Image-based quantitative measurement of lipid layer thickness for diagnosis of evaporative dry eye syndrome

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Dry eye syndrome (DES) is one of the most common ocular diseases; affecting more than 5% of the US adult population. Measuring the lipid layer thickness (LLT) is essential for accurate diagnosis and proper treatment of evaporative dry eye syndrome. We designed quantitative image analysis techniques to evaluate the lipid layer thickness. To analyze the LLT from interference colors, we developed a novel algorithm that can automatically process the image frames including finding the radius of iris and center of the pupil, defining region of interest (ROI), ROI tracking, compensating iris and illumination color, and producing comprehensive analysis output. Patients' LLTs were statistically analyzed in time, visualized with 3D surface plots and displayed using 3D scatter plots of image pixel data in space to provide an intuitive assessment. We demonstrated that LLT analysis of patients was consistent with the functions of meibomian glands that were clinically evaluated by an ophthalmologist. This is a significant step forward in developing a fully automated instrument for evaluation of dry eye syndrome and proper guidance of treatment.

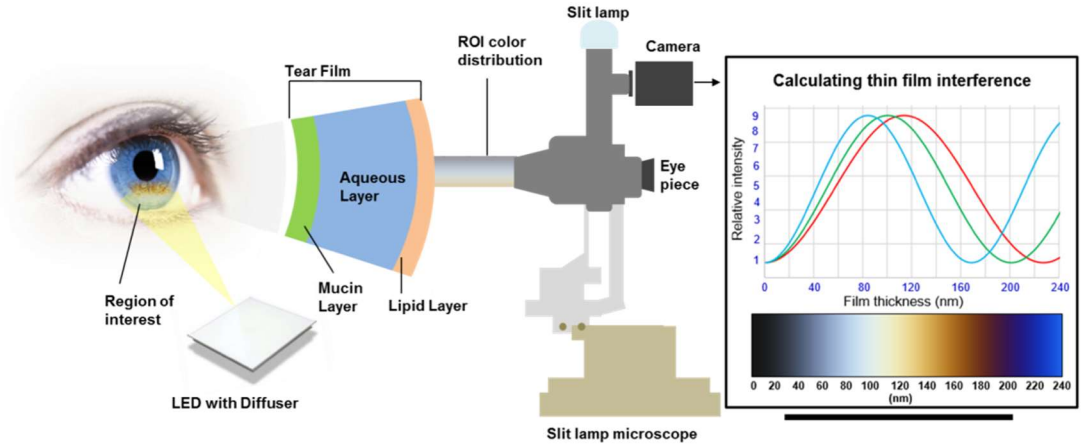

Figure 1. The optical system for thin film interference measurement. This custom-modified device is used to observe the lipid layer of the tear film with a slit lamp microscope for ophthalmology and a scientific complementary metal-oxide semiconductor (sCMOS) camera. A patient's head is placed in a fixed position on the head-chin rest of the slit lamp microscope and white light from the LED illumination is irradiated onto the lipid layer of the eye.

Reference:

1. H. Hwang, H.-J, Jeon, K.C, Yow, H.S, Hwang, & E. Chung, "Image-based quantitative analysis of tear film lipid layer thickness for meibomian gland evaluation." Biomedical engineering online, 16(