Speckle reduction in optical coherence tomography images by use of a deformable mirror

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Summary: A deformable mirror was incorporated into our OCT imaging system for modification of the reflected wavefront, resulting in speckle reduction in obtained images.

The presence of coherent speckle in optical coherence tomography (OCT) images can obscure identification of small or thin tissue structures. We present a method of reducing the effect of speckle in a multifunctional spectral domain OCT system by modifying the wavefront in between consecutive depth scans and consequently the speckle pattern using a micro-deformable mirror (μDM) placed in the sample arm beam path. By adjusting the wavefront modification between each depth profile acquisition and subsequently incoherently averaging small numbers of adjacent depth profiles, we were able to achieve a considerable reduction in speckle contrast without a significant increase in the phase noise floor or overall acquisition time. We demonstrated our results on phantom agar samples, as well as an eye of Limulus polyphemus. Using our method, we were able to reduce the contribution of speckle by 34% and 37% (agar and biological sample, respectively), as calculated using an image’s speckle contrast ratio. As coherence imaging continues to emerge as the prevalent player in the field of non-invasive diagnosis imaging, the importance of resolution cannot be understated.

Schematic of ultrahigh speed, ultrahigh resolution polarization-sensitive spectral-domain optical coherence tomography system (PS-SD-OCT) at central wavelength of 1295nm with the integration of a deformable mirror in the sample arm.