Locating transparent cavities in optical absorption and scattering tomography

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Abstract

The aim of optical absorption and scattering tomography is to reconstruct the optical properties inside a physical body, e.g. a neonatal head, by illuminating it with near-infrared light and measuring the out coming flux of photons on the object boundary. Because brain consists of strongly scattering tissue with imbedded cavities filled by weakly scattering cerebrospinal fluid, propagation of near-infrared photons in the human head can be treated by combining the diffusion approximation of the radiative transfer equation with geometrical optics to obtain the radiosity-diffusion forward model of optical tomography. Currently, a disadvantage with the radiosity-diffusion model is that the locations of the transparent cavities must be known in advance in order to be able to reconstruct the physiologically interesting quantities, i.e., the absorption and the scatter in the strongly scattering brain tissue. In this work, we introduce two methods for locating the transparent cavities through the boundary measurements of optical tomography assuming that the background optical properties of the strongly scattering tissue are known. The first one is an application of the factorization method of Andreas Kirsch and the second one is a Newton type algorithm based on the output least squares formulation of the inverse problem. The functionality of the methods is demonstrated by numerical experiments.