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OBLIQUE VOLTAGE EXCITAION FOR CP-FDTD

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1 Introduction

The FDTD method is used for the design and analysis of wide variety antennas. A small restriction of FDTD method is that the target structure should be coincide with cell unit to obtain high accuracy results. To extend the FDTD method for arbitry shaped object, a Contour Path (CP) method has beed proposed. The CP method is easy to fit the FDTD analysis boundary with target object, however, the feeding voltage is still along with the cell unit. In this paper, a vector voltage synthesis is proposed to give an obligue voltage excitation in the CP-FDTD method. The proposed method is applied to V-shaped dipole and oblique monopole antenna on the ground plane, and obtained results compared with the moment method show its effectiveness.

2 Oblique Voltage Excitation for CP-FDTD

When a wire antenna is computed by the CP method as shown in Fig. 1, the magnetic field component just placed on the antenna boundary, and additional magnetic components on both sides of boundary. When an antenna characteristic is computed, the modeling of the feeding structure is very important. In the conventional FDTD method, a feeding voltage is replaced with one side of a cell for the delta gap feeding, as shown in Fig. 2. The input impedance Z is obtained by eq. (1), where the current I is calculated by the magnetic components and Ampere's law.

In this paper, two voltage components are used for oblique voltage excitation, as shown in Fig. 2. Two voltage components along with the x- and y-axis denoted by V_1 and V_2, the input impedance Z is expressed by eq. (2).

$$Z = \frac{V}{I} \qquad (1)$$

$$Z = \frac{V_1}{I_1} + \frac{V_2}{I_2} \qquad (2)$$

The proposed feed model is applied to the dipole antenna, the V-shaped dipole antenna, and the monopole antenna. Analytic results are compared with the moment method.

3 Analytic Results

The dipole antenna, which is coincided with the cell, can be calculated by the conventional FDTD method. Table 1 shows the FDTD analytic condition in this paper. The result of the FDTD analysis of approximating an antenna diameter with the wire is good agreement with the result by the moment method (NEC2) using an antenna diameter of 0.7 mm.

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3.1 Tilted Dipole Antenna

Figure 3 shows the analytic model of the tilted dipole antenna that is tilted 45 degrees to z-axis in the yz plane. The length of the antenna is 14.85 cm, and a proposed vector excitation is used for feed point, and CP method is used for the conductor. Figure 4 shows analytic results by FDTD and moment method. The resonant frequency obtained by moment method is higher in comparison with the FDTD result in the case of length of 14.85 cm. An analytic result by moment method of the length of 16.12 cm is good agreement with the FDTD result. The antenna modeling by the FDTD method becomes longer than the actual length by the effect of the antenna end. In this case, the FDTD model is two cells longer than the actual model.

3.2 V-shaped Dipole Antenna

Figure 5 shows the V-shaped dipole antenna, and the analytic condition is also used as shown in Tab. 1. When the V-shaped dipole antenna is computed by the FDTD method, an additional magnetic field is used for the conductor of an antenna and the proposed vector excitation is used for the feed point. The V-shaped angle is set up with 90 degrees. The upper conductor is 7 cm, and the lower conductor is one cell longer than the upper conductor. When the antenna is analyzed by the moment method, the antenna length is the same as that by the FDTD method. Figure 6 shows the computation result, and the error of the resonant frequency between the FDTD and moment method is 10 MHz.

3.3 Tilted Monopole Antenna

Tilted monopole antenna is also used the analytic condition as shown in Tab. 1. The monopole antenna is arranged on the infinite ground plane. Figure 7 shows the analytic model for the FDTD method, and for the moment method. The antenna length for the moment method is 7.78 cm including a feed port. Figure 8 shows the return loss characteristics of the tilted monopole antenna. The resonant frequency obtained by FDTD method is lower than the result of moment method. In this case, the FDTD model is one cell longer than the actual model because the errors of the frequency decrease when antenna length is 8.48 cm with moment method.

4 Conclusion

In this paper, a vector voltage synthesis was proposed to give an obligue voltage excitation in the CP-FDTD method. A 45-degree tilted dipole antenna, V-shaped dipole antenna, and a 45-degree tilted monopole antenna were computed using the proposed method. The FDTD result, which is modeled carefully the effect of the antenna end, is good agreement with the result of moment method. The proposed feed model is fit for a wide use, and can be applied to arbitry shaped feed structure.

References

[1] T. Arima and T. Uno, "FDTD Analysis for Wire Antenna using CP Method," *Technical report of IEICE*, AP99-160, Jan. 2000.

Table 1: FDTD Analytic Condition

Analytic Region	70 × 70 × 50 cells
Cell Size	$\Delta x = \Delta y = \Delta z$ =5.0mm
Iteration	2,000 time steps
ABC	PML 8 layer
Incident Voltage	Gaussian Pulse

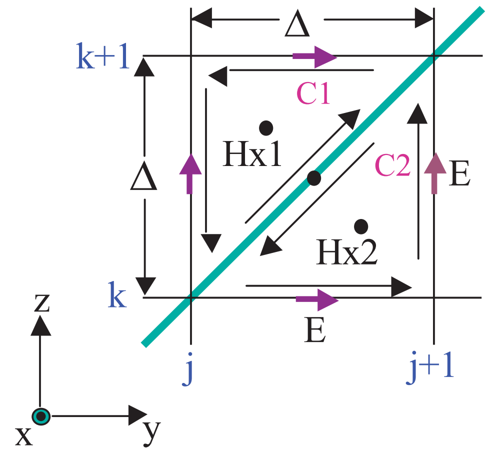

Figure 1: Wire model using Contour Path method

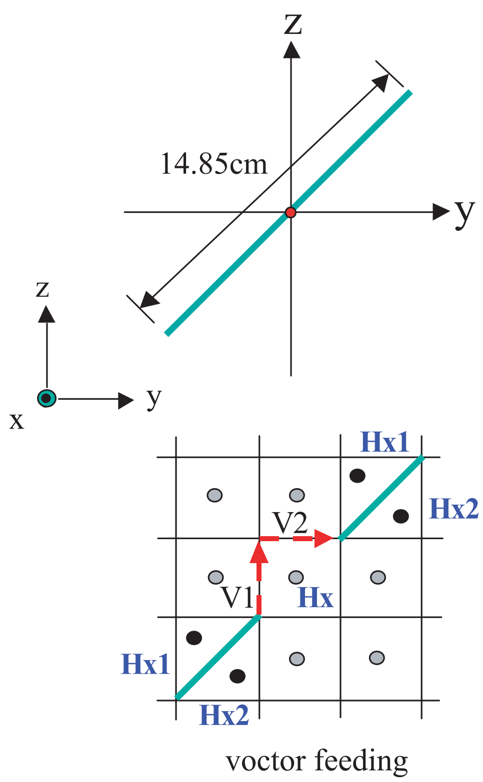

Figure 3: Tilted dipole antenna

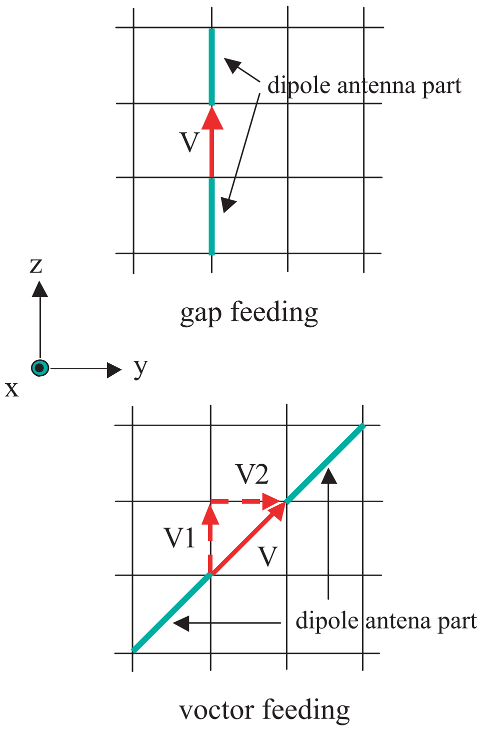

Figure 2: Proposed feed model

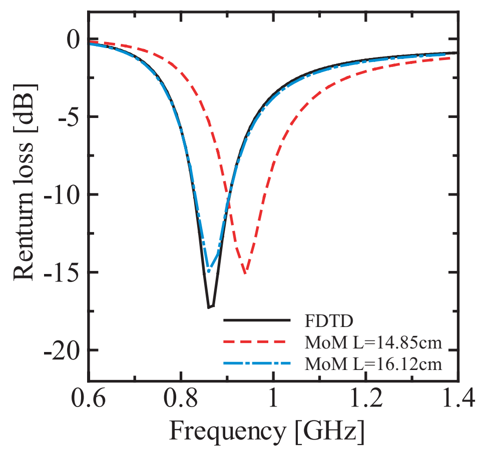

Figure 4: Return loss characteristics of tilted dipole antenna

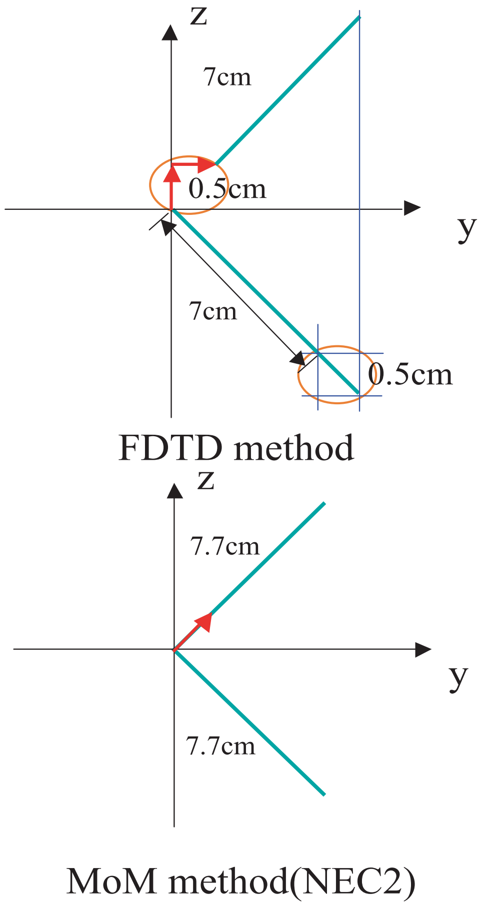

Figure 5: V-shaped dipole antenna

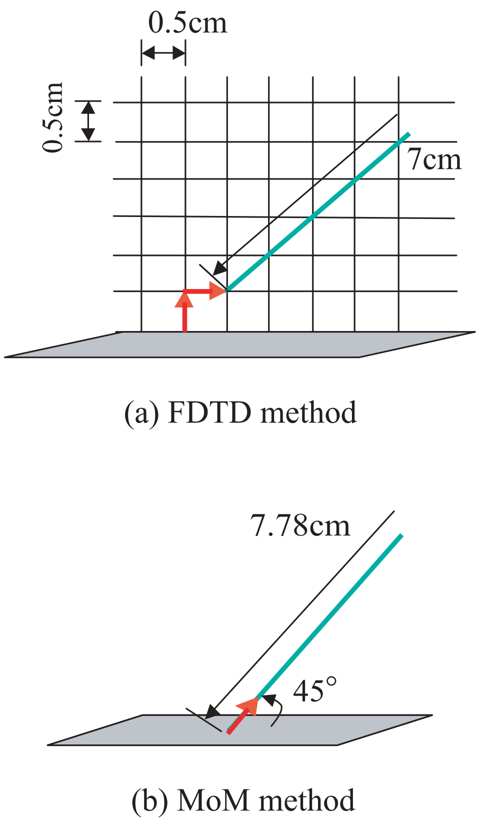

Figure 7: Tilted monopole antenna

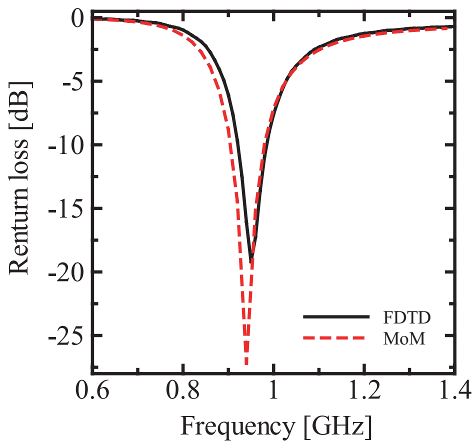

Figure 6: Return loss characteristics of V-shaped dipole antenna

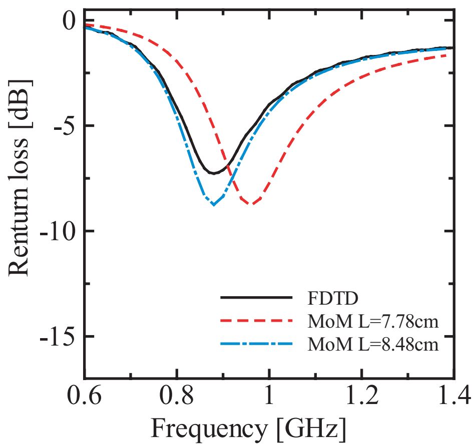

Figure 8: Return loss characteristics of tilted monopole antenna