Application of p-Laplacian relaxed steepest descent to technical free surface flows

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The contribution aims to scrutinize the p-Laplacian relaxed steepest descent approach to turbulent free surface flows. To this end, the approach introduced in [1, 2] is applied to the minimization of fluid dynamic drag in 3D high Reynolds-number test cases. Comparisons involve state-of-the-art approaches [3, 4], the Hilbertspace baseline method (p = 2) as well as larger values of p to outline the advantages. It is demonstrated that the p-Laplacian approach reduces the number of shapes visited during the optimization process and preserves quality of the computational mesh - even for optima that feature edges or corners, cf. Fig. 1 (top). Applications
included refer to generic shapes and merchant marine vessel hulls exposed to two-phase flows as depicted by Fig. 1.

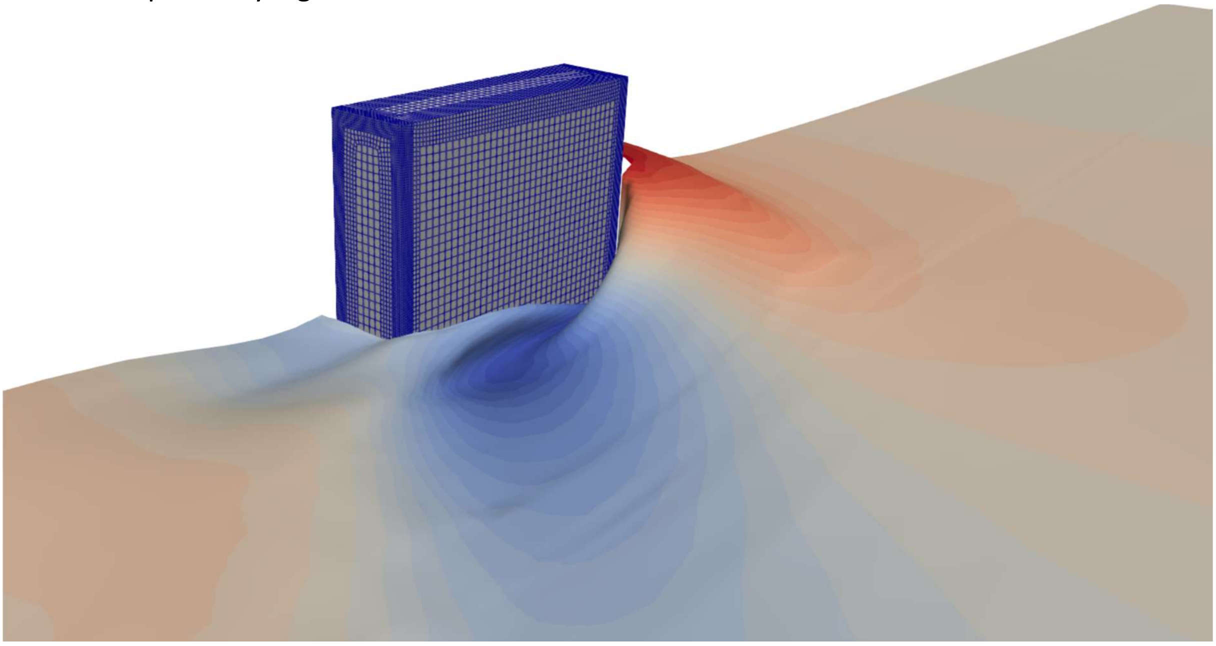

Figure 1: Free-surface elevation for a partially submerged box at Reynolds & Froude numbers of Re = 1.7 · 105, Fn = 0.71 (top) and a MOERI container ship (http://www.simman2008.dk/KCS/kcs_geometry.htm) at Re = 1.43 · 107, Fn = 0.26 (bottom).

References

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[4] V. Schulz and Siebenborn M. “Computational Comparison of Surface Metrics for PDE Constrained Shape Optimization”. In: Computational Methods in Applied Mathematics 16.3 (2016), pp. 485–496. doi: 10. 1515/cmam-2016-0009.