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A R&D software platform for shape and topology optimization using body-fitted meshes

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Topology optimization is devoted to the optimal design of structures. It aims at finding the best material distribution inside a working domain while fulfilling mechanical, geometrical and manufacturing specifications. The need for lighter and efficient parts and assemblies has made topology optimization a vigorous research field in both academic and industrial structural engineering communities. This contribution focuses on PISCO, a Research and Development software platform for shape and topology optimization where the computational process is carried out in a level set framework combined with a body-fitted approach [3]. The level set method relies on the classical sensitivity analysis from the shape optimization framework to compute a descent direction and advect the structural interface. In the present setting the level set method is coupled with a remeshing routine which enables the reconstruction of a body-fitted mesh at each step of the underlying optimization process, as proposed in [1, 2]. Since the structural interface is known explicitely at each step of the iterative procedure, the body-fitted approach simplifies the evaluation of the mechanical quantities of interest. PISCO comprises several components including an algorithmic toolbox specialized in the treatment of level sets, a generic interface to finite element solvers, a toolbox handling mesh files in several classical formats, several algorithms for the resolution of constrained optimization problems, physical and geometrical optimization criteria and an advanced interface to the remeshing tool mmg3d. The components devoted to the physical simulations and the constrained optimization algorithms are implemented in a generic fashion in dedicated modules. The actual coupling of PISCO with several external physical solvers demonstrates the practical benefits of the chosen weakly intrusive strategy. We rely on a gradient-flow numerical optimization algorithm to handle the balancing between the minimization of the objective and the non-violation of the constraints. Several industrial applications are presented to highlight the capabilities of the platform.

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