

Multiple-Region FDTD Method for Multi-Angle Bi-Static Ground Penetrating Rader

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A GP (Ground Penetrating) radar is often used to detect buried objects or underground facilities. In this radar system, an SAR (synthetic aperture radar) technique is used. In the GP-SAR technique, transmitting antenna and receiving antenna are used separately. In recent years, multi-angle GP-SAR is proposed to obtain more rich images. In the GP-SAR, the distance between the transmitting antenna and the receiving antenna are changed. Therefore, a lot of simulations are required to analyze multi-angle GP-SAR. In this paper, we will apply the multi-region FDTD method to the GP-SAR. In the multi-region FDTD, the rotated coordinate is also used to model the oblique antenna and target.

In the MR-FDTD method, the Love's equivalence principle [IEEE AP Magazine, vol. 42, Issue 4, pp. 122–128, 2000] and the Stratton-Chu's formula [Physical Review, vol. 56, Issue 1, pp. 99- 107, 1939] are used to connect each region electromagnetic fields. E_2 and H_2 which are region #2 fields can be obtained as shown in Eq. (1) and Eq. (2).

$$\mathbf{E}_2 = \int_S [-j\omega\mu(\mathbf{n}\times\mathbf{H}_1)G - (\mathbf{E}_1\times\mathbf{n})\times\nabla_1G + (\mathbf{n}\cdot\mathbf{E}_1)\nabla_1G]dS \quad (1)$$

$$\mathbf{H}_2 = \int_S [-j\omega\varepsilon(\mathbf{E}_1\times\mathbf{n})G + (\mathbf{n}\times\mathbf{H}_1)\times\nabla_1G + (\mathbf{n}\cdot\mathbf{H}_1)\nabla_1G]dS \quad (2)$$

where G is green's function, \mathbf{E}_1 and \mathbf{H}_2 are region #1 fields.

Simulation model is shown in Fig. 1 left. In region #1, a dipole antenna is placed and the region is tilted by 45°. The FDTD cell size of region #1 is 3mm. In region #2, a PEC is placed. The FDTD cell size of region #1 is 3mm, the FDTD cell sizes of region #2 is also 3mm. The observed electric fields are shown in Fig.1 right. The MR-FDTD results are compared with full FDTD results and staircase approximation FDTD method. The results are good agreement with full FDTD result, on the other hand, staircase approximation result is not agreement with full FDTD result. The method is suitable for multi angle GRP system analysis.

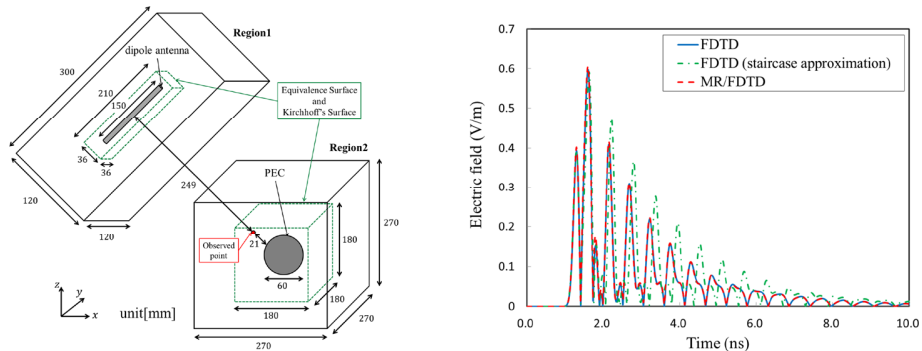


Figure 1. Simulation model and results