Non-invasive dynamic and wide-field imaging through strong scattering media

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In turbid media, scattering of light scrambles information of the incident beam and represents an obstacle to optical imaging. Non-invasive imaging through opaque layers or around corners is challenging for dynamic and wide-field objects due to unreliable image reconstruction processes. Here we present a non-invasive method that overcomes this challenge. We characterize the wave distortions in scattering layers in the frequency domain. By exploiting the redundant information from multiple camera-captured patterns, diffraction-limited images can be achieved within 0.2 seconds with our algorithm. This approach addresses the unreliability and the high computational cost of image reconstruction, with which we demonstrate video imaging at 25–200 Hz of a moving object behind or around an opaque layer. By scanning a localized illumination on the object plane, we have also obtained the image of a complex object with a field of view more than five times that available with speckle correlations.

The experimental setup is described in Fig. a. For dynamic imaging, we fix the pinhole and move the object. After capturing a sequence of speckle patterns with a camera, we reconstruct the video imaging with our phase retrieval algorithm based on multi-frames. The samples of recovered video are shown below (Fig. b). By raster scanning of the pinhole, a diffraction-limited (20 μm) wide-field image (Fig. c&d) is achieved with our technique.