Sound Field Reconstruction in Low-Frequency Room Acoustics: A Benchmark Study with Simulation

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Abstract

When it comes to room acoustic design, it is of paramount importance to be able to assess the sound field distribution inside a room, in order to identify and optimally locate the corrective measures. Generally, an accurate depiction of the sound field would result in an impractically high number of microphones in the room. Fortunately, at low frequencies, the existence of certain types of sparsity can help reduce the total number of measurement points significantly without affecting the accuracy of the sound field reconstruction. In this research, we propose to use a combination of Greedy algorithm and Least-square optimization techniques to first recover the modal parameters of the room and then to reconstruct the entire enclosed sound field. This series of techniques has previously been proved to be effective in recovering the Room Impulse Responses at certain positions of a room and can now be extended to focus more on the frequency and spatial aspects in low-frequency room acoustics. In COMSOL Multiphysics® simulation, we use the different available studies in the "Pressure Acoustics, Frequency Domain" physics interface to provide the inputs to the reconstruction algorithm as well as to validate the faithfulness of the entire process. Furthermore, we model an actual 3D non-rectangular room with varying wall absorption properties to emphasize the robustness of the reconstruction algorithm. The evaluation gives promising results as the reconstructed sound fields are in very good agreement with the ones given by the reference simulation and the effects of room modes are clearly visible. This demonstration provides a broad assessment of the reliability of the entire reconstruction framework, which is crucial for its future implementation for room acoustics practitioners.

Figures used in the abstract

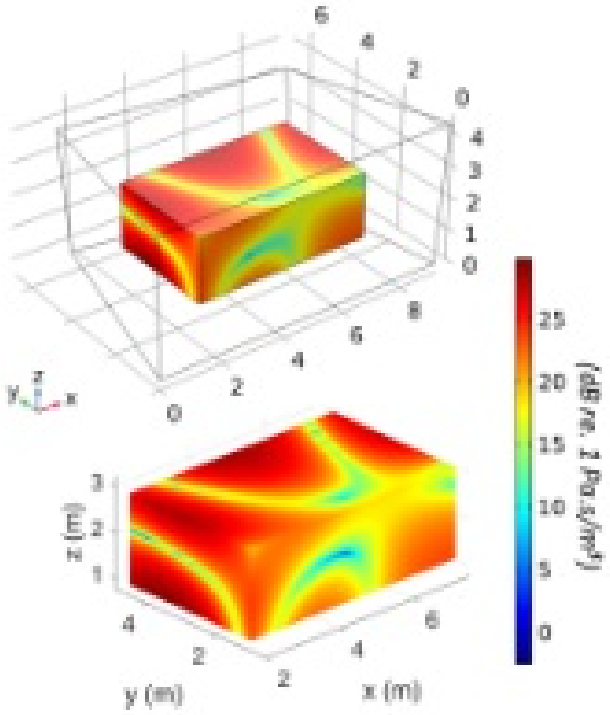

Figure 1: An example of one comparison between the reconstructed sound field (bottom) and the reference sound field (top) for regions far from the walls of a non-rectangular room model.