Electromagnetic Simulation of Transmission Line Structures Using M1-D FDTD Method on Mobile Devices

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Finite-difference time-domain (FDTD) method is one of the most popular computational methods for solving electromagnetic problems. The common platforms for FDTD simulations all this while are usually the computers or workstations. Exploiting the increasing computational capacity of smart hand-held mobile devices, multiple one-dimensional (M1-D) FDTD method is developed to perform electromagnetic simulation of transmission line structures on pads or phones. Based on the M1-D FDTD method, electromagnetic waves propagation along the transmission lines can be observed in time domain while simulation is in progress. Such transient observation of wave propagation could help engineers to carry out quick initial design and analysis of transmission line structures. It could also help students to better understand the operating principles of transmission line structures through real-time visualizations. Several examples are simulated and demonstrated using M1-D FDTD method on iPad, which include a microstrip filter loaded with open or shorted stubs, a branch-line coupler and a coupled line filter, etc. These simulations show the real-time propagations of electromagnetic waves in the circuits. Their corresponding S parameter frequency responses agree well with those obtained by Advanced Design System (ADS).

To further enhance the computational efficiency, multiple 1-D fundamental alternating direction implicit (FADI) or fundamental locally one-dimensional (FLOD) FDTD method is proposed to simulate the transmission line structures as well. The microstrip stub filter and branch-line coupler are simulated using time step larger than the Courant-Friedrich-Lewy (CFL) limit. By using larger CFL number (CFLN), the simulations would become more computationally efficient. The frequency responses using M1-D FADI/FLOD FDTD method with various CFLN still agree quite well with those obtained by M1-D (explicit) FDTD method and ADS.