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信息科学与技术学院2008年发表论文明细表

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2	王毅 曹群生	博士生 教授	041 041	Convergence analysis of Runge-Kutta time-domain Scheme	APMC conference	2008年F6卷
3	王毅 曹群生	博士生 教授	041 041	Treatment Technology for Dielectric Media Interfaces Using Multiresolution Time-Domain Scheme	ICMMT2008 Proceedings	2008年2卷
4	王乾 陈振华 曹群生	硕士生 硕士生 教授	041 041 041	Study of Reduce-surface-wave Antenna	APMC conference	2008年G1卷
5	王乾 曹群生	硕士生 教授	041 041	Analysis of waveguide structure using the MPSTD algorithm	APMC conference	2008年G2卷
6	李琳 曹群生	硕士生 教授	041 041	Application of the Unconditionally Stable ADI-MPSTD for Scattering Analysis	ICMMT2008 Proceedings	2008年2卷
7	陈振华 曹群生	硕士生 教授	041 041	Study of A Two-arm Simulation Antenna and the Relevant Wideband Balun	ICMMT2008 Proceedings	2008年4卷
8	刘少斌	正高	041	Wentzel-Kramer-Brillouin and finite-difference time-domain analysis of Terahertz band electromagnetic characteristics of target coated with unmagetized plasma	系统工程与电子技术	2008年19卷1期
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26	赵 伟 邓宏伟 赵永久	博士生 硕士生 教 授	041 041 041	Dispersion Characteristics Analysis of Lossy Coaxial Metal Waveguide with 4-Component Compact 2-D FDFD Method	2008年 International Symposium on Antennas, Propagation and EM Theory 会议交流	
27	赵 伟 邓宏伟 赵永久	博士生 硕士生 教 授	041 041 041	Application of 4-Component Compact 2-D FDFD Method in Analysis of Lossy Circular Metal Waveguide	Journal of Electromagnetic Wave and Application	2008.22
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33	邓宏伟 何小祥 刘少斌	硕士生 副教授 教　授	041 041 041	A novel ultra wideband planar antenna	2008年International Conference on Microwave and Millimeter Wave Technology 会议交流	
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45	姚彬炎 周永刚 李琳 曹群生	硕士生 副教授 硕士生 教授	041 041 041 041	Compact UWB Bandpass Filter With Improved Upper-Stopband Performance Using Multiple-Mode Resonator	在2008年The 8th International Symposim on Antennas,Propagation and EM Theory会议上交流	
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ICMMT2008

Ultra-Wideband Bandpass Filter with Notched Band Using Microstrip/CPW Structure

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***Abstract*-In this paper, a new ultra-wideband (UWB) bandpass filter (BPF) with narrow notched (rejection) band in the UWB passband, which is realized with hybrid microstrip/CPW structure, is presented and implemented for using in wireless communication applications within the unlicensed UWB range set by the Federal Communications Commission (FCC). Such an UWB bandpass filter with notched band is required in practical systems in order to avoid the interference between the UWB radio system and existing radio systems. The notched band can be easily adjusted to some specific frequency band by tuning the length of the embedding open stub on the bottom of the coplanar waveguide (CPW). The UWB bandpass filters with notched band have been carried out by related simulations and designs. The filters proposed have demonstrated relative excellent ultra-wide bandwidths and notched band performances compared with the references.**

***Index Terms*—Bandpass filters, hybrid microstrip/coplanar waveguide, notched band, ultra-wideband.**

I. Introduction

The ultra-wideband (UWB) radio system has been receiving great attention from both academy and industry since the Federal Communications Committee (FCC) authorized the unlicensed use of the ultra-wideband (3.1 — 10.6 GHz) frequency spectrum for indoor and hand-held wireless communications in early 2002 [1]. Recently, different methods and structures have been used to develop new UWB filters which have a fractional frequency bandwidth (FBW) of 110% [2]–[11]. One general problem of UWB systems is a possible interference with relatively strong narrowband signals within the allocated UWB spectrum like those from wireless local-area network (WLAN) applications. Therefore, a narrow notched band or multi notched bands in the UWB passband is (are) necessary in order to avoid interference that may occur with the existing systems. In reference [12], a single stopband was obtained in the passband of UWB filter by asymmetric parallel-coupled lines. Also, a UWB suspended stripline filter which has a single stopband by incorporating a resonant slot into one of its elements is introduced in [13]. In reference [14] the narrow notched band was introduced by using a technique which involves embedding open stubs in the first and last connecting lines. In order to generate multi rejection bands in the UWB passband, stubs were integrated in the mid of the conductors of a broadside-coupled UWB filter [15].

