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Influence of Optical Fluence Distribution on Photoacoustic Imaging

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Abstract : Photoacoustic imaging (PAI) is a non-invasive and non-ionizing imaging modality that combines the absorption contrast of light with ultrasound resolution. Laser is used to deposit optical energy into a target (i.e., optical fluence). Consequently, the target temperature rises, and then thermal expansion occurs that leads to generating a PA signal. In general, most image reconstruction algorithms for PAI assume uniform fluence within an imaging object. However, it is known that optical fluence distribution within the object is non-uniform. This could affect the reconstruction of PA images. In this study, we have investigated the influence of optical fluence distribution on PA back-propagation imaging using finite element method. The uniform fluence was simulated as a triangular waveform within the object of interest. The non-uniform fluence distribution was estimated by solving light propagation within a tissue model via Monte Carlo method. The results show that the PA signal in the case of non-uniform fluence is wider than the uniform case by 23%. The frequency spectrum of the PA signal due to the non-uniform fluence has missed some high frequency components in comparison to the uniform case. Consequently, the reconstructed image with the non-uniform fluence exhibits a strong smoothing effect.

Keywords : finite element method, fluence distribution, Monte Carlo method, photoacoustic imaging
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