Design of passive directional acoustic devices using Topology Optimization - from method to experimental validation - DTU Orbit (16/10/2018)

The paper presents a topology optimization based method for designing acoustic focusing devices, capable of tailoring the sound emission pattern of one or several sources, across a chosen frequency band. The method is demonstrated numerically considering devices optimized for directional sound emission in two dimensions and is experimentally validated using three dimensional prints of the optimized designs. The emitted fields exhibit a level difference of at least 15 dB on axis relative to the off-axis directions, over frequency bands of approximately an octave. It is demonstrated to be possible to design focusing devices of dimensions comparable to the acoustic wavelength, a frequency range which is typically problematic, as well as devices operating at higher frequencies. The classical parabolic reflector is used as a benchmark. The devices designed using the proposed method are shown to outperform the latter in terms of directivity and maximum side-lobe level over nearly an octave band. A set of frequencies are considered simultaneously in the design formulation and performance robustness toward uniform spatial production errors in the designed devices is assured by including perturbations of the geometry in the design formulation.

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