A GNU library for high order boudary integral equation methods in electromagnetism

Felipe Vico

February 2022

1 Abstract

In this talk we will present a GNU library made by The Simons Foundation, Inc (Leslie Greengard and Manas Racch), Michael O'Neil, Felipe Vico and others. The library can be downloaded from https://fastalgorithms.github.io/ and consist of a set of functions for the high order discretization of integral equations in electromagnetism. We will explain the main functionalities and interfaces available. The source code is made in fortran and there are wrappers from Matlab, Python, C and other high order languages. The surface geometry is provided by using high order triangular patches and the induced densities on the surface are described by using Koorwninder orthogonal polynomials. The functions provided allow to compute the field on the surface by using a multilevel fast multipole algorithm that is stable in low frequency and a fast adaptive quadrature algorithm for the near interaction terms. The EM formulations provided are: the decoupled potential integral equation (DPIE), the non-resonant charge-current integral equation (NRCCIE) and the regularized combined source integral equation (RCSIE). Those formulations are particularly interesting in the low frequency regime due to its stability but can be also used in higher frequencies. The library uses openmp for paralelization and explicit SIMD vectorization for the evaluation of the near field in the adaptive quadrature algorithm. The resulting algorithms don't suffer from high density mesh breakdown, instead the user can obtain arbitrarily low errors by doing hp refinement (reducing the size of the triangles and increasing the order of the polynomials on each triangle). The formulations allow also adaptive discretizations for geometries with small details.

The talk will include a quick user's guide to the library and interfaces and its installation process in different platforms. We will also show different numerical results.

The library also contains low level functions that allow to implement easily other EM formulations or the use of different basis/test functions easily making use of all the adaptive integration and FMM machinery.