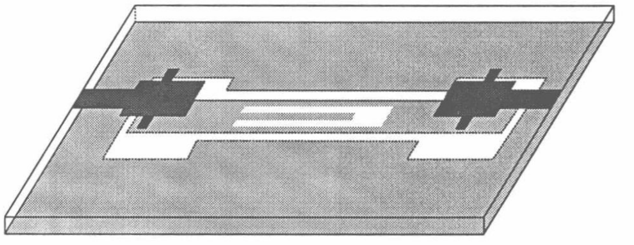
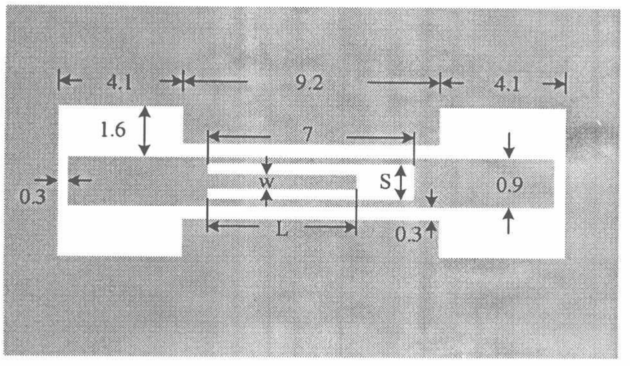


Fig. 1. Configuration of the proposed BPF with notched band.

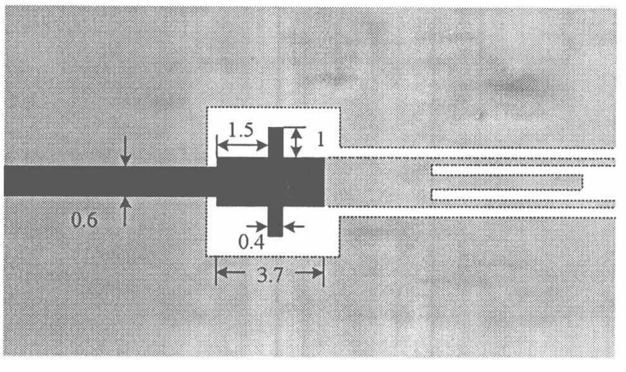
Our work is attempt to propose a novel high-selective UWB BPF mode with band notch structures for using in the unlicensed UWB range released by the FCC. Thus, the filter with narrow notched band in the UWB passband will avoid interference that may occur with the existing radio systems. In this paper, the notched band is introduced by embedding open stub on the bottom side of the coplanar waveguide (CPW) BPF [9]. The outline of paper is following, in Section I, a 3D configuration of UWB BPF with notched band is presented. The structure and operation of the filter are described in Section II. Section III is given demonstrator of this type filter with electromagnetic (EM) simulated results. Finally, a conclusion is given in Section IV.

II. Structure and Characteristics of the UWB Filter With Notched Band

A new UWB BPF with notched band has been studied, which the resonator is embedded open stub on the bottom side of the coplanar waveguide (CPW) BPF, shown in Fig. 1. The original CPW bandpass filter design was illustrated in reference [9]. Fig. 2(a) shows the bottom view of the filter with a narrow notched band, and an open-circuited stub line with a width of W and a length of L is embedded on the CPW resonator. In order to enhance the coupling degree of



(a)



(b)

Fig.2. (a) Bottom view for the hybrid microstrip/CPW filter with notched band. (b) Top view for the hybrid microstrip/CPW filter with notched band.

the input/output (I/O), a broad-side [6] coupled microstrip/CPW structure is introduced. Also, two open stubs, which have a width of 0.4 mm and a length of 1 mm, are added on the two sides of the broad-side coupled line to improve the return loss, shown in Fig. 2(b). The 50-Ω I/O feed lines with a width of 0.6 mm are connected to broad-side coupled lines.

