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PROCEEDINGS

A 1-D Non-Local Metasurface-Based Broadband Acoustic Diffuser

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ABSTRACT

An acoustic diffuser refers to a device that spreads sound energy uniformly in all directions. Such a device plays a very important role in architectural acoustics, i.e., concert halls and auditoriums. Many designs such as the wellknown Schroeder diffusers [1] have been proposed and developed throughout the past several decades. However, most of these conventional designs achieve uniform sound diffusion by using different air trenches to create a phase shift profile following a specific sequence such as maximum length sequence or quadratic residue sequence derived from the number theory [1,2]. As such, these diffusers have considerable thicknesses, which makes them difficult to be applied in certain practical settings. Recently, metasurface-based diffusers have been proposed. These local resonator-based diffusers can significantly reduce the thickness, resulting in ultrathin diffusers that potentially have high commercial values [3,4]. However, resonators naturally have narrow bands. Hence, designing high-performance broadband resonator-based diffusers is challenging. In this talk, we will present a general design methodology based on genetic algorithm (GA) and topology optimization (TO) for the design of broadband metasurface-based acoustic diffusers. The diffusion performance is set explicitly as the design objective and a nonlocal design is carried out with the consideration of the interaction between different parts of the diffuser. Hence, optimal designs are no longer limited to designs based on specific phase shift profiles and high-performance can be achieved. Several designs targeting at different frequency ranges will be presented. Numerical results show that the proposed designs have comparable or even better performance compared to Schroeder diffusers over a broad frequency range and wide incident angles, but with much reduced thicknesses.

KEYWORDS

Acoustics; metasurfaces; diffusers

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