Fast Modeling of Reflectance Image of Turbid Medium with Full-field Illumination

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Reflectance imaging with oblique full-field illumination is a powerful tool for non-invasive determination of internal structure of turbid materials and diagnosis of lesions in human tissues. Extraction of structural information from the reflectance imaging data, however, requires quantitative modeling of light transportation and distribution in the turbid medium. Radiative transfer theory offers an accurate model and often has to be realized through Monte Carlo simulations, which is time consuming due to its statistical nature. In contrast, the diffusion approximation to the radiative transfer theory can be solved analytically but only applicable to the distribution of multiply scattered photons.

Based on previous studies of radial distribution of reflected light with single-fiber illumination [1–3], we compared different hybrid models that combine the Monte Carlo simulation with calculations based on the diffusion approximation of radiative transfer theory. On the basis of these results, we investigated a hybrid model that is most appropriate for full field illumination in which photon tracking in the Monte Carlo simulation is truncated to significantly increase the calculation speed. The contribution to the reflected light distribution at the surface of the imaged medium by the truncated photons is obtained from the analytical solution of the diffusion equation for these multiply scattered photons. We will present the numerical results on the validity and applicability of this fast hybrid method for modeling reflectance images with fullfield illumination and its potential use in the inverse determination of internal stricture in turbid medium.

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