phantom, motion down to half an OCT pixel (~1 μm) can be measured. For *in vivo* tissue, this increased to a small number of pixels (~4 μm).

A more quantitative investigation is explained here. Included in Fig. 8 is the applied, measured, and residual error for the fast-axis motion from the experiment shown previously in Fig. 5. The amplitude of the motion was measured in normalized units (normalized to the diffraction-limited resolution) as previously described in [15]. The standard deviation of the differential error from Fig. 8 was calculated to be 0.018 s^{-1} which is well below the stability requirements for Brownian motion along either the fast or slow axes [15]. The residual sinusoidal motion was then approximated by the peak-to-peak amplitude of the error signal. This was calculated to be 0.45 resolution elements which does not satisfy the stability requirements for sinusoidal motion, but is much smaller than 2.5 resolution elements which was the original strength of the motion. We believe much of the residual error to be a result of non-sinusoidal motion of the piezoelectric stage and not a limitation of the speckle-tracking.

5. Conclusion

The techniques demonstrated here were shown to correct for 3-D motion with enough sensitivity for computed optical interferometric techniques such as defocus and aberration correction. Axial motion correction used only the OCT data for phase correction without the use of a coverslip, and transverse motion correction used an additional speckle-tracking subsystem. The speckle-tracking subsystem is well-suited for general-purpose motion tracking, and has several benefits over incoherent imaging techniques. First, with even smooth, seemingly feature-less samples, coherent imaging will provide high-contrast speckle which can be tracked with high precision. In addition, even if the imaging system is imperfect, high-contrast speckle will still form on the camera. This is because, although optical defocus and aberrations will change the speckle, the statistical speckle size depends on the NA of the imaging system, which remains the same.

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