As mentioned above, the problem of interference between UWB devices and systems is an important issue in developing an UWB radio module or system. An efficient way for solving this problem is to implement an optional notched band in the full passband. In order to introduce a narrow notched band, an open-circuited stub line with a width of W and a length of L is embedded on the CPW resonator, shown in Fig. 2(a). The structure was implemented on a microstrip substrate with a relative dielectric constant of 10.8 and a thickness of 0.635 mm. The dimensions of the new notched band filter are given in Fig. 2(a) and Fig. 2(b), respectively. The filter is designed and simulated by the Agilent ADS-Momentum software. The parameters of S, L and W are the main factors that influence the notched band

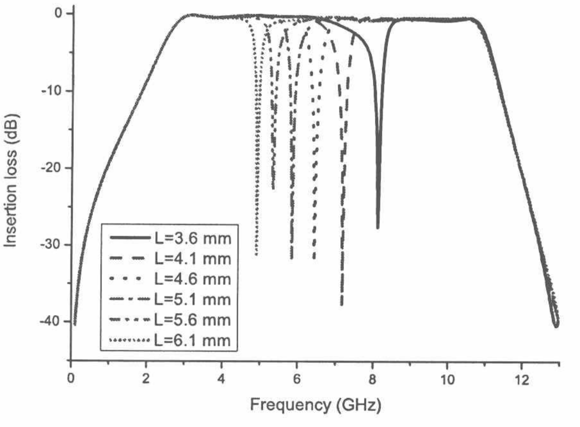


Fig.3. EM-simulated results of the notched band characteristics with fixed S=0.6 mm, W=0.2 mm and varying length L.

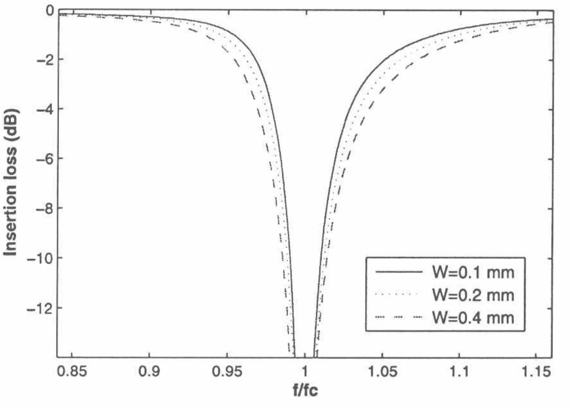


Fig.4. EM-simulated results of the bandwidth characteristics with fixed S = 0.6 mm and varying width W.

characteristic. Fig. 3 displays the scattering characteristic of notched band for a new structure with the fixed values $S = 0.6\,mm$ and $W = 0.2\,mm$, and variable L. It has found that the frequency position of the notched band moves to the lower frequencies with increasing of L. The notched band can be allocated at any desired frequency when L is chosen as a quarter-wavelength at the center frequency of the notched band. The Fig.4 shows the relation of the insertion loss of the notched band structure for $S = 0.6\,mm$ with varying width of W. We found that the bandwidth of the notched filter are controlled by width of W, namely, the bandwidth increases due to the increase of W.

III. Performance of the UWB Filter With EM-Simulation

The Fig.5 gives the relation of the S-parameter of the notched band filter with the frequency in our simulations.

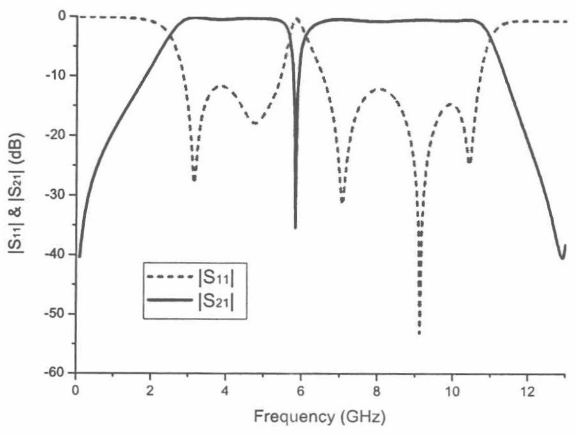


Fig.5. Full-wave EM-simulation of the notched band filter with W=0.2 mm, S=0.6 mm.

