CONVOLUTION QUADRATURE METHODS FOR TIME-DOMAIN SCATTERING FROM UNBOUNDED PENETRABLE INTERFACES

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Abstract. We present a class of boundary integral equation methods for the numerical solution of acoustic and electromagnetic time-domain scattering problems in the presence of unbounded penetrable interfaces in two-spatial dimensions. The proposed methodology relies on Convolution Quadrature (CQ) methods in conjunction with the recently introduced Windowed Green Function (WGF) method. As in standard time-domain scattering from bounded obstacles, a CQ method of the user's choice is utilized to transform the problem into a finite number of (complex) frequency-domain problems posed on the domains involving penetrable unbounded interfaces. Each one of the frequency-domain transmission problems is then formulated as a second-kind integral equation that is effectively reduced to a bounded interface by means of the WGF method—which introduces errors that decrease super-algebraically fast as the window size increases. The resulting windowed integral equations can then be solved by means of any (accelerated or unaccelerated) off-the-shelf Helmholtz boundary integral equation solver capable of handling complex wavenumbers with large imaginary part. A high-order Nyström method based on Alpert quadrature rules is utilized here. A variety of numerical examples including wave propagation in open waveguides as well as scattering from multiply layered media, demonstrate the capabilities of the proposed approach.

Keywords: time-domain scattering, boundary integral equations, layered media, waveguides.

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