Application of Deep Neural Networks to the Hull Form Optimization of a SWATH Vessel for Improving Its Calm Water Resistance

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This paper utilizes an approach of deep neural networks (DNN) to optimize the hull form of a small water-plane area twin hull vessel for the purpose of improving its resistance at a given speed and draught in calm water where two pairs of NACA-shaped fin stabilizer are installed on its pontoons to acquire an even keel condition. The target condition of the vessel is a speed of 24 knots and a displacement of 120 tons. The ship resistance in calm water is contributed by three components, namely the strut resistance, the pontoon resistance and the fin resistance where the pontoon resistance is approximated by the deeply submerged component along with a free-surface component as function of draught which is obtained from a series of free surface ship flow calculations. Five parameters, i.e., radius, fore-body length, aft-body length, angle of entrance and angle of run, are employed to define the pontoon geometry which is only considered in the hull form optimization. The pontoon length is fixed at 22.5 m. A RANSE code, STAR-CCM+, is used to predict the free-surface piercing struct and the deeply submerged resistance of pontoon as well as fin stabilizer while a CAD tool, Rhino, is employed in the parametric pontoon design. About 1400 pontoon designs are used to train the DNN model to correlate the dependence of resistance on the design parameters with the help of MATLAB and 80 cases are adopted for the validation purpose where good agreements are obtained. Compared to a baseline design, an improvement of 12.8% in calm-water resistance under the target condition is achieved for a pontoon design with the fore-body of 2 m, the aft-body of 5.7 m, the angle of entrance of 37° and the angle of run of 19°.