Multi-Resolution Geometrical Acoustics Modeling

by

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ABSTRACT

Geometrical-Acoustics (GA) modeling techniques assume that surfaces are large relative to the wavelengths of interest when determining or simulating their reflection properties. For a given simulation scenario, practitioners typically create a single 3D model with large, flat surfaces that satisfy this assumption over a broad range of frequencies. Such geometric approximations lead to errors in the spatial distribution of the simulated sound field because geometric details that influence reflection and scattering behavior at high frequencies are omitted. To compensate for these approximations, modelers typically estimate scattering coefficients for the surfaces to account stochastically for the actual, wavelength-dependent variations in reflection directivity. A more deterministic approach could consider a series of models with increasing geometric detail, each to be analyzed at a corresponding frequency band for which the requirement of large surface dimensions is satisfied. Thus, to improve broadband spatial accuracy for GA simulations, a multi-resolution modeling approach is proposed in this thesis.

A thorough analysis of a corrugated wall, including analyses using the boundary element method and the Biot-Tolstoy-Medwin secondary-source edge diffraction model as well as scale model measurements, confirms that the multi-resolution GA approach more accurately characterizes reflection directivity from such surfaces. The method's applicability to room acoustics is demonstrated via an analysis of a hypothetical auditorium, where predicted values of lateral fraction coefficients demonstrate the superiority of the multi-resolution approach over standard single-resolution methods. Finally, GA analyses using single- and multi-resolution models are compared to *in situ* transfer function measurements taken in an outdoor space with a multifaceted coffered ceiling. These examples demonstrate that multi-resolution geometric models provide more spatially accurate results than single-resolution models when using GA techniques.