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van de Ven, Emiel; Langelaar, Matthijs; Ayas, Can; Maas, Robert; van Keulen, Fred

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Topology optimization with overhang filter considering accessibility of supports.

Emiel van de Ven[1,2], Matthijs Langelaar[1], Can Ayas[1], Robert Maas[2], Fred van Keulen[1]
[1] *Structural Optimization and Mechanics, TU Delft, Delft, The Netherlands*
E-mail:e.a.vandeven@tudelft.nl,m.langelaar@tudelft.nl,c.ayas@tudelft.nl,a.vankeulen@tudelft.nl

[2] *Collaborative Engineering Systems Department, NLR, Amsterdam, The Netherlands*
E-mail:robert.maas@nlr.nl

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Topology Optimization and additive manufacturing complement each other well. Additive manufacturing is often the only manufacturing technique capable of producing the complex topology optimized parts. Concurrently, topology optimization is one of the few design tools that fully utilizes the new design freedom that comes with additive manufacturing, and in part justifies additive manufacturing as a production tool.

In reality, additive manufacturing is not free of manufacturing constraints, one of the most notable being the overhang constraint. Recently, a significant effort has been made to incorporate the overhang constraint into topology optimization, such that a directly printable topology is obtained [1,2,3]. This saves machine time, material, and post-processing cost.

However, the addition of a (manufacturing) constraint almost always leads to a decrease in performance. With an overhang constraint incorporated in topology optimization, one often finds some fraction of material that does not serve the main objective, but merely supports overhanging regions of the topology. In a practical setting, it is unlikely that a designer would choose to decrease the performance of a part, if a support can be removed easily, especially considering that parts that are additively manufactured are usually expensive, high-performance parts, as also highlighted in [4].

Therefore, we present an algorithm that will enforce the overhang constraint only in regions that are difficult to access. For example, in internal channels it would be impossible to remove supports, therefore, it should be free of overhang. However on the outside of a part, support is easily removed and is thus allowed. The algorithm is based on a propagating front to mark areas as difficult or easy to access for support removal. A front propagation based overhang constraint [3] is then enforced in the difficult to access regions. Numerical examples will be presented of 3D topologies, where the limited reduction in performance of these designs compared to fully overhang free designs will be highlighted.

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