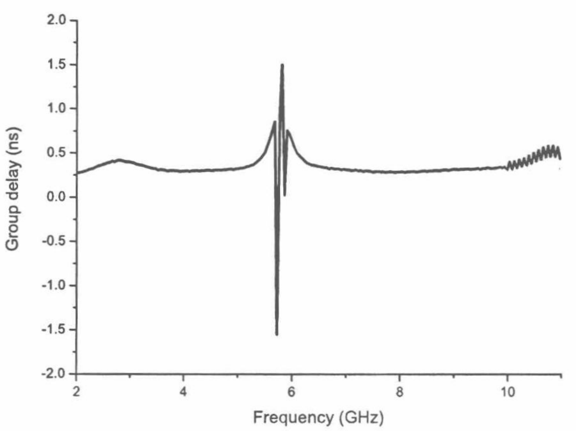


Fig.6. Simulated result of the group delay.

The filter has the embedded stub with of $W = 0.2\,mm$ and gap of S = 0.6mm. It can be seen that the filter exhibits an excellent UWB bandpass performance with FBW of about 120%. Also, a narrow notched band is obtained in the passband, and its center frequency is located at about 5.833 GHz with 10dB FBW of about 2.5%. We find that the rejection loss is more than -35 dB at the center frequency of the notched band, and the insertion loss is less than 0.6 dB in the passband. The return loss is better than 11 dB in the passband. The group delay is also simulated by the full-wave EM-simulation software, as Fig.6 depicts, a flat group delay of less than 0.5 ns in the passband is obtained.

IV. Conclusion

In this paper, a compact UWB BPF with notched band has been presented. The filter design is based on the hybrid microstrip/CPW structure. The notched band is introduced by embedding an open-circuited stub, which is a $\lambda/4$ long at the desired center frequency, on the bottom of the CPW. Meanwhile, the width of the notched band can be controlled by tuning the width of W and the gap of S. The filters with different length of the open-circuited stubs are simulated by full wave EM-simulation software, where the good performance is obtained. In additional, the proposed filter has a compact size. Therefore, the proposed filter is promising for use in the UWB wireless communication to provide an efficient means for solving the problem of the radio interference between the UWB and existing radio systems.

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APMC 2008

Convergence analysis of Runge-Kutta Multiresolution time-domain scheme

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Abstract

The MRTD method highlighted an improvement in the observed dispersion characteristics over the classical FDTD, however the high convergence is hindered because of the low order time-stepping procedure. In this paper, we analyze the convergence of a newly introduced scheme in which the MRTD is incorporated a high-order Runge-Kutta time integrators technique, and show that the mth-order convergence can only be achieved using the same spatial integration order and the same mth-order SSP RK method.

Introduction

The multiresolution time-domain (MRTD) method [1] for the numerical simulation of solutions to Maxwell's electromagnetic equations was initially introduced by M. Krumpholz [1]. In the MRTD scheme, the field quantities are expanded with scaling and wavelet functions, this results in the potential for highly resolved spatial variations, compared to the popular and classical finite-difference time-domain (FDTD) scheme [2].

The original developments of the MRTD highlighted an improvement in the observed dispersion characteristics over the classical FDTD [3]. Daubechies' wavelets were used widely because of its high versatility and simplicity [4, 5], and the choice of Daubechies' expansion wavelets made it possible to control its spatial convergence.

However, in typical implementations, the high convergence of the MRTD is hindered because of the low order time-stepping procedure. The new class of MRTD scheme was reported in [6], which is incorporated a high-order Runge-Kutta [7] time integrators technique to overcome this problem.

In this paper, we focus on the convergence analysis of this Runge-Kutta multiresolution time-domain scheme, and show the high order Runge-Kutta method in time updating and its corresponding order of Daubechies's scaling function, finally, the high convergence has been obtained corresponding with the theoretical.

