Turbidity suppression by optical phase conjugation (TSOPC)

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Abstract:

Demonstration in thick tissues

TSOPC signal decay over time

Spatial resolution vs. turbidity

Light transmitted through thicker tissues will spread to a larger area. Since the finite size of the OPC mirror, a sampled portion of the transmitted light can be phase conjugated. Will the dynamics of the spatial resolution vary? We implemented the following experiment [1] to investigate this phenomenon.

Digital optical phase conjugation (DOPC)

A challenge of using conventional nonlinear optical techniques is that the conventional nonlinear optics based methods require the tissue to be static to produce the phase conjugated beam, which can cause artifacts and reduce the spatial resolution. For biomedical applications, the tissue varies over time, which may perturb the TSOPC process. We performed DOPC experiments on a live rabbit to evaluate the spatial resolution of the TSOPC system.

Conclusion:

OPC is a robust method of forming focus through turbid media. The phase conjugate beam retraces its trajectory in a time reversible process. Using OPC to reconstruct a USAF target through 0.5 mm and 1 mm thick tissues with co- recording. The results confirm that random scattering can help increase the spatial resolution of TSOPC.

Digital optical phase conjugation (DOPC)

A full DOPC wave contains both amplitude and phase information, which requires two sets of degrees of freedom to fully describe or encode. Experimentally, it will be much easier if we can discard one set of degrees of freedom. In this way, we can reduce the required information processing to half and potentially speed up the playback rate. Experimentally, such a system would also be simpler to implement. Here we use a combination of spatial light modulator and a reference light field to play back the scattered wavefront. An arbitrary image-bearing light field can be directly imaging through a turbid medium by digital optical phase conjugation.

Molecular imaging in deep tissues

Focus light onto targets embedded in tissues. Without scattering, resolution determined by the spatial coherence of the optical system. With scattering, resolution determined by the size of the scattering centers. TSOPC in live animal

Previous work

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