Coupled Problems in Computational Electromagnetics

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This talk discusses recent advances in the computation of electromagnetic fields, i.e., computational electromagnetics, coupled with additional multiphysical phenomena, i.e., computational multiphysics. In particular, the focus is put on new hardware-oriented models and methods related to contemporary Graphic Processing Units (GPUs) and other future many-core architectures, that may change coupling paradigms ('Optimize data movement, not Flops').
Our applications stem from electrical engineering and involve, in particular, the numerical testing of electromagnetic compatibility (EMC) in complex scenarios as e.g. automotive design (particularly: e-mobility) and numerical dosimetry of biological organisms in complex electromagnetic exposure situation, in order to ensure occupational safety and health. Also of interest is the simulation of complex systems in electromagnetic power transmission, e.g. the simulation of high voltage insulators, cable terminators or energy cables. The talk focuses on the following coupled formulations

- multiscale dosimetry simulations using microscale tissue models in macroscale simulation of electromagnetic exposure of human bodies [1],
- electromagnetic compatibility simulations of fields and cables in an automobile [2],
- electromagnetic field and thermal simulations [3, 4].

Coupled formulations do not only occur in multiphysical models, but also because of different methods that are used on different subdomains (e.g. discretization methods). Often, exploiting this degree of freedom allows more efficient simulations for certain problems, e.g.

- FEM-BEM coupling for electro-quasistatic fields simulations [5],
- Method of Moments coupled to Finite Difference Time Domain method for radio-frequency problems [6],
- quasistatic magnetic fields coupled with electric power networks [7].

Finally, the talk will discuss advantages and disadvantages of different coupling strategies, i.e., convergence of weak and strong couplings, and the implications of future computer hardware.

References

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