RK-MRTD basic theory

A. Spatial discretization:

The expansion of the fields we used in the RK-MRTD is largely as in general MRTD, except for the use of impulse functions in time. For simplicity, it is taken E_x component as an example, so the representation is taken the form as

$$E_x(r) = \sum_{i,j,k=-\infty}^{+\infty} {}_{\phi x}E_{i+1/2,j,k}\phi_{i+1/2}(x)\phi_j(y)\,\phi_k(z), \qquad (1)$$

Using the Galerkin's method, we can derive the update equation. Explicitly, for isotropic space distribution, the update equation of E component along x-direction (assuming σ=0) is

$$\frac{\partial_{\phi x}E_{i+1/2,j,k}(t)}{\partial t} = \frac{1}{\varepsilon_0\varepsilon_r}\sum_{v}\alpha(v)\times({}_{\phi z}H_{i+1/2,j+v+1/2,k}(t)\frac{1}{\Delta y} - {}_{\phi y}H_{i+1/2,j,k+v+1/2}(t)\frac{1}{\Delta z}), \qquad (2)$$

B. High order time integration:

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We first simplify the update equation in the following form,

$$\frac{\partial \mathrm{F}}{\partial t} = \mathrm{LF} + \mathrm{S}(t) \tag{3}$$

here $\mathrm{F} = \{ {E^\phi \atop H^\phi} \}$ and $\mathrm{L} = \begin{pmatrix} 0 & \mathrm{L}_H \\ \mathrm{L}_E & 0 \end{pmatrix}$

To achieve the high order convergence, we propose to discretize the system with *m*th-order *m* stage strong stability preserving Runge-Kutta (SSP-RK) method [7], it has the form:

$$\begin{aligned} &\mathrm{F}^{(0)} = \mathrm{F}_n \\ &\mathrm{F}^{(i)} = \mathrm{F}^{(i-1)} + \Delta t\, \mathrm{LF}^{(i-1)} + \Delta t\, \mathrm{S}^{(i)} \\ &\mathrm{F}_{n+1} = \sum_{k=0}^{m} \alpha_{m,k}\, \mathrm{F}^{(k)} \end{aligned} \tag{4}$$

Where

$$\mathrm{F}_n = \mathrm{F}(t_n)$$

$$\mathrm{S}^{(i)} = (I + \Delta t \frac{\partial}{\partial t})^{i-1}\, \mathrm{S}(t_n)$$

The coefficients $\alpha_{m,k}$ are given as follows:

$$\alpha_{1,0} = 1$$

$$\alpha_{m,k} = \frac{1}{k}\alpha_{m-1,k-1}, \quad k = 1,\ldots,m-2$$

$$\alpha_{m,m} = \frac{1}{m!} \quad \alpha_{m,m-1} = 0 \quad \alpha_{m,0} = 1 - \sum_{k=1}^{m} \alpha_{m,k}$$

Convergence analysis

According to ref. [8], for Daubechies scaling functions D_N, the spatial representation of any function converges with order *N*. However, in the MRTD scheme, the high-order convergence is limited by low order time integration and the choice

$$\Delta t = \alpha \frac{\Delta x}{c} \quad (a \le 1) \tag{5}$$

to satisfy the Courant-Friedrichs-Lewy (CFL) stability condition. Indeed the overall error is bounded by

$$A\Delta x^N + B\Delta t^2 \le A\Delta x^N + B\Delta(\alpha\frac{\Delta x}{c})^2 \le C\Delta x^2 \tag{6}$$

with this *m*th-order *m* stage SSP RK-MRTD approach, the overall error can be estimated

$$A\Delta x^N + B\Delta t^m \le C\min(\Delta x^N, \Delta t^m) \tag{7}$$

In order to get the high order of convergence corresponding to D_N, the same error order of RK method should be used.

Numerical results and discussion

We first analyzed a single direction pulse, which is same as used in ref. [6] propagating in one-dimensional (1D) case. To apply single direction pulse source in the MRTD and the RK-MRTD scheme, there is different excitation method for them. In the MRTD scheme, the source is added into the following field expansions: $E^{(0)}, H^{(0+1/2)}$, namely, the components of E and H has half cell in the space. While in the RK-MRTD scheme, the initial fields is excited in same cell position, that is $E^{(0)}, H^{(0)}$.

