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A NURBS-BASED APPROACH FOR SHAPE AND TOPOLOGY OPTIMIZATION OF FLOW DOMAINS

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Shape and topology optimization are important engineering tools for generating optimal fluid flow domains during a development process. For shape optimization usually a body-fitted grid generation is used for the geometric changes of the flow domain. Drawbacks of this approach are for example a limited degree of deformation respectively ill-conditioned cells due to the grid deformation and the missing possibility for topological changes of the flow domain. To overcome these problems several topology optimization methods have been developed which use a fixed cartesian grid. However, most of these methods suffer from slow convergence of the optimization process, non-smooth interfaces or a large number of design variables [1].
To reduce the number of design variables and to ensure smooth, mathematically described interfaces the present work utilizes non-uniform rational basis splines (NURBS) for the solid-fluid interface representation. We use the control points of the NURBS as design variables and therefore are able to describe complex shapes with a small number of design variables. To model the solid part of the flow domain a Brinkman penalization method [2] is used. An additional advantage of using NURBS is that they are commonly used in compuder-aided design (CAD) and so it is easy to transfer the design of the optimal solution to a CAD system for further post-processing.
To investigate the presented method with respect to efficiency and quality we compare it to a NURBS-based shape optimization method which uses body-fitted grids. We also discuss the potential use of the method for topology optimization and compare it to traditional topology optimization approaches based on a Brinkman penalization method.

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