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

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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

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Base Case Generation: data augmentation

Boundary condition

Simulation

Meshing

Post processing

Data processing

ANN competition

Verification

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400 Geometry variations (L/B; B/T; L/T)
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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 \( k \in \left[ \frac{2\pi}{0.1L_w}, \frac{2\pi}{2.0L_w} \right] \)

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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<table>
<thead>
<tr>
<th>Methodology</th>
<th>ANN competition</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Introduction</td>
<td>Layers</td>
</tr>
<tr>
<td>• Seakeeping</td>
<td>1 - 3</td>
</tr>
<tr>
<td>• Objectives</td>
<td>Neurons</td>
</tr>
<tr>
<td>• Methodology</td>
<td>1 - 30</td>
</tr>
<tr>
<td>• Verification and Results</td>
<td>Optimizer</td>
</tr>
<tr>
<td>• Conclusions</td>
<td>Adam, RMS…</td>
</tr>
</tbody>
</table>

Non-normalised

<table>
<thead>
<tr>
<th>Activation</th>
<th>Epoch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sigmoid, ReLU,…</td>
<td>10 - 300</td>
</tr>
</tbody>
</table>

Overfitting

| Dropout, batchnorm, … | |

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- Objectives
- Methodology
- Verification and Results
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Verification and Results

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- Methodology
- Verification and Results
- Conclusions

Verification ships

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

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- Methodology
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- Conclusions

Added masses and dampings:
Verification and Results

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- Seakeeping
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- Methodology
- Verification and Results
- Conclusions
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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