INTERFEROMETRIC SPECKLE VISIBILITY SPECTROSCOPY FOR IMPROVED MEASUREMENT OF BLOOD FLOW DYNAMICS

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The dynamics of blood flow within tissue is a key indicator of metabolic function, providing functional information about physiological activity [1]. Speckle visibility spectroscopy (SVS) [2,3] is an emerging technique which allows for blood flow dynamics to be measured non-invasively by analyzing the statistical properties of a captured optical speckle field which has interacted with blood in a volume of interest. Blurring of the speckle field caused by the dynamic scattering of the blood cells contains information about the blood flow dynamics. However, at weak signal light intensities, the impact of camera noise prevents accurate measurements of the sample dynamics using SVS. This means that longer camera exposures are required in order to accumulate enough signal photons to accurately determine the dynamics of the sample, which leads to reduced measurement refresh rates.

In this poster we will present an optical measurement method which enables high-speed measurement of the optical field dynamics with shot-noise limited sensitivity. This method, termed interferometric speckle visibility spectroscopy (iSVS), enables sensitive, non-invasive monitoring of hemodynamic activity, even when dealing with very weak signal light intensities. Furthermore, the interferometric nature of the measurement allows for calculations to be performed with the electric field autocorrelation function $g_1(t)$ directly, avoiding the errors typically encountered when relating the intensity autocorrelation function $g_2(t)$ to the blood flow signal of interest and enabling accurate measurements in samples where the scattering dynamics are non-ergodic. In this poster we will develop the theoretical advantages of iSVS compared to other methods for measuring blood flow in dynamic samples and also present some proof-of-concept *in-vivo* blood flow data collected from rodent models.

References:

[1] Durduran, Turgut, and Arjun G. Yodh. "Diffuse correlation spectroscopy for non-invasive, micro-vascular cerebral blood flow measurement." Neuroimage 85 (2014): 51-63.
[2] Dixon, P. K., and Douglas J. Durian. "Speckle visibility spectroscopy and variable granular fluidization." Physical review letters 90.18 (2003): 184302.
[3] Bandyopadhyay, Ranjini, et al. "Speckle-visibility spectroscopy: A tool to study time-varying dynamics." Review of scientific instruments 76.9 (2005): 093110.