct as for the mooring line example. Hence, one neural network is not sufficient to cover the entire structure. It is demonstrated how a series of neural networks can be set up to sequentially simulate the dynamic response at critical locations along a complex riser structure. The final part of the thesis deals with the optimization of neural networks. It is shown how trained networks can be dramatically reduced in size while still maintaining a high simulation accuracy. Beside providing a more compact neural network the optimization procedures can be used to rank the importance of external effects on structures. Such sensitivity studies usually require numerous simulations. But by using this method these studies can be based on just one short simulation sequence which reduces the computational cost significantly. The great advantage with the hybrid method is that it gives rise to significant reductions in computation time associated with nonlinear dynamic time domain simulations. However, since the neural network depends on pre-generated training data, one must always consider the balance between saved computation time and time spend on establishing the hybrid method.

General information
State: Published
Organisations: Department of Mechanical Engineering, Solid Mechanics
Contributors: Christiansen, N. H., Sødahl, N., Høgsberg, J. B.
Number of pages: 114
Publication date: 2014

Publication information
Publisher: DTU Mechanical Engineering
ISBN (Print): 978-87-7475-410-7
Original language: English
(DCAMM Special Report; No. S182).
Electronic versions:
Hybrid_Method_Simulation.pdf
Research output: Research › Ph.D. thesis – Annual report year: 2015