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TOWARDS AUTOMATED COMPUTATION WITH UNCERTAINTY ESTIMATION FOR INDUSTRIAL SIMULATION OF SHIP FLOW

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Mesh generation is a bottleneck for the current industrial use of CFD, due to its dependence on expert user knowledge and its unpredictable cost, since iterative modification of the meshes may be needed to correctly resolve flow features. Adaptive mesh refinement is a natural solution to these problems. However, mesh adaptation is only acceptable in an industrial context if it can be performed automatically, with little or no user intervention, and if it is robust enough to produce reliable solutions for a large range of test cases.

This paper studies the use of adaptive refinement for the industrial simulation of free-surface water flows. We ensure the reliability of the simulation results by two means. First, the computational setup is automated; physics-based arguments are used to derive guidelines to automatically set the simulation parameters correctly for each simulation, independent of the flow conditions and the geometry [2]. With these parameters, adaptive meshing produces grids that are suitable for capturing each flow.

Furthermore, the metric-based refinement criteria that we use make it easy to produce series of coarse to fine meshes, which can be combined with classical numerical uncertainty estimation procedures [1]. It is shown that the grid convergence obtained is remarkably smooth for unstructured meshes, which implies that the estimated uncertainty bounds are sharp and accurate.

The procedure is demonstrated for the resistance evaluation of ships. A first test case is used to fine-tune the simulation guidelines, which are then applied unchanged to three other ships, ranging from a destroyer to a supertanker. In all cases, the simulation results are good, which proves the generality of the approach. Thus, the mesh adaptation and uncertainty estimation procedure appears powerful and reliable enough for routine use in industry.

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