TOPOLOGY OPTIMIZATION IN WAVE-PROPAGATION PROBLEMS

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We consider topology optimization of structures and materials subjected to wave-loads. By distributing one or more materials in a design domain, one may design optimal loud speakers, acoustic or optic lenses, wave guides, band gap materials and others. A band gap material is a multi-phase material that inhibits wave-transmission in certain frequency ranges - so-called band gaps.

Acoustic, elastic shear and planar electromagnetic waves are all modelled using the Helmholtz equation. Taking basis in problems modelled by the Helmholtz equation we develop topology optimization formulations that can be used to minimize or maximize local wave magnitude or propagation energy [1]. Contrary to most other topology optimization problems haven been considered so far [2], a volume constraint is not necessary. This is due to the observation that homogeneous materials or structures cannot be used to minimize or maximize wave magnitudes and therefore a composite structure with unknown filling fractions will always be better than a homogeneous structure. In order to optimize responses in wider frequency ranges we formulate the optimization problems as max-min problems.

After a description of theory and implementation aspects, we show applications such as the design of acoustic horns and lenses, resonators, wave guides, sound walls, filters and others.

References

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[2] M. P. Bendsøe and O. Sigmund. *Topology Optimization - Theory, Methods and Applications*. Springer Verlag, Berlin Heidelberg, Xiv+370 pp., 2003.