Photoacoustic Imaging with Coherent Light

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The use of the photoacoustic effect for biomedical applications has increased tremendously in the past decade. Photoacoustic imaging of biological tissue is a multi-wave imaging modality, which is based on the detection of acoustic waves generated light absorption. Its interest is twofold : 1) it provides images of optical absorption at large depth in optically scattering media with the resolution of ultrasound. 2) it is specifically sensitive to optical absorption, as opposed to optical scattering. Photoacoustic excitation is most of the time based on pulsed lasers, as they provide short and energetic pulses. In this work, we show that beyond energy/power considerations, photoacoustic imaging may also benefit from the coherence of laser light. First, we illustrate how a random-structured optical illumination (optical speckle) can reveal otherwise invisible absorbing structures [1]. Second, we show that optical wavefront-shaping through optically scattering media can be coupled to photoacoustics to yield the measurement of a photoacoustic transmission matrix [2]. This matrix provides a flexible way to selectively focus light towards a region of interest, and therefore improve photoacoustic imaging.
[1] J Gateau, T Chaigne, O Katz, S Gigan and E Bossy, ”Improving visibility in photoacoustic imaging using dynamic speckle illumination”, Optics Letters 38(23), 5188-5191, 2013.
[2] T Chaigne, O Katz, AC Boccara, M Fink, E Bossy and S Gigan, ”Controlling light in scattering media noninvasively using the photo-acoustic transmission-matrix”, Nature Photonics, doi:10.1038/nphoton.2013.307, 2013.