TOWARD OPTICAL IMAGING OF SMALL TUMORS IN BREASTS USING CUMULANT FORWARD MODEL AND INDEPENDENT COMPONENT ANALYSIS

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Screening is one of the most effective way to reduce the mortality from breast cancer. Noninvasive *in vivo* optical mammography, as one emerging screening methodology, has some unique advantages. It can access both scattering and absorption properties of tumors and the surrounding tissue which contains physiological information and may be used to detect and distinguish normal and malignant lesions. Among the main issues of optical mammography are the lack of an accurate forward model usable for reconstruction in real time and the low resolution resulting from the diffusive nature of light propagation in the medium and the ill-posedness of the inverse problem.

We developed a cumulant transport forward model and a three-dimensional (3D) tomographic image reconstruction algorithm based on that model. We have also introduced a novel interpretation of optical mammography as a source separation problem and used independent component analysis from information theory to sort out the inhomogeneities within the turbid media. We tested our methods with use of simulated and experimental data.

The result shows that the cumulant transport forward model is a much more accurate forward model than the commonly used diffusion approximation to radiative transfer. Its application improves the quality of image reconstructed from the 3D tomographic image reconstruction algorithm. Optical mammography using independent component analysis is able to localize and characterize objects as small as 1mm within highly scattering turbid media.

Together, the cumulant forward model and independent component analysis constitute a major advance in developing novel inverse reconstruction algorithms to overcome the low imaging resolution and an important step towards localization and characterization of small tumors at early stage of development.

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