Master's project COSSE programme: solving large linear systems

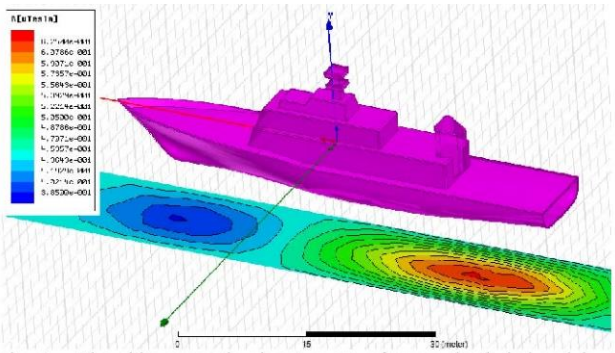
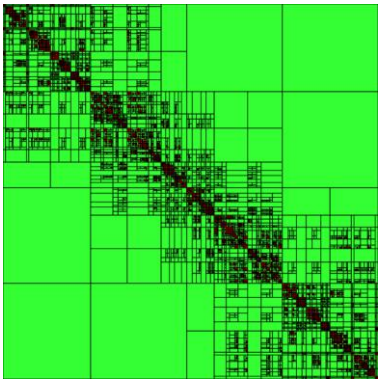


Fig. 5 The ship magnetic signature at reference depth induced by the



Steel ships disturb the local geomagnetic field. Through this mechanism, among other things, ships can be detected by modern sea mines that are equipped with a magnetic sensor. The magnetic disturbance field of a ship is also known as the magnetic signature. For naval vessels that must be able to operate in conflict areas, the mine threat, and therefore also the magnetic signature, is of great importance. That is why these ships have a coil system on board with which the magnetic signature can be minimized. This so-called degaussing system is a control loop: the position and orientation of the ship in the geomagnetic field are continuously monitored and with this information, the currents in the coils are controlled.

To calculate the magnetic signature of a steel ship, the Method of Moments (MoM) is a suitable method because the fact that the ship's structure consists of thin steel plates can be used with advantage [1]. The MoM also supports ferromagnetic hysteresis, anisotropy and inhomogeneous material properties. However, the system matrix is full and when using a realistic mesh and realistic ship dimensions, large linear systems are obtained. These then require a lot of memory and lead to long computation times. This assignment is aimed at efficiently assembling and solving large, full systems. Possible solution directions [2] are:

- Use of GPU to process matrix assembly in parallel;
- Iterative solver;
- Preconditioning;
- Adaptive cross approximation, Hybrid cross approximation, Fast Multipole Method;
- Hierarchical matrices, H^2 matrices;
- Faster programming language.

These directions are explored in order to find the best possible methodology for magnetic ship signature calculations.

For more information about this assignment, please contact:

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[1] A. Morandi, M. Fabbri & P. Ribani, A Modified Formulation of the Volume Integral Equations Method for 3-D Magnetostatics, IEEE Trans Mag. Vol 46, No 11, 2010.

[2] S. Börm, S. Christophen, Approximation of integral operators by Green quadrature and nested cross approximation, arXiv:1404.2234 [math.NA], 2015.