Regularization methods for CFD shape optimization problems using parameter-free approach

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ABSTRACT

In parameter-free shape optimization, where the node positions are the design variables of the problem, filtering and mesh regularization methods are necessary for obtaining a physical and reliable design. In this contribution the recently developed in-plane regularization and out-of-plane regularization methods are described. Moreover, their importance in parameter-free shape optimization is outlined.

More precisely, the in-plane regularization is a global method which regularizes the mesh of the optimized surface towards a desired condition [1]. In this method, an artificial stress field is applied on the mesh under consideration and a global linear system of equations is solved. The applied stress adapts each element towards a desired predefined template geometry and at the end a globally smooth mesh is achieved. In this way both the shape and the size of each element is effectively controlled.

On the other hand, a local method is used to smoothen the sensitivity field which is responsible for the appearance of oscillatory shapes [2]. The out-plane regularization method uses non-parametric regression and the continuous sensitivity field is established by convolving the gradients with a kernel function.

The optimization framework as well as the position of these modules in the optimization chain is presented. Various examples which motivate the use of the aforementioned methods are shown and the application of the overall methods in CFD problems from the automotive industry is demonstrated.

References

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