A complete data-driven framework for the efficient solution of parametric shape design and optimisation in naval engineering problems

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ABSTRACT

In the reduced order modeling (ROM) framework, the solution of a parametric partial differential equation is approximated by combining the high-fidelity solutions of the problem at hand for several properly chosen configurations. Examples of the ROM application, in the naval field, can be found in [2, 3]. Mandatory ingredient for the ROM methods is the relation between the high-fidelity solutions and the parameters. Dealing with geometrical parameters, especially in the industrial context, this relation may be unknown and not trivial (simulations over hand morphed geometries) or very complex (high number of parameters or many nested morphing techniques).
To overcome these scenarios, we propose in this contribution an efficient and complete data-driven framework involving ROM techniques for shape design and optimization, extending the pipeline presented in [1]. By applying the singular value decomposition on the nodes coordinates, we are able to compute the optimal space which the deformed geometries belong to, hence using the modal coefficients as the new parameters we can reconstruct the parametric formulation of the domain. Finally the output of interest is approximated using the proper orthogonal decomposition with interpolation. To conclude, we apply this framework to a naval shape optimization problem where the bulbous bow is morphed to reduce the total resistance of the ship advancing in calm water.

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