

CUT-ELEMENT BASED TOPOLOGY OPTIMIZATION OF SPEAKERPHONE SOUND RADIATION

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Abstract

Speakerphones for online conferencing must radiate sound effectively towards off-axis listener positions, where meeting participants are typically seated. Commercial speakerphone designs are typically realized in either upfiring or downfiring configurations. In upfiring configurations, the loudspeaker becomes increasingly directive with frequency, concentrating acoustic energy towards the ceiling rather than the listeners. Downfiring units mitigate this but at the cost of stronger ripple in the frequency response. Acoustic topology optimization offers a systematic approach to address these drawbacks by tailoring the radiated sound field.

We present a cut-element based topology optimization framework for steering the sound radiation of a speakerphone, optimizing for improved directivity at off-axis listener positions. In contrast to density-based approaches, cut-element methods maintain a sharp interface between material domains throughout the optimization, yielding designs with clear geometric boundaries that are directly interpretable and closer to a realizable geometry. We will demonstrate how this framework can be applied to both upfiring and downfiring configurations, and show the trade-offs involved in constraining sensitivities to the boundary interface. The crisp geometric boundary also facilitates coupling with additional physics, such as vibroacoustic coupling, or viscothermal boundary loss modelling.