Seakeeping analysis of monohull ships at preliminary design using artificial neural networks

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Introduction

The result of the work will be a set of ANN algorithms that allow the pre-assessment of a ship’s seakeeping with very short pre-processing and solver times, and to determine the added masses, damping and external forces required to compute the seakeeping of conventional monohulls.

\[ (M + A_{ij})\ddot{\eta}_j + B_{ij}\dot{\eta}_j + K_{ij}\eta_j = F_j \cdot e^{-i\omega t} \]
The design in early stages should be based on seakeeping. To obtain an initial result, in a short time and without high computational cost, to solve the problem in the design phase and consequently design taking into account the seakeeping.

The main idea is to obtain a Generalized Algorithm based on Artificial Neural Network to predict the seakeeping of any type of monohull vessel.
Methodology

- Introduction
- Seakeeping
- Objectives
- Methodology
- Verification and Results
- Conclusions

Base Case Generation: data augmentation
Boundary condition
Meshing
Simulation
Post processing
Data processing
ANN competition
Verification

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Base Case Generation: data augmentation

Up to $2,0 \cdot 10^4$ simulation cases

400 Geometry variations (L/B; B/T; L/T)

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Methodology

Base Case Generation: Simulations & data processing

Simulations
- Potential solver simulation in frequency domain (> 2.0 x 10^4 simulations)
- 7 wave heading from 0 to \(\pi\) rad
- Up to 30 frequencies \(k \in [\frac{2\pi}{0.1 \cdot L_W}, \frac{2\pi}{2.0 \cdot L_W}]\)

Data processing
- Principal component analysis
- Selection main parameters regarding ship particulars
- Break down seakeeping components: added masses, damping, excitation forces, diffraction forces.

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#### ANN competition

<table>
<thead>
<tr>
<th>Normalised</th>
<th>Non-normalised</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layers</td>
<td>1 - 3</td>
</tr>
<tr>
<td>Neurons</td>
<td>1 - 30</td>
</tr>
<tr>
<td>Optimizer</td>
<td>Adam, RMS...</td>
</tr>
<tr>
<td>Activation</td>
<td>Sigmoid, ReLU, ...</td>
</tr>
<tr>
<td>Epoch</td>
<td>10 - 300</td>
</tr>
<tr>
<td>Overfitting</td>
<td>Dropout, batchnorm, ...</td>
</tr>
</tbody>
</table>

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IX International Conference on Computational Methods in Marine Engineering
Verification and Results

- Introduction
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Verification ships

Six monohulls totally different from data base to face with potential solver
Verification and Results

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Added masses and dampings:

- Dimensionless A11
- Frequency (rad/s)

- Dimensionless A14
- Frequency (rad/s)

- Dimensionless A15
- Frequency (rad/s)

- Dimensionless A21
- Frequency (rad/s)

- Dimensionless A31
- Frequency (rad/s)

- Dimensionless A32
- Frequency (rad/s)

- Dimensionless A33
- Frequency (rad/s)

- Dimensionless A34
- Frequency (rad/s)

- Dimensionless A35
- Frequency (rad/s)
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Forces and moments:
Conclusions

- Difficulty in obtaining a sufficient number of vessels to apply these techniques, thousands of hours of computing.
- Ability to predict the seakeeping behaviour of any conventional monohull, with uncertainty similar to that of a potential solver and considerable time savings.
- Vessel data required for the study, principal characteristics.
Thanks for your attention

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