Thermoacoustic Tomography - Reconstruction of Data Measured under Clinical Constraints

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Abstract: Thermoacoustic tomography (TCT) is a hybrid imaging technique that has been proposed by Kruger, et. al. as an alternative to xray mammography. Radiofrequency (RF) energy is deposited into the breast tissue uniformly in space, but impulsively in time. This heats the tissue causing thermal expansion. Cancerous masses absorb more RF energy than healthy tissue, creating a pressure wave, which is detected by standard ultrasound transducers placed on the surface of a hemisphere surrounding the breast. Assuming constant sound speed, the data represent integrals of the tissue's RF absorptivity over sphere centered about the transducers.

$$R_{TCT}f(t,\omega) = \int_{\theta\in S^2} f(\omega + t\theta)\ d\theta$$

The inversion problem for TCT is therefore to recover the RF absorptivity from integrals over spheres centered on a hemisphere. We present an inversion formula for the complete data case, where integrals are measured for centers on the entire sphere:

$$f(x) = -\Delta_x \left(\frac{1}{2\pi} \int_{o\in S^2} |x-o|\, R_{TCT}f(|x-o|\,, o)\ do \right)$$

We derive consistency conditions upon TCT data and discuss their implications for reconstructing clinically realizable 1/2-scan data sets.