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Spatial Correlation of Speckle Fluctuations Reveals Thickness and Features of the Ocular Surface Tear Film

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Here we present Fluctuation Analysis of Spatial Image Correlation (FASIC), a non-invasive method for evaluating the complex dynamics of the tear film surface by spatial correlation analysis. Tear film stability and its interaction with the corneal surface play an important role in maintaining ocular surface integrity and quality of vision. Dry Eye Syndrome (DES) refers to abnormalities of tear film secretion and/or stability diagnosed by conventional methods such as the Schirmer test and tear break-up time (TBUT). Several different physical methods have been developed to measure non-invasively the structure and function of the tear film including high-speed videokeratography and dynamic wavefront aberrometry. Interferometry and optical coherence tomography are amongst new proposed methods to measure tear film thickness that have remained in research phase.

With FASIC, a series of images are obtained using a laser illumination and a CMOS camera. The spatial correlation is calculated for every frame. A sinusoidal background due to interference of the tear film appears in this spatial correlation together with other features. We have developed a mathematical model to obtain the thickness of the tear film from this sinusoidal background. The model includes the macroscopic dynamics of small lipid droplets in the tear film. Consistent data with live animal model and human clinical study has been obtained. The authors gratefully thank the support from NIH grant numbers: PHS-5P41-RR003155 and P50-GM076516.