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Multi-resolution geometrical-acoustics modeling

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Geometrical-Acoustics (GA) modeling techniques assume that surfaces are large relative to the wavelengths of interest. For a given scenario, practitioners typically create a single 3D model with large, flat surfaces that satisfy the 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 are omitted. To compensate for the approximations, modelers typically estimate scattering coefficients for the surfaces to account stochastically for the actual, wavelength-dependent variations in reflection directionality. 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, we propose a multi-resolution modeling approach. Using scale model measurements of a corrugated wall, comparisons of our method with non-GA techniques, and some simple listening tests, we will demonstrate that multi-resolution geometry provides more spatially accurate results than single-resolution approximations when using GA techniques, and that this improved accuracy is aurally significant.