Parametric roll prediction based on Machine Learning strategies

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ABSTRACT

Roll instability can cause a ship to capsize and is caused by changes in the restoring moments as the ship sails. These fluctuations in the restoring moments are caused by changes in the waterplane inertia moments and the submerged volume of the ship when it is in waves [1]. Roll instability is known to occur when the incoming wavelength is approximately equal to the ship's length. International Towing Tank Conference (ITTC) has identified that there are currently no codes or tools available to predict this type of ship instability during the design stage [2].

To cover the existing gap, we propose a mathematical regression models based on a collected data from independent (ships geometry and wave variables) and dependent (gradient in metacentric height) obtained using in-house tools. Firstly, Generalized Additive Model (GAM) [3] will be used as an alternative method to build a model without knowing in advance the order of nonlinear relationship between the output and input features, by adding non-linear functions constructed by Artificial Neural Networks (ANNs) and assuming the superposition principle for each effect considered: wavelength, wave amplitude, wave phase or ship draught. Secondly, a fully non-lineal regression model based on Machine Learning (ML) techniques to inference the relationships between the variables governing the parametric roll, the wave, and the ship will be intended. Machine Learning should model the dataset and make predictions about the metacentric height gradient. It is expected that the model tailors the metacentric height changes due to waves well. Developed models will be verified against numerical results obtained by high-fidelity seakeeping hydrodynamic code and experimental results.

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