Vox Popular - Applying Voxel-based Fast Methods to Nanophotonics, IC Interconnect, and Fields in MR Imagers

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Voxel-based 3-D structure generation has become so fast and reliably automatic, it is now the standard for a broad range of applications including medical-imaging-based anatomical reconstruction, 3-D printer model creation, and virtual nanofabrication. Its remarkable speed allows engineers and clinicians to interactively generate and visualize incredibly complicated structures, enabling them to quickly assess manufacturing processes, diagnose diseases, create implants, or even plan surgery. However, if one needs to determine structure-specific electromagnetic fields, that enabling interactivity evaporates. The problem is that general finite- or volume-element-based methods, used in most 3-D field simulators, are too mismatched to the billion-cube geometries produced by voxel-based structure generators, resulting in days-long simulation times. Much faster simulation can be achieved by embracing the voxelization, and computing fields using FFT-accelerated volume integral equation methods (FFT-VIEM), but at a significant loss in algorithmic generality. In this talk we describe the application-specific additions needed to use FFT-VIEM in three different applications: nanophotonics, on-chip interconnect, and MR imaging, to demonstrate both the tremendous speed benefits as well as the substantial development complexities.