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"High Performance Algorithms for Interface Identification and Shape Optimization"

Shape optimization constrained to partial differential equations is a vivid discipline in the field of optimal control with a variety of applications. This ranges from the optimization of exterior contours of solid bodies, e.g. drag reduction of an aerodynamic specimen, to the estimation of interior interfaces, which distinguish discrete, spatially distributed parameters or material properties.

In this talk we present our advances in the development of optimization algorithms, that are focused on efficiency and scalability as well as on robustness with respect to geometric deformations. These questions are tightly coupled with the definition of an appropriate space of admissible shapes and the corresponding tangent space.
For this purpose, we propose a class of nonlinear extension operators within the method of mappings and investigate how reachable shapes are influenced by this choice.
The developed methodology is demonstrated for computational models of cellular composite materials, motivated by the human skin, as well as design optimization in fluiddynamic applications. We particularly demonstrate that combining quasi-Newton methods and multigrid solvers lead to scalable optimization algorithms on large distributed-memory cluster computers.