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Deep Neural Network (DNN) Method to predict the displacement behavior of neutral axis for ships in vertical bending

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The shifting of the neutral axis in the cross section of ship structures is an important result of progressive collapse analyses. Especially for damaged ship structures where the load carrying capacity is reduced, to ensure a safe salvage operation, the residual hull girder strength has to be estimated rapidly.
The main purpose of the present study is to apply a Deep Neural Network (DNN) method to linear systems and estimate in a relatively short time span the shift of the neutral axis for intact and damaged ships by presenting their performances and highlighting the definition of DNN inputs.
First, the initial source data related to the intact condition and several symmetric damaged grounding scenarios of five different vessels (Double Hull Oil Tanker, Single Hull Tanker, 1350 TEU Container Vessel, 3500 TEU Container Vessel, Bulk Carrier) have been determined with a self-developed code based on the well-established Smith Method as an iterative incremental approach. The preliminary data has been validated against Bureau Veritas's software MARS 3.0.1.
Second, a Deep Neural Network approach composed by multiple fully connected layers with a Rectified Linear Unit (ReLU) non-linear activation function has been applied to over 6000 samples and validated using leave-one-out validation, where one subject is entirely excluded from the training set in order to check the generalization capabilities of the neural network on a new unknown data set.
Finally, the shift of the neutral axis has been predicted for a set of completely new damage scenarios of a ship cross section, demonstrating that the deep neural analysis approach can estimate the neutral axis performance for a correlated damage index. It is expected that this study would be a novel approach, when dealing with hull girder analysis of damaged ship cross sections.

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