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ADAPTIVE GRID REFINEMENT FOR CONVERGENCE STUDIES

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Numerical simulation of fluid flow for today's practical applications often involves the use of unstructured grids. Modern unstructured grid generators allow the simulation of complex geometries, while they can perform the mesh generation in an industrial context largely automatically. Unfortunately, most unstructured mesh generators cannot precisely control the local cell sizes and orientations throughout the mesh, which makes it difficult to generate series of coarse to fine meshes where the ratios of the cell sizes are the same throughout the mesh (so-called conformal or nested meshes). As such series of meshes are needed for verification studies, this difficulty is one of the main bottlenecks for the widespread adoption of verification on unstructured meshes.

We have recently shown [1] that adaptive grid refinement can create series of nested unstructured grids, provided that the refinement is based on a metric criterion [2]. Adaptive refinement is the technique of locally refining an initial coarse grid by subdivision of the cells, based on a refinement criterion which indicates where the flow needs a better resolution. In the metric context, this criterion is a real field computed from the flow; the mesh is refined such that the product of the local cell size and the criterion everywhere is equal to a constant threshold value. Thus, if the criterion varies little when the mesh is refined, all the cell sizes are proportional to this threshold. This implies that series of meshes can be created by starting adaptive refinement from the same initial mesh and simply varying the threshold value.

In this paper, series of grids are created for two test cases: a two-dimensional airfoil and a ship, the KVLCC2 tanker. Despite some limitations (notably, the cells of the original grid can only be divided in powers of two, so the cell sizes cannot be adjusted continuously), the method performs well. An established uncertainty estimation method [3] applied to the computed series of forces provides useful estimations, while visual inspection of the wakes shows that the local flow field can be brought close to grid independence on reasonably fine grids. Thus, adaptive refinement provides a practical approach for convergence studies which can make verification studies more easily feasible on unstructured grids.

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