Photoacoustic scanning tomography (PHAST) with coded optical excitation: theory and experiment

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Abstract. Photoacoustic (PA) imaging of biological tissues is emerging as a novel diagnostic modality that relies on noninvasive detection of tissue optical contrast, which may be related to specific diseases. Generation of acoustic waves in response to intensity-modulated laser irradiation of targeted tissues constitutes the basic principle of photoacoustic imaging. A number of clinically important applications are concerned with the maximum imaging depth and image contrast that can be achieved using the PA method. In the present talk, various modes of laser-induced acoustic wave generation are reviewed with particular attention given to coded optical excitation and frequency-domain signal processing methods. Advantages of specific forms of optical modulation with emphasis on the signal-to-noise ratio, imaging contrast, and maximum imaging depth will be analyzed theoretically and compared with experimental data. The dual-mode (time and frequency domain) photoacoustic scanner utilizing a multi-element transducer array will be presented with results obtained using tissue-simulating phantoms and an ex-vivo animal model.

Learning objectives:

1. Understand the principles of photoacoustic imaging with coded optical excitation of tissue chromophores.

2. Learn about instrumentation, signal processing and image formation using the PA response to custom optical modulation waveforms.

3. Understand issues related to PA system design and potential clinical applications.