Towards a Fast Direct Solver for Maxwell Scattering

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Fast Algorithms

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Team

My Research Focus:

1. High Performance & Scientific Computing
2. Fast algorithms for Integral Equations
3. Software Engineering

Find our Software on GitHub:
https://github.com/betckegroup
https://github.com/fastalgorithms

Srinath Kailasa
GitHub: skailasa

Manas Rachh
GitHub: mrachh

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Motivation

1. solving PDE as BIE leads to small, dense matrices.
2. Benefits $\rightarrow$ for unbounded problems, integrate over fixed domain, however main tradeoff are dense matrices.
3. BIE $\rightarrow$ so called fast algorithms, accelerated application and inversion of system matrices that arise upon discretization (Galerkin, Nystrom etc)
4.

Problem setting for BIE of Helmholtz scattering in exterior.

History

Timeline of fast algorithms, beginning with FMM and latest FDS methods

FMM - an $\mathcal{O}(N)$ matvec

Brief overview of FMM and its underlying operational principle in its analytic form.

From Analytic to Algebraic Fast algorithms

Drawbacks of analytic FMM, and analytic fast algorithms. Give sketch of semi-analytic methods, and what might be accomplished by a fully algebraic method.

Algebraic Fast Algorithms for Matrix Inversion

Fast direct solvers, overview of what they are trying to accomplish, and of course the major pros and cons.

Summary

Summarise the motivation for fast algorithms, and briefly discuss their other applications outside of integral equations.

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FMM-LU: A fast direct solver for BIEs

Introduce motivation behind FMM-LU (RS-S).

Proxy Compression I

Proxy Compression II

Laplace

Helmholtz - Sound Hard

Numerical Results - Sound Hard

Helmholtz - Transmission

Towards Maxwell

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Open Problems & Future Directions

1. Unification of fragmented software landscape for fast-solvers. Offer overview of what's out there and who's working on what, what is parallelized and what's not.
2. FDS for high-frequency problems.
3. Complete a first FDS for maxwell. What kind of problems would this allow us to solve? How close are we to this goal?

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