INTERPOLATION OF 2D PERIODIC LAYERED-MEDIUM GREEN'S FUNCTION

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This study investigates speeding up the calculation of the mixed-potential layered-medium 2D periodic Green's function by means of interpolation. This Green's function gives the potentials due to a 2D array of point sources spaced on a periodic lattice in the *xy* plane within a layered structure, with *z* being the direction normal to the layers. The sources are in general arranged on a skewed lattice, with a rectangular lattice being a special case.

The layered medium Green's function is first regularized by subtracting from it terms representing periodic Green's functions for the lattice in a homogenous medium. The homogenous-medium Green's functions correspond to direct and pseudo-image terms arising from layer boundaries. The regularized Green's function has no source singularity at the lattice points when the lattice is embedded within a layer; when the lattice is at an interface there is a source singularity, though the potentials are finite at the lattice points. In either case, the regularized periodic Green's function is much smoother and therefore more amenable to interpolation than the unregularized one. Furthermore, the regularized Green's function is much faster to compute than the unregularized one, since the subtraction of the homogenous-medium terms accelerates the convergence. The homogenous-medium periodic Green's functions must be added back to the regularized Green's function to obtain the total Green's function, and these are calculated using the Ewald method, which exhibits Gaussian convergence but requires the calculation of the complementary error function of a complex argument.

By taking advantage of the periodic property of the regularized Greens function we need only interpolate for observation points within a single unit cell. For observation points outside the unit cell the point is shifted an integral number of lattice periods into the unit cell, and the result is multiplied by a progressive phase shift term. Since the regularized Greens function components are not smooth at interfaces, one should avoid interpolating across an interface.

A direct interpolation requires a set of 4D interpolation tables in the variables x-x', y-y', z, and z', with different tables for different combinations of source and observation layers. An alternative to interpolating the regularized Green's function is to tabulate and interpolate the transmission line voltage, current, and boundary reflection coefficient functions that appear in the layered-medium Green's function as a function of the transverse wavenumber k_t. These values need only be calculated and stored for source and observation points at the layer boundaries. One can then calculate, in terms of these tabulated values, the exact voltage and current functions for each k_t and any z and z' using sinusoidal interpolation in z and z'.

Finally, approaches for speeding up the Ewald calculation by regularizing the homogenous-medium periodic Green's function and interpolating it will also be explored.