Practical application of hull shape optimization with an integrated process combining automated optimization and classical design methods

MARINE 2023

Gaetano De Luca*, Francesco Conti†, Davide Grassi*, Giuseppe Statti†, Bianca Rimini† and Francesco Furcas*

* CETENA S.p.A.
Via Ippolito d'Aste, 5, 16121 Genova, Italy
e-mail: davide.grassi@cetena.it, web page: http://www.cetena.it

† Fincantieri Naval Vessel Business unit
Via Cipro, 11, 16129 Genova, Italy
Email: giuseppe.statti@fincantieri.it - Web page: http://www.fincantieri.it

ABSTRACT

In the past decades, the use of Computational Fluid Dynamics (CFD) for the naval design process has largely increased, also combined with automated optimization systems. Thanks to the increase in computational power and to the development of innovative tools for the deformation and parameterization of the hull shapes, these optimization processes allow to find the optimal solutions even through unconventional configurations that would not have been identified with traditional design methods.

The classical ship design loop is a quite conservative process, due to the complexity of the hull and to many physical phenomena and constraints mainly related to construction issues. Therefore, the practical application of these new design tools generating unconventional shapes is often very difficult. In this work, the extensive experience of Fincantieri in hull design and an automated optimization tool based upon surrogated methods and RANSE simulations for hull resistance prediction have been integrated and applied to drive the design of a Coast Guard vessel toward the optimum in terms of bare hull resistance in calm water.

The work started from an initial hull geometry to which both global and local transformations were applied based upon design experience and RANSE simulation results. These deformations affected the skeg, transom, and bow region of the hull shape. Once defined a reasonable starting configuration, the automated optimization of bulbous bow was applied. This automated process integrates a suite of different software. DAKOTA has been applied to manage the whole optimization loop, create the DOE, build the surrogate, and identify the optimum. A fully parametric modeler developed in the GrassHopper-Rhinoceros environment by CETENA has been integrated to link the deformation of the NURBS surface with the main characteristics of the vessel using the Rhinoceros cage-edits. Simcenter STAR-CCM+ has been used as a solver to compute the bare hull resistance and attitude through an implicit unsteady RANSE approach. This software suite has been setup to be compatible with both Windows and Linux operating systems, in order to take advantage of all available computational resources, from standalone Windows workstations to HPC, which operates under Linux OS.

The optimal configuration obtained through the application of the optimization procedure has been verified through an experimental campaign. The results of the towing tank test confirmed the optimum and the effectiveness of the integrated process featuring an automated optimization technique and a classical design strategy.