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Characterization of photo-acoustic wave imaging using probe beam deflection technique

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Abstract

The motivation behind this study is to develop a computer simulation model in order to predict the pressure variations in an enclosure experiencing acoustic disturbances, produced by the thermal expansion of laser irradiated tissue within the enclosure. We have developed a ray trace simulation to predict the interaction between the focused probe beam and the acoustic wave in the enclosure, based on the vector form of Snells Law and the Lorentz-Lorenz Relation. Photo acoustic tomography (PAT) has been extensively explored; however, most applications of PAT employ conventional pressure transducers. This paper demonstrates the ability of the probe beam deflection technique to detect the propagating acoustic energy produced in PAT. We have applied modeling, simulation and visualization of a laser probe beam focused in a medium, disturbed by acoustic waves produced by the thermal expansion of a tissue sample within the medium. Here, a ray tracing algorithm is combined with k-wave techniques implemented by Treeby and Cox to predict the interaction of the probe beam and acoustic wave front. The simulation model allows for the prediction of the intersection points of the probe beam with the surface of a quadrant photodiode (QPD), resulting in close agreement of the predicted QPD signal with that obtained in experiment. It will be shown that the probe beam deflection technique can be used to determine the direction of a travelling wave front, thereby improving upon piezoelectric transducers currently implemented in PAT technologies.