

Application of Fast Multipole Method to Biot-Savart Law Computations

Wolfgang Hafla, André Buchau, Wolfgang M. Rucker,
Institute for Theory of Electrical Engineering, University of Stuttgart,
Pfaffenwaldring 47, 70569 Stuttgart, Germany, wolfgang.hafla@ite.uni-stuttgart.de

Abstract

When field problems are solved it is often necessary to compute the magnetic field due to free currents with Biot-Savart law. In many formulations for solving field problems it is common to split the total magnetic field into a part due to magnetized material and the one due to free currents. In these cases Biot-Savart law is used to assemble the right-hand side of the system of algebraic equations. It is also needed to compute field values at observation points e.g. to compute forces with Maxwell's Stress Tensor. Since volume integrations are generally time-consuming, evaluation of Biot-Savart law is often slow. We therefore developed an approach that allows application of the Fast Multipole Method for efficient evaluation of Biot-Savart Law. It can be easily integrated in an existing Fast Multipole Method implementation. The decrease of computation time is demonstrated with a numerical example consisting of two air coils. The obtained results differ from direct evaluation of Biot-Savart law by not more than 1%.