Abstract

Fast, High-Order Methods in Computational Scattering

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Scattering theory remains an active and challenging scientific and mathematical field. Although most scattering problems take on a similar mathematical form, they find application in a wide range of fields: communications, materials science, plasma physics, biology and medicine, radar and remote sensing, etc. At the same time, obtaining solutions to the scattering equations requires novel mathematical approaches and powerful computational tools.

We present fast, high-order integral equation methods for acoustic scattering by two- and three-dimensional inhomogeneous media. In the two-dimensional case, we approximate the Green's function and the solution by truncated Fourier series in polar coordinates. In the three-dimensional case, on the other hand, a partition of unity decomposes the Green's function into smooth and singular parts. In each case, the required convolutions are accomplished via efficient and high-order accurate Fourier-based integration methods. We thereby obtain methods that require only O(N log N) operations per iteration and achieve high-order convergence even for discontinuous scatterers. Finally, we demonstrate the performance of these methods through several computational examples.

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