Effects of multispectral excitation on the sensitivity of molecular optoacoustic imaging.

Abstract:
Molecular optoacoustic (photoacoustic) imaging typically relies on the spectral identification of absorption signatures from molecules of interest. To achieve this, two or more excitation wavelengths are employed to sequentially illuminate tissue. Due to depth-related spectral dependencies and detection related effects, the multispectral optoacoustic tomography (MSOT) spectral unmixing problem presents a complex non-linear inversion operation. So far, different studies have showcased the spectral capacity of optoacoustic imaging, without however relating the performance achieved to the number of wavelengths employed. Overall, the dependence of the sensitivity and accuracy of optoacoustic imaging as a function of the number of illumination wavelengths has not been so far comprehensively studied. In this paper we study the impact of the number of excitation wavelengths employed on the sensitivity and accuracy achieved by molecular optoacoustic tomography. We present a quantitative analysis, based on synthetic MSOT datasets and observe a trend of sensitivity increase for up to 20 wavelengths. Importantly we quantify this relation and demonstrate an up to an order of magnitude sensitivity increase of multi-wavelength illumination vs. single or dual wavelength optoacoustic imaging. Examples from experimental animal studies are finally utilized to support the findings. In vivo
MSOT imaging of a mouse brain bearing a tumor that is expressing a near-infrared fluorescent protein. (a) Monochromatic optoacoustic imaging at the peak excitation wavelength of the fluorescent protein. (b) Overlay of the detected bio-distribution of the protein (red pseudocolor) on the monochromatic optoacoustic image. (c) Ex vivo validation by means of cryoslicing fluorescence imaging.