

Technical University of Denmark



Finite Volumes Discretization of Topology Optimization Problems

Evgrafov, Anton ; Gregersen, Misha Marie; Sørensen, Mads Peter

Publication date:
2011

[Link back to DTU Orbit](#)

Citation (APA):

Evgrafov, A., Gregersen, M. M., & Sørensen, M. P. (2011). Finite Volumes Discretization of Topology Optimization Problems. Abstract from US National Congress on Computational Mechanics, Minneapolis and St. Paul, Minnesota, USA, .

DTU Library

Technical Information Center of Denmark

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Finite Volumes Discretization of Topology Optimization Problems

Anton Evgrafov¹, Misha M. Gregersen² and Mads P. Sørensen³

¹ Associate Professor and Presenting Author, Department of Mathematics, Technical University of Denmark, Kongens Lyngby, Denmark e-mail: a.evgrafov@mat.dtu.dk

² Postdoc, Department of Mathematics, Technical University of Denmark

³ Associate Professor, Department of Mathematics, Technical University of Denmark

Utilizing control in the coefficients of partial differential equations (PDEs) for the purpose of optimal design, or topology optimization, is a well established technique in both academia and industry. Advantages of using control in the coefficients for optimal design purposes include the flexibility of the induced parametrization of the design space that allows optimization algorithms to efficiently explore it, and the ease of integration with existing computational codes in a variety of application areas, the simplicity and efficiency of sensitivity analyses—all stemming from the use of the same grid throughout the optimization procedure. As topology optimization is gaining maturity, the method is applied to increasingly more complex coupled multi-physical problems. As a result it becomes vital to utilize robust and mature PDE solvers within a topology optimization framework.

Finite volume methods (FVMs) represent such a mature and versatile technique for discretizing partial differential equations in the form of conservation laws of varying types. Advantages of FVMs include the simplicity of implementation, their local conservation properties, and the ease of coupling various PDEs in a multi-physics setting. In fact, FVMs represent a standard method of discretization within engineering communities dealing with computational fluid dynamics, transport, and convection-reaction problems. Among various flavours of FVMs, cell based approaches, where all variables are associated only with cell centers, are particularly attractive, as all involved PDEs on a given domain are discretized using the same and the lowest possible number of degrees of freedom. In spite of their numerous favourable advantages, FVMs have seen very little adoption within the topology optimization community, where the absolute majority of numerical computations is done using finite element methods (FEMs). Despite some limited recent efforts [1,2], we have only started to develop our understanding of the interplay between the control in the coefficients and FVMs.

Recent advances in discrete functional analysis allow us to analyze convergence of FVM discretizations of model topology optimization problems. We illustrate the numerical behaviour of a cell based FVM topology optimization algorithm on a series of benchmark examples.

References

- [1] C. Othmer. A continuous adjoint formulation for the computation of topological and surface sensitivities of ducted flows. *Internat. J. Numer. Methods Fluids*, 58(8), 2008.
- [2] A. Gersborg-Hansen, M. Bendsoe, and O. Sigmund. Topology optimization of heat conduction problems using the finite volume method. *Struct. Multidiscip. Optim.*, 31:251–259, 2006.