Null Space Gradient Flows for Constrained Optimization with Applications to Shape Optimization

Florian FEPPON, Centre de Mathématiques Appliquées, École polytechnique, Palaiseau, France

Grgoire ALLAIRE, Centre de Mathématiques Appliquées, École polytechnique, Palaiseau, France

Charles DAPOGNY, Laboratoire Jean Kuntzmann, Université Joseph Fourier, Grenoble, France

A gradient flow algorithm is proposed for solving generic equality or inequality constrained optimization problems set on Hilbert spaces. Our ultimate goal is non parametric shape optimization, for which more classical optimization methods are often difficult to use because of the infinite dimensionality or the need for tuning algorithm parameters. We rely on a variant of classical gradient flows for equality constrained problems: the search direction is a combination of a null space step and a range space step, which are aimed to reduce the value of the minimized objective function and the violation of the constraints, respectively. Inequality constraints are specifically addressed by solving a dual quadratic programming subproblem of size the number of active or violated constraints, which allows to detect the subset of these to which the optimization trajectory needs to remain tangent. We then extend the method to quite general optimization sets equipped with a suitable manifold structure, and notably to sets of shapes as it occurs in shape optimization with the framework of Hadamard's boundary variation method. The cornerstone of this latter setting is the classical operation of extension and regularization of shape derivatives. Some numerical comparisons on simple academic examples are performed to illustrate the behavior of our algorithm. Its numerical efficiency and ease of implementation are finally demonstrated on more realistic shape optimization problems.

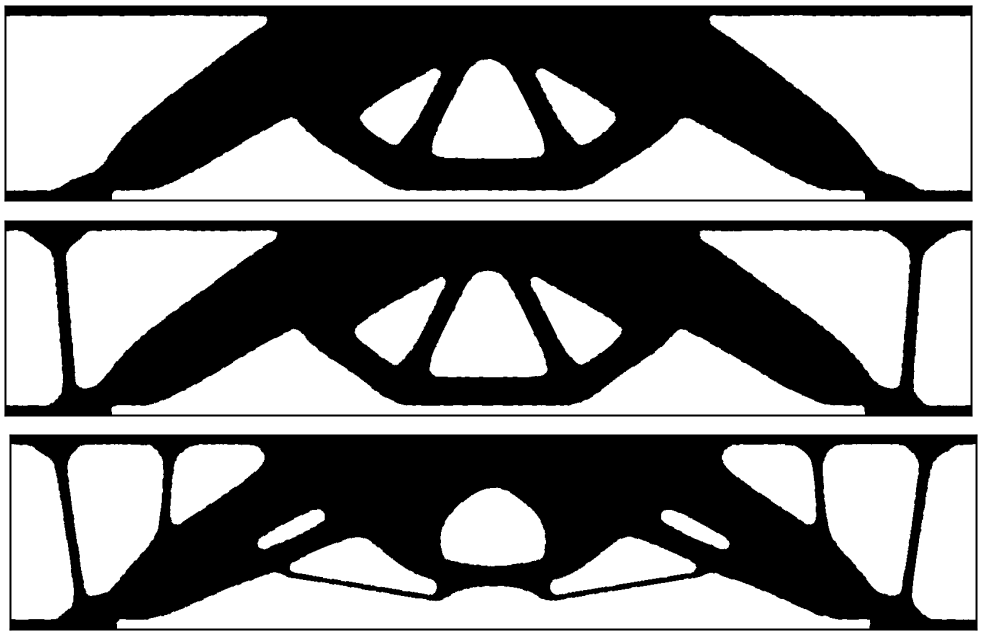

Figure 1: A multiple load case featuring 10 constraints (from [1]).

Références

[1] Feppon, F, and Allaire, G and Dapogny, C, *Null space gradient flows for constrained optimization with applications to shape optimization*, Submitted. HAL preprint hal-01972915, 2019.

Florian FEPPON, Safran Tech, Magny-les-Hameaux, France
florian.feppon@polytechnique.edu