URSI AP-RASC, Sydney, Australia, 17-22 August 2025

Verification of Identifying Singly Reflected Light Using ADE-FDTD Method and Two-Dimensional Fourier Transform

T. Sugimoto*, S. Kishimoto, S. Inoue, and S. Ohnuki
Nihon University, Tokyo, Japan; e-mail: csta24010@g.nihon-u.ac.jp; ohnuki.shinichiro@nihon-u.ac.jp

We have proposed an imaging method involving the irradiation of femtosecond optical pulses to the biological sample and performing time-resolved measurement [1]. At this measurement, the singly reflected ballistic light multiply scattered light is generated. The multiply scattered light becomes background noise and deteriorates the contrast of the deeper parts of the image. To achieve a high signal-to-noise ratio in these measurements, the use of quantum pulse gates (QPG) has been considered [2]. A waveform similar to the pump optical pulses can be extracted from the reflected light by QPG. Therefore, it is necessary to generate and apply pump optical pulses that are identical to the singly reflected light. It is difficult to identify a singly reflected light in an experiment, so it is important to simulate and understand the time response waveform of a singly reflected light.

In this study, we developed a method for identifying singly reflected light using the ADE (Auxiliary Differential Equation)-FDTD (Finite-Difference Time-Domain) method and a two-dimensional Fourier transform [3, 4]. The ADE-FDTD method extends the FDTD method by incorporating an ADE, for the analysis of electromagnetic fields in dispersive media. A two-dimensional Fourier transform is applied to the electromagnetic field in real space obtained by the ADE-FDTD method and transformed into wavenumber space. The propagation direction of light in real space can be determined in wavenumber space. By filtering the propagation directions of light in wavenumber space, we can isolate light that propagates in any desired direction. It is possible to eliminate multiply scattered light and identify the singly reflected light.

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