There are many practical situations and imaging modalities where there is significant scatter due to the media being studied. While solutions may involve circumventing the obscuring scatter, there are important new approaches that image based on the scattering properties. This latter category includes optical imaging in tissue, as well as in aerosol and turbid fluid applications, where the scatter may be high but the absorptive losses modest. In many situations, a Boltzmann transport equation or in some cases the simpler diffusion equation may be suitable as forward models in imaging algorithms. In this case, imaging can be treated as an optimization problem, where an image is formed based on the spatial variations of absorption and scatter. This field has become known as optical diffusion tomography (ODT).

Other than cost and performance motivations, the primary reason to use light for imaging is the spectroscopic information available. Media of interest, such as tissue, have important properties, as well as relatively low absorption, in the infrared wavelength range. By making measurements at a number of wavelengths, blood chemistry information can be garnered. By using fluorescence, additional contrast can be achieved. With appropriate targeting, fluorescence data with a suitable imaging approach may provide a means to safely detect tumors at an early stage.

This special section has four papers dealing with imaging in scattering media using light. In “Image reconstruction in optical tomography using local basis functions,” Schweiger and Arridge present a comparison of local basis functions in a finite element representation of the diffusion equation forward model in ODT. The image formed on inversion is dictated by these basis function weights, so the quality of the image will be a function of the character, for example, the order and discretization level, of the local basis functions. In “Three-dimensional optical tomography with the equation of radiative transfer,” Abdoulaev and Hielscher use the Boltzmann transport equation directly for optical imaging in scattering media. This allows imaging in applications where the diffusion equation does not hold, but where there is still significant scatter. In “Application of transform algorithms to high-resolution image reconstruction in optical diffusion tomography of strongly scattering media,” by Konovalov et al., back projection techniques are investigated for ODT applications and compared with a solution achieved by inverting the diffusion equation. Good quality images are shown using this approach, without capturing all the physics, with very little computational effort. In “Near-infrared breast tomography calibration with optoelastic tissue simulating phantoms” by Jiang et al., the imaging performance of a diagnostic tool is evaluated, along with phantom models for tissue that can be used in instrument calibration.
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