It, as shown in Fig.1, shows clearly that the convergence of MRTD (D_3) is limited to 2.0674 by the low order of time derivation, and the ideal convergence of D_3 can be achieved using *3*rd-order SSP-RK method (3.0589 in this simulation).

In Fig.2, we compare convergence expanding with Dubechies's D_3 and D_4 scaling function for the MRTD and RK-MRTD scheme. It shows clearly the convergence does not change with increasing of the order of the scaling function in the MRTD scheme. But for the MRTD scheme, the simulation results have been shown exactly convergence corresponding to the theoretical convergence.

For two-dimensional (2D) case, we have analyzed a 2D rectangular waveguide to validate the current approach. Fig.2 and 3 are depicted the resonant frequency and the convergence of the FDTD, the MRTD and the RK-MRTD schemes for the waveguide, respectively. The high-order convergence of results has been presented excellent agreement with our theory.

Conclusion

In this paper, we have studied the high-order convergence of the RK-MRTD scheme, and through several examples, we draw the conclusion that the *m*th-order convergence can only be achieved using the same spatial integration order and same *m*th-order SSP RK method. In typical implementation, the high-order convergence makes it faster to get destined accuracy order, which means the saving of computational time.

Acknowledgement

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Figures

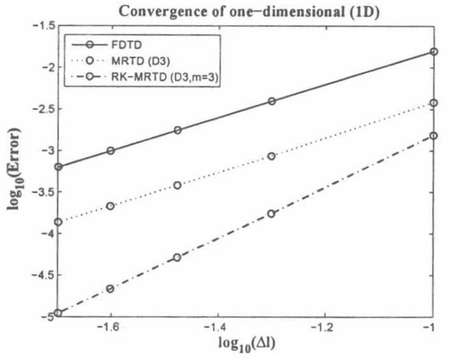

Fig.1 Convergence of FDTD, MRTD (D_3) and RK-MRTD (D_3, m=3) for 1D pulse propagation

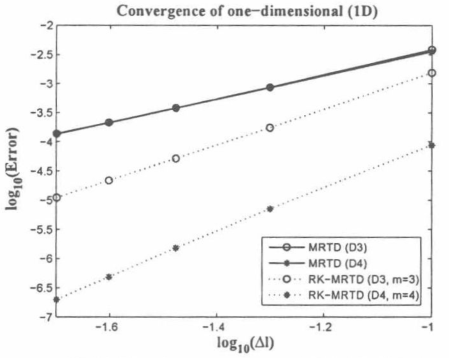

Fig.2 Convergence of MRTD (D_3, D_4) and RK-MRTD (D_3, m=3; D4, m=4) for 1D pulse propagation

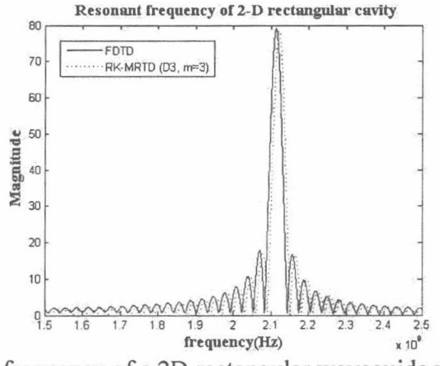

Fig.3 Resonant frequency of a 2D rectangular waveguide versus frequency

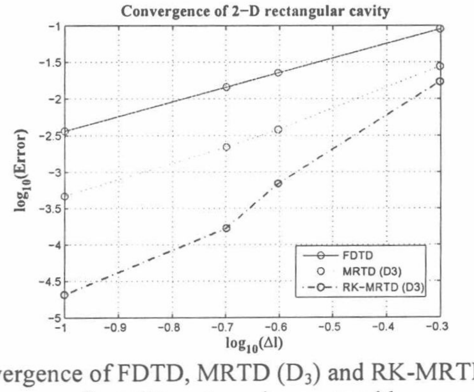

Fig.4 Convergence of FDTD, MRTD (D_3) and RK-MRTD (D_3, m=3) for a 2D rectangular waveguide

