Quantitative Optical Characterization of Tissue-like Medium Using Light and Sound

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Abstract

Acousto-optic imaging (AOI) is a dual-wave imaging technique, in which the diffuse light in tissue-like medium is modulated with focused ultrasound to sense the optical properties of diffuse media with the relatively high spatial resolution of ultrasound. We have demonstrated the ability to image optical inhomogeneities embedded within tissue-like media and now seek to quantitatively measure spatially-dependent optical properties. By measuring the ratio of the AOI signal strength induced by two different acoustic pressures we obtain information that is independent of background light intensity and the details of optical collection, and yet serves as a measure of the average optical efficiency of the AOI signal strength induced by two different acoustic pressures.

Experimental Results

Pressure ratio at the focus as a function of optical properties:

- 3 groups of homogeneous tissue-mimicking gel phantoms: Group 1-\(\mu_c=0.14, \mu_s=0.03\) cm\(^{-1}\); Group 2-\(\mu_c=0.14, \mu_s=0.05\) cm\(^{-1}\); Group 3-\(\mu_c=0.14, \mu_s=0.06\) cm\(^{-1}\).

- The pressure ratio information is obtained experimentally.

- With the pressures of a focal pressure pair, the ratio is only a function of the optical properties within the acoustic-optic interaction region, and is a relatively simple means for characterizing turbid media.

Summary

In a given system, the signal strength ratio under a given pressures pair is determined by the optical properties of the acoustic-optic interaction regions only, potentially offering a relatively simple means for quantifying the tissue characterization and inhomogeneity diagnosis at depth in tissue or tissue-like media with the spatial resolution of ultrasound.

References


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