On Using Bandlimited Local-Global Solution Modes for Direct High Frequency Solutions

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It has been observed that bandlimited local-global solution (LOGOS) modes provide sparse direct representations of spectral solution operators for convex targets at high frequencies. In this paper we make a number of additional observations regarding the practical application of bandlimited LOGOS modes to high frequency scattering problems.

An important limitation of previously reported bandlimited LOGOS algorithms was the relatively large computational complexity associated with the determination of the LOGOS modes. It will be shown during the presentation of this paper that these costs can be significantly reduced by imposing the sparse boundary conditions at a significantly reduced set of points. Another limitation of previously reported results was the use of non-overlapping modes. In this presentation we will demonstrate that use of overlapping bandlimited LOGOS modes yields an O(N log N) direct representation of the spectral solution operator at high frequencies. Because the use of overlapping modes yields a basis of spectral excitations which is no longer orthogonal to $O(\varepsilon)$, the resulting direct representation requires an efficient implementation of the spectral projection operation. This is accomplished using a least square procedure involving the nonradiating LOGOS concepts previously used to develop fast factorization algorithms for low frequency applications.

Applications of the bandlimited LOGOS concepts have previously been limited to scattering from smooth, convex targets. It will be demonstrated that the bandlimited LOGOS concept can be used to determine direct representations for scattering from non-convex targets which exhibit both small-scale roughness (on the scale of the excitation wavelength) and large scale multiple scattering interactions. The former is accomplished with only minor modifications to previously reported results. The latter is more involved and entails the recursive application of previous bandlimited LOGOS algorithms.