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TOPOLOGY OPTIMIZATION OF MODULATED AND ORIENTED PERIODIC MICROSTRUCTURES BY THE HOMOGENIZATION METHOD IN PRESENCE OF SINGULARITIES IN THE ORIENTATION FIELD

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Thanks to the homogenization method, the topology optimization of structures made of periodically perforated material, where the microscopic periodic cell can be macroscopically modulated and oriented, is reduced to an easy parametric optimization problem. The projection of the optimal microstructure at a desired lengthsccale is a more challenging task, due to the orientation of the cells. Indeed, nor gap neither superposition between two neighbors cells is allowed. In the seminal paper [1], the authors introduce a diffeomorphism φ of the plan, which distorts a regular grid in order that each cell is well-oriented and well-connected to its neighbors. We improved this method in two ways. First, thanks to an harmonicity constraint on the angle describing the optimal orientation, φ is a conformal map, which can be straigthly computed. In other words, although the periodicity cell has varying parameters and orientation throughout the computational domain, the angles between its members or bars are conserved. Second, we address the case of singularities in the orientation field. The main application of our work is the optimization of so-called lattice materials which are becoming increasingly popular in the context of additive manufacturing.

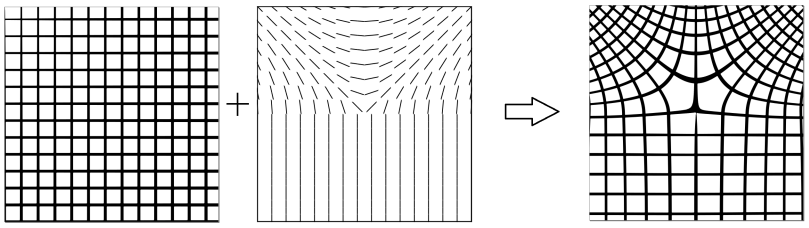

Figure 1: A regular grid (left) is distorted (right) according to a direction field featuring a singularity (center)

REFERENCES

[1] Pantz, O. and Trabelsi, K. *A post-treatment of the homogenization method for shape optimization*. SIAM Journal on Control and Optimization 47.3 (2008): 1380-1398