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FAST DIRECT SOLVERS: APPLICATIONS TO BOUNDARY ELEMENT METHODS AND OTHER LINEAR SYSTEMS

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ABSTRACT

Many problems in engineering lead to the solution of large linear systems. In recent years, many techniques, generically called fast direct solvers, have appeared to solve dense linear systems with computational cost close to O(N) using direct methods (e.g., variants and approximations of the Gaussian elimination). Such algorithms can make several methods such as the Boundary Element Method (BEM) very competitive. In addition, many "exact" direct solvers for sparse matrices, based on multifrontal or supernodal techniques, lead to dense sub-blocks. Operating on these blocks can be accelerated using these fast techniques.

These fast direct solvers are based on low-rank approximations that can be obtained using a variety of techniques including randomized algorithms, rank-revealing QR and LU schemes, pseudo-skeletal decompositions, adaptive cross approximation, interpolative decompositions... These methods allow discovering many structures in matrices, including hierarchical, hierarchical^2, and hierarchically semi-separable matrices, multipole representations (fast multipole method), etc, that can lead to many different kinds of fast O(N) solvers.

This symposium aims at discussing recent progresses in the development of such fast methods and their applications. An example focus application will be the accelerated forms of the BEM and applications of such techniques to large-scale computations.

Topics include:

- Fast direct solvers
- Application to sparse linear solvers
- Preconditioning and fast iterative solvers

- Methods to find low-rank approximation of matrices
- Methods to identify various types of hierarchical matrix structures (H, H^2, HSS, etc)
- Development and applications of fast BEM
- Solvers for elliptic partial differential equations