SAND2019-14941C

Computational Design for Diffuse Acoustic Fields on Demand

Wilkins Aquino[+] and Jerry Rouse[++]

[+]Department of Mechanical Engineering and Materials Science
Duke University
Durham, NC 27708

[++]Engineering Sciences Center
Sandia National Laboratories*
Albuquerque, NM 87185

Reverberation chambers are used for design, optimization and qualification of structures. The low frequency limit (Schroeder frequency) of applicability is dependent upon the chamber size. We have developed a source optimization methodology which can decrease this cut-on frequency. The target diffuse field is represented by plane waves having uniformly distributed direction and phase. The corresponding cross-spectral density can be shown to be a Bessel function of the first kind in 2D and a sinc function in 3D. The construction of the diffuse field at a given frequency (or set of frequencies) is then cast as a constrained optimization problem. To this end, the goal is to find the cross-spectral density of a set of point sources that closely approximates (in some sense) the target diffuse field cross-spectral density (e.g. sinc or Bessel function). To enforce positive definiteness of the solution, we use a matrix factorization approach in which the matrix factors become the design variables. We demonstrate that we can construct diffuse fields on demand in arbitrary enclosures with known wall impedance. Furthermore, we demonstrate that there exist source configurations that can generate near diffuse fields at frequencies below the Schroeder frequency.

* Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International, Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA-0003525.