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AN OPTIMIZATION BASED APPROACH TO MULTI-BLOCK STRUCTURED GRID GENERATION

Marcel Sauer

German Aerospace Center (DLR), Institute of Propulsion Technology, Linder Höhe,
51147 Cologne, Germany, E-mail: Marcel.Sauer@dlr.de

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Grid generation is a necessary step for all computational fluid dynamics (CFD) calculations. It has a big impact on the convergence speed and quality of the results. Especially within a design optimization process (e.g. [1]) grid generation is crucial. The geometries may vary greatly which often leads to failures in the grid generation step or results in poor quality grids which lead to non-convergence or to doubtful results. Multi-block structured meshes, compared with unstructured grids, need to follow a complex topology and are more difficult to create but provide faster CFD calculations and more accurate gradient estimations.

In this paper, a novel approach suited to the specific requirements of multi-block structured grid generation within design optimizations for turbomachinery components is presented. In contrast to traditional methods like elliptical grid generation [2] and algebraic grid generation, the presented approach optimizes grid quality criteria such as cell expansion ratios, inner cell angles, and curvatures. These criteria are evaluated approximately on a coarse mesh representing the topology. The coarse mesh is used as a control grid for 2^{nd} degree B-spline formulation, which has a set of modifications to be able to represent multi-block structured grids. The usage of this abstraction layer reduces the degrees of freedom for the grid generation drastically and allows a coupled optimization of all degrees of freedom. As a prerequisite, a coarse initial mesh representing the desired topology and containing boundary conditions is required. The boundary conditions, defined on nodes of the coarse mesh, are used to include restrictions for nodes to be placed on curves and surfaces or to ensure orthogonality and prescribed distances in the final grid. Due to the strong convex hull property of B-splines, small deltas between the discretization of the abstract representation and the real geometry remain requiring a final projection.

In this paper, the 2D mathematical formulation of the abstraction layer and the optimization itself are presented. As examples automatically generated grids for 2D blade-to-blade slices of compressors, turbines and a tandem configuration are shown.

REFERENCES

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