6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

Enhanced BEM enrichment for wave scattering problems

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Keywords: *Helmholtz, PU-BEM, high-frequency scattering, Bessel functions*

Helmholtz scattering in infinite domains is a rich and fertile field of study, in which the Boundary Element Method (BEM) performs particularly well when compared with the Finite Element Method (FEM). This is largely due to the reduction in dimensionality of the approximation space, but is also in part a result of the Sommerfeld radiation conditions being automatically satisfied via the utilisation of Green's functions. High-frequency scattering remains an open problem that can provide a challenge for even the most efficient solvers. This is because the number of degrees of freedom required relies strongly on the wavelength, when using conventional interpolating functions. A successful approach to combat this is by employing a plane wave basis, as in the Partition of Unity Boundary Element Method [1]. The result being a reduction from the heuristic requirement of 8-10 degrees of freedom to 2 per wavelength.
The focus of the current work is to further improve PU-BEM for domains containing polygonal scatterers by including a combination of plane waves and fractional order Bessel functions. This is motivated by the prospect of accurately and efficiently capturing the singular behaviour at a corner of a scatterer [2]. Attempts to incorporate this Bessel function basis have improved accuracy when coupled with the Method of Fundamental solutions (MFS) [3] and in a Discontinuous Galerkin (DG) setting [4]. Extending this to PU-BEM enjoys both the reduction in degrees of freedom required and the greater accuracy associated with an operator dependent basis.

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