Hierarchical Compression for Integral Equation Methods Using FLAM

TECHNISCHE UNIVERSITÄT DARMSTADT

Proposal for a bachelor's or master's thesis
Study field: Computational Engineering | Computer Science | Electrical Engineering | Mathematics
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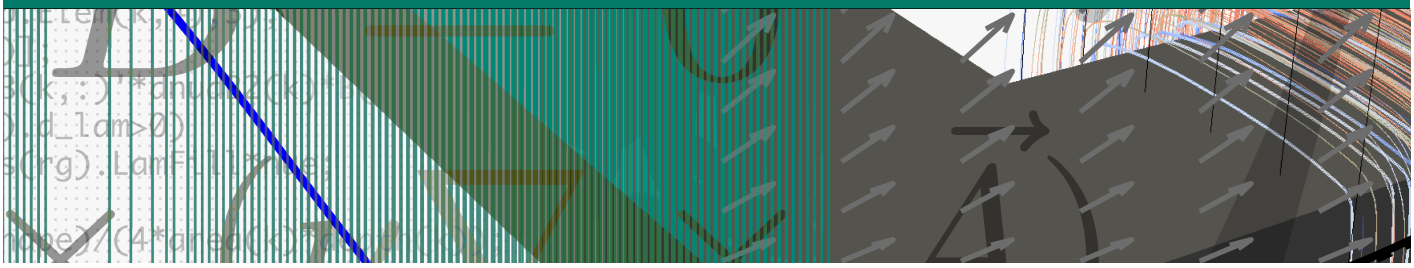

Description

Integral equation methods are widely used in computational electromagnetics to model open-domain problems such as electrostatic, magnetostatic, or magnetoquasistatic fields. After discretization with basis functions, the resulting linear systems are typically dense, leading to quadratic memory consumption and computational cost.

Hierarchical compression techniques exploit the fact that interactions between well-separated regions of the domain are often of low numerical rank. By approximating these interactions with low-rank representations, both memory usage and computational complexity can be significantly reduced. One such approach is *recursive skeletonization*, implemented in the MATLAB library *FLAM (Fast Linear Algebra in MATLAB)* [1].

The goal of this thesis is to investigate the use of FLAM to compress system matrices arising from integral equation formulations. A simple electromagnetic model problem will be discretized and solved both with and without compression. The student will analyze the influence of hierarchical compression on solution accuracy, memory consumption, and computation time. If time permits, the impact of higher-order basis functions on compression efficiency may also be explored.

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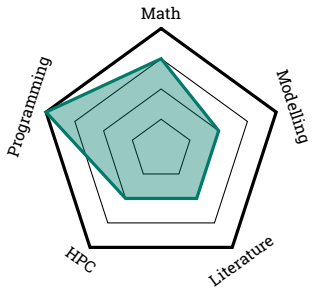
Weighted Core Areas:



Prerequisites

- Basic knowledge of electromagnetics.
- Familiarity with numerical methods for partial differential equations.
- Programming experience in MATLAB.
- Interest in numerical linear algebra and scientific computing.

References

[1] K. L. Ho, *FLAM: Fast Linear Algebra in MATLAB*, available online: https://github.com/klho/FLAM.

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