Design of Passive Acoustic Wave Shaping Devices and Their Experimental Validation

Christiansen, Rasmus Ellebæk; Sigmund, Ole; Fernandez Grande, Efren

Publication date: 2017

Document Version Peer reviewed version

Link back to DTU Orbit

Design of Passive Acoustic Wave Shaping Devices and Their Experimental Validation

Authors:
Rasmus Ellebæk Christiansen¹, Ole Sigmund.
Department of Mechanical Engineering, Technical University of Denmark.
Efren Fernandez-Grande
Department of Electrical Engineering, Technical University of Denmark.

Abstract

We discuss a topology optimization based approach for designing passive acoustic wave shaping devices and demonstrate its application to; directional sound emission [1], sound focusing and wave splitting. Optimized devices, numerical and experimental results are presented and benchmarked against other designs proposed in the literature. We focus on design problems where the size of the device is on the order of the wavelength, a problematic region for traditional design methods, such as ray tracing.

The acoustic optimization problem is formulated in the frequency domain and modeled by the Helmholtz equation. An exterior 2D model domain is used and an array of point sources is considered as sound emitters. The optimization goal is to identify a distribution of solid material in a design sub-domain which produces a desired spatial sound field pattern across a frequency band of interest in a target sub-domain. The objective is the integral of the deviation in pressure magnitude, between a prescribed sound field and the solution to the model problem for a given design realization over the target sub-domain. Filtering is used for regularization and to allow for meaningful optimization for geometric robustness [2]. The Globally Convergent Method of Moving Asymptotes is used to perform the optimization [3].

References


¹E-mail: raelch@mek.dtu.dk Address: Nils Koppels Allé 404, DK-2800 Kgs. Lyngby, Denmark