ICMMT2008

Treatment Technology for Dielectric Media Interfaces Using Multiresolution Time-Domain Scheme

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***Abstract* – In the paper, we have discussed the distribution of the dielectric coefficients for the dielectric media interfaces, and have studied the solving methods of the permittivity in the multiresolution time-domain (MRTD) scheme. The MRTD results have been compared with those of analysis results and the FDTD method in an EBG structure and a half-filled cavity. It has been shown that the MRTD scheme with different basis functions is more accuracy and less computational memory than the traditional FDTD method.**

***Index Terms*: Multiresolution time-domain; Dielectric media interfaces; Basis functions**

I. Introduction

The multiresolution time-domain (MRTD) method for the numerical simulation of solution to Maxwell's electromagnetic equations was initially introduced in [1] as an alternative to the popular and classical finite difference time-domain (FDTD) [2] approach. The basic idea is rather simple, as it reduces to a method of moments [3] (MoM) wherein the spatial basis functions are chosen from a multiresolution analysis (MRA) [4].

The original developments of MRTD [1] highlighted an improvement in the observed dispersion characteristics over classical FDTD. Since then, a variety of studies have concentrated on the further analysis and applications of these techniques, including the investigation of their dispersion properties [4], the design of schemes for the incorporation of boundary conditions [5, 6], the application of different basis functions [7, 8]; the recent book [9] provides a good introduction to the subject.

However, in typical implementations, the overlap of expansion functions (space basis function) of electromagnetic field results in the difficulty of treating the dielectric media interfaces, some technology has been introduced to treat this problem [9, 10]. In this paper, we discuss a treatment technology for the dielectric media interfaces, and study the distribution of relativity permittivity and their effect.

The remainder of this paper is organized as follows. First, in Section II, we review the basic equations and concepts related to MRTD scheme, and then we give a treatment technology for dielectric media interfaces. The 1D's results using this treatment technology are displayed in Section III. Section IV introduces the 3D's results using this technology. Finally, our conclusions are summarized in Section V.

II. MRTD and Treatment Technology

A. MRTD Method

The original MRTD scheme [1] is based on a spatial multiresolution representation of the fields at each instant in time. For simplicity, it is taken E_x component as an example, so the representation takes on the form,

$$E_x(r,t)=\sum_{n,i,j,k=-\infty}^{+\infty} {}_{\phi x}E^{n}_{i+1/2,j,k}\phi_{i+1/2}(x)\phi_j(y)\,\phi_k(z)h_n(t) \quad (1)$$

where ${}_{\phi x}E^{n}_{i+1/2,j,k}$ is the expansion coefficients. The function ϕ is a scaling function, it satisfies,

$$\phi(v)=\phi(\frac{v}{\Delta v}-l),\quad \text{for } v=x,y,z, \quad (2)$$

$h(t)$ is a rectangular pulse function and has form

$$h_l(t)=h(\frac{t}{\Delta t}-l) \quad (3)$$

Using Galerkin's [6] method, we can derive the update equation. Explicitly, for isotropic space distribution, the update equation of E component along x-direction (σ=0) is

$$\begin{aligned}{}_{\phi x}E^{n+1}_{i+1/2,j,k} &= {}_{\phi x}E^{n}_{i+1/2,j,k}+\frac{1}{\varepsilon_0\varepsilon_r}\sum_{v}\alpha(v)\\ &\times({}_{\phi z}H^{n+1/2}_{i+1/2,j+v+1/2,k}\frac{\Delta t}{\Delta y}-{}_{\phi y}H^{n+1/2}_{i+1/2,j,k+v+1/2}\frac{\Delta t}{\Delta z})\end{aligned},\quad (4)$$

Similarly, we can derive the remaining components' update equations of the electromagnetic field.

B. Treatment Technology

In the equations above, the influence of the dielectric media is yet to be considered. Unlike in the classic FDTD scheme, the average permittivity of cells nearby is used at the interface of dielectric media, the treatment in MRTD scheme is more complex.

To classify this technology, we consider the constitution equation,

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