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Fast and Accurate Extracting Surface and Leaky Wave Poles for Multilayered Structures Based on GPU/CPU Heterogeneous Platform

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1. Extended Abstract

In this paper, a fast and accurate method for extracting surface and leaky wave poles in planar multilayered structure is reported, which is based on GPU/CPU heterogeneous platform. As well known, the spatial domain dyadic Green's functions of a multilayered structure and the corresponding mixed potential integral equation (MPIE) are vital parts in full wave analysis of complicated integrated passive circuits in multilayered structures when using the method of moments (MoM) [1-3]. For generalized multilayered structure, the extraction of surface and leaky wave poles is significant for accurate evaluation Green’s functions. By using the equivalent recursively fractional forms of spectral Green's functions, all the surface wave poles can be fast located on the real axis of the complex k_ρ plane by using the modified dichotomy to the denominators of the spectral Green's functions. Theoretically, the number of leaky wave poles is infinite, but only those who are close to the branch cut need to be located by using the consecutive perturbation algorithm.

Both of the two methods have been proposed and applied to multilayered structures [4]. However, with the increasing number of layers, neither the modified dichotomy method, nor the consecutive perturbation method has weak affection from the recursive expression of spectral domain Green’s functions. In order to overcome this problem, parallel computing is a potential scheme to accelerate the existing algorithms. Different from the traditional methods, which adopt OpenMP with multi-core CPU or MPI with PC-cluster, a novel massively parallel processor, Graphic Processing Unit (GPU), has been widely used in computer simulation for complicated problems in many areas. The authors have successfully adopted this new hardware architecture and developed the conjugate gradient algorithm on a GPU/CPU platform, which reached a significant acceleration for large scale dense matrix solving [5].

In this paper, based on the modified dichotomy method, an embarrassingly parallel algorithm is established. Meanwhile, the consecutive perturbation algorithm is adopted for locating all the surface and leaky wave poles for lossy dielectric layers on a GPU/CPU heterogeneous platform. According to the abundant resource in arithmetic logical unit (ALU) in GPU structure, a precise division can be set to avoid second iteration, which can achieve parallel computing simultaneously. Considering the serial mechanism of Newton-Raphson iteration in consecutive perturbation algorithm, it may be not reasonable to be realized only on GPU, which could not demonstrate the advance in parallel computing. To avoid the increased communication and data transfer between GPU and CPU, the texture memory is used.

To demonstrate the accuracy and efficiency of the proposed method, both the surface and leaky wave poles of a 10-layer structure with different thickness, different permittivity and different loss are extracted, while the corresponding Green’s function is calculated by the discrete complex image method (DCIM). The tradeoff between time cost and hardware resource occupation is analyzed and discussed. The computer program is developed by CUDA-C language [6] on a Dell Precision 5400 which is equipped with two Intel Xeon quad-core CPUs (with a clock speed of 2.5 GHz), 16 GB RAM memory and one NVIDIA GTX 660 GPU card. This GPU’s architecture is Kepler GK104 and its core frequency is 1015 MHz.

2. References

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