EM FIELD SIMULATION BASED ON VOLUME DISCRETIZATION: FINITE INTEGRATION AND RELATED APPROACHES

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Abstract

Today's design and analysis demands for accelerator components request for reliable, accurate, and flexible simulation tools for electromagnetic fields. Amongst the widest spread approaches is the Finite Integration Technique (FIT), which has been used in electro- and magnetostatics, eddy current problems, wave propagation problems, as well as PIC codes. FIT belongs to the class of local approach in the sense, that the discrete equations are derived cell-by-cell by transforming the continuous Maxwellian equations onto the computational grid. Other representatives of local approaches are Finite Differences (FD), Finite Volumes (FV), Finite Elements (FE), and the Cell Method (CM). All these approaches are based on a volume discretization, defined by the three-dimensional mesh. Whereas the close relations between FIT and FD has been known since the beginning of both approaches in the seventies, recent research has revealed that under certain circumstances, also FIT and FE have many important properties in common. In the light of the forthcoming 30 years-anniversary of the first FIT-publication in 1977, this contribution reviews these properties as well as some still existing important differences, and their consequences for the usage of the methods in practice. It is shown that the differences between the main representatives of so-called "geometrical methods" (FIT, FD, FE, CM) are surprisingly small. Some of the recent research on this topic is presented, which has lead to new theoretical insights in computational electromagnetics. Finally the possible impact of these results on the derivation of new simulation methods is discussed.

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