Fourier-based image reconstruction in photoacoustic tomography

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Abstract

Photoacoustic tomography (PAT), also known as optoacoustic or thermoacoustic tomography, is a hybrid imaging technique that possesses great potential for a wide range of biomedical imaging applications. Image reconstruction in PAT is tantamount to solving an inverse source problem, where the source represents the optical energy absorption distribution in the object that is induced by an interrogating pulsed optical waveform. In this work, we reexamine the PAT image reconstruction problem from a Fourier domain perspective by use of established time-harmonic inverse source concepts. A mathematical relationship between the photoacoustic pressure wavefield data on an aperture that encloses the object and the three-dimensional Fourier transform of the optical absorption distribution evaluated on a collection of concentric spheres is investigated. In addition to providing a framework for deriving both exact and approximate analytic reconstruction formulas, we demonstrate that this mapping provides an intitive means of understanding certain spatial resolution characteristics of PAT and reveals features of the limited angular-view reconstruction problem.