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CHARACTERISTICS OF A MONOPOLE ANTENNA MOUNTED ON A CONDUCTING RECTANGULAR BOX

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1. INTRODUCTION The characteristics of a monopole antenna attached to a conducting rectangular box have been analyzed by the finite-difference time-domain(FDTD) method. In [1], the radiation patterns and impedance were calculated for a relatively small size box. In these calculations of radiation pattern the FDTD cell size was adjusted to equal the wire diameter. These cells were much smaller than needed, forcing the FDTD code to use excessive amounts of memory and preventing analysis of larger boxes. The impedance was calculated with subcell method introduced by K.R.Umashankar in [2], but only the result that the wire was centered on the smaller box was shown.

In this paper the FDTD cells are made larger. The subcell method is applied to all the calculations. This allows analysis of larger boxes. Results for the monopole located away from the center of the box as well as centered are presented. In this paper not only are radiation pattern and impedance shown, but also actual gain is calculated. Radiation pattern is compared with moment method, impedance and gain with measurements only as the available moment method was not capable of calculating these quantities.

2. DESCRIPTION OF THE METHOD The geometry is shown in Figure 1. The box and the wire are perfect conductor. The FDTD calculations are made using Yee's algorithm [3] with cubical cells, and Mur [4] absorbing boundariers acting on electric fields are used. The E_z component of the lowest cell of the monopole is used as the source and the source voltage is $E_z \cdot \triangle z$, where the $\triangle z$ is the space increment in the z direction, and the current is found from the magnetic fields which surround this E_z.

The far zone fields are obtained from the electric and magnetic currents on a surface which encloses the entire structure as shown in [5].

3. RESULTS The dimensions of the box are $a = 60mm$, $b = 10mm$, the monopole length $h = 50mm$ and radius $r = 0.5mm$, $c \triangle t = 1/(2 \triangle z)$.

First consider a radiation pattern in the $\phi = 0°$ plane. For the largest (c=200mm) box, the FDTD cells are $\triangle x = \triangle y = \triangle z = 5mm$ and the FDTD space is $72\times 62\times 100$ cells. Far zone fields in 4 degree increments are calculated. The source is $E_z =$

$sin(2\pi f_0 t)$, where f_0=1.5GHz. The FDTD pattern is compared with that of moment method [6] in Figure 2.

Next consider impedance. Two cases are considered. For the first, the wire is offset from the center (w=10mm) on a smaller (c=50mm) box. The FDTD cells have $\Delta x = \Delta y = \Delta z = 1.67mm$ and the FDTD space is 130× 90× 180. The source is changed to a 0.13ns Gaussian pulse for more efficient wideband calculation. The impedance is compared with experiments as shown in Figure 3. For the second case, the wire is centered on the top of a larger (c=130mm) box. The FDTD cells are increased to $\Delta x = \Delta y = \Delta z = 2.5mm$ to accommodate the larger box, with the FDTD space now 100× 90× 150 cells. The impedance is compared with experiments in Figure 4.

Finally consider the gain of antenna. The wire is centered and all the conditions are the same as for the first impedance calculation as above. The gain of the antenna in the $\phi = 0°$, $\theta = 90°$ direction is compared with experiments as shown as Figure 5.

4. CONCLUSION The radiation pattern and the impedance results calculated with the FDTD method agree with those of the moment method and the experiments. The gain agrees with the experiments from 1.3GHz to 2.5GHz. At lower and higher frequency the experimental determination of antenna gain is difficult. The results as shown above indicate that the FDTD method is applicable to this antenna. The wire can be centered on the box or offset. Because the subcell method is adopted to model the small wire radius, the method is applicable to larger boxes and the CPU time of FDTD is shortened.

REFERENCES

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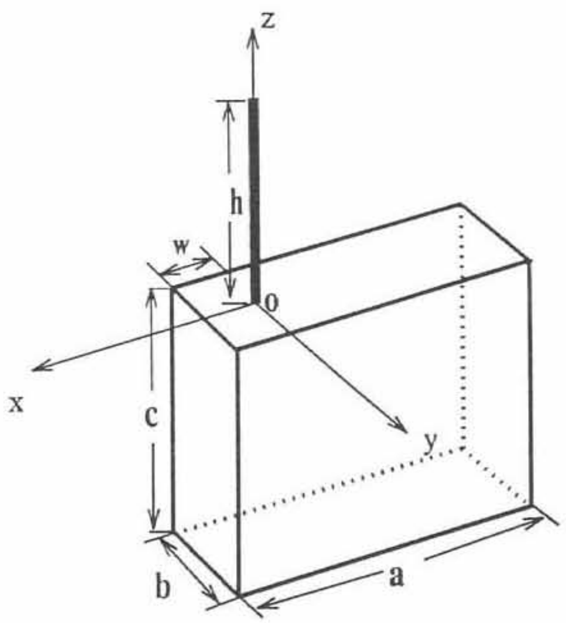

Fig.1 Geometry

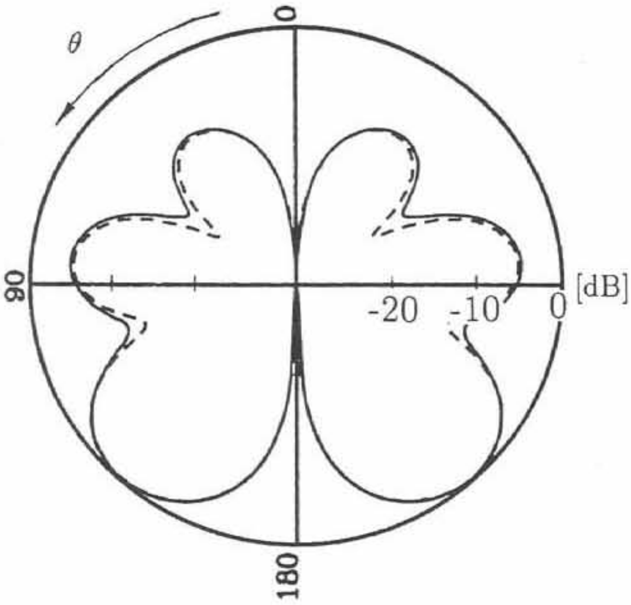

Fig.2 The patterns c=200mm

— FDTD, - - - MoM

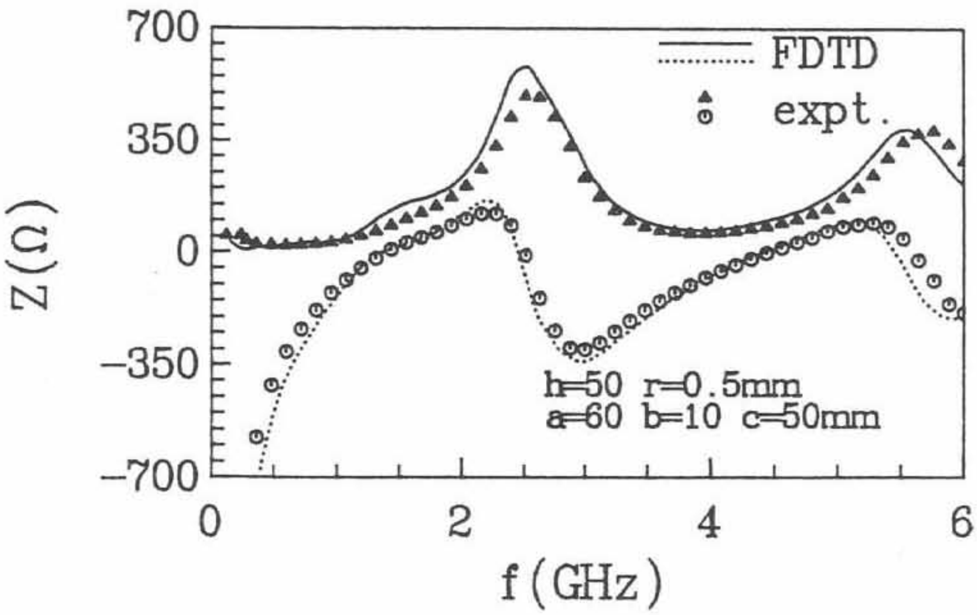

Fig.3 The impedance for the wire offset. w=10mm

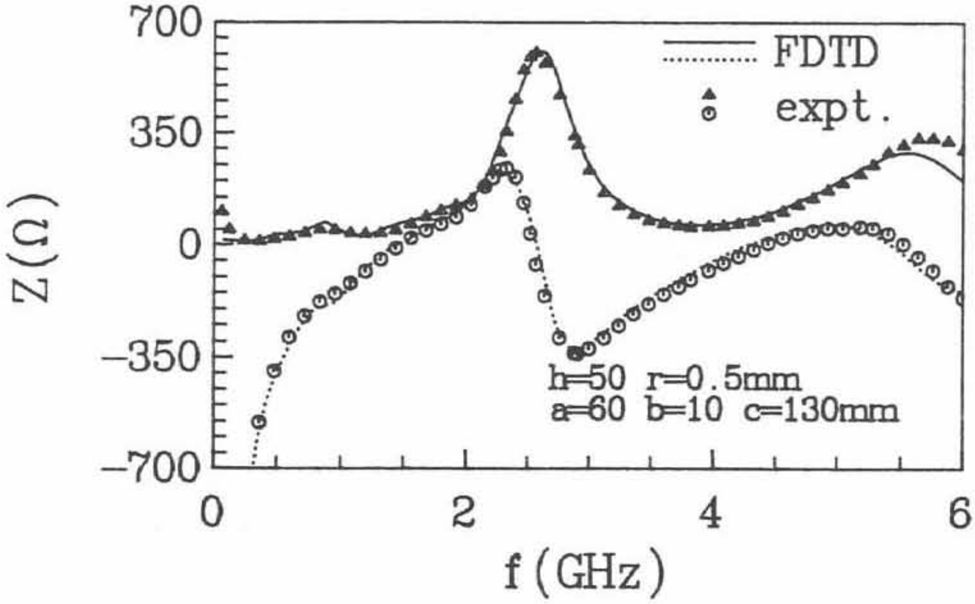

Fig.4 The impedance of a larger box

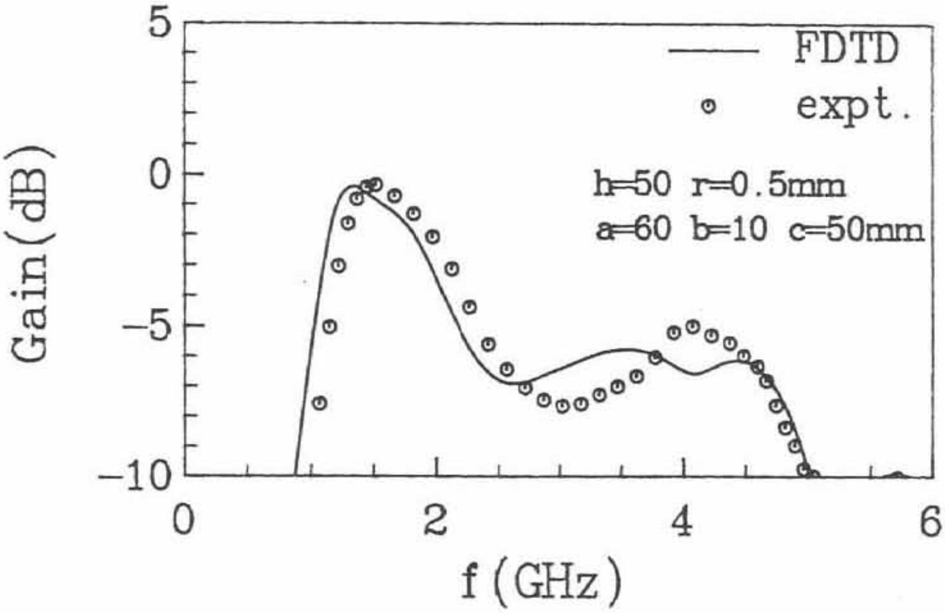

Fig.5 Actual gain