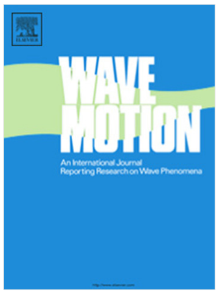
Accepted Manuscript



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PII: S0165-2125(17)30158-0
DOI: https://doi.org/10.1016/j.wavemoti.2017.12.008
Reference: WAMOT 2217

To appear in: *Wave Motion*

Received date : 20 July 2017
Revised date : 14 December 2017
Accepted date : 20 December 2017

Please cite this article as: S.P. Groth, D.P. Hewett, S. Langdon, A hybrid numerical-asymptotic boundary element method for high frequency scattering by penetrable convex polygons, *Wave Motion* (2017), https://doi.org/10.1016/j.wavemoti.2017.12.008

A hybrid numerical-asymptotic boundary element method for high frequency scattering by penetrable convex polygons

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December 21, 2017

Abstract

We present a novel hybrid numerical-asymptotic boundary element method for high frequency acoustic and electromagnetic scattering by penetrable (dielectric) convex polygons. Our method is based on a standard reformulation of the associated transmission boundary value problem as a direct boundary integral equation for the unknown Cauchy data, but with a nonstandard numerical discretization which efficiently captures the high frequency oscillatory behaviour. The Cauchy data is represented as a sum of the classical geometrical optics approximation, computed by a beam tracing algorithm, plus a contribution due to diffraction, computed by a Galerkin boundary element method using oscillatory basis functions chosen according to the principles of the Geometrical Theory of Diffraction. We demonstrate with a range of numerical experiments that our boundary element method can achieve a fixed accuracy of approximation using only a relatively small, frequency-independent number of degrees of freedom. Moreover, for the scattering scenarios we consider, the inclusion of the diffraction term provides an order of magnitude improvement in accuracy over the geometrical optics approximation alone.

Keywords: Helmholtz equation, transmission problem, high frequency, boundary element method, Geometrical Theory of Diffraction, acoustic and electromagnetic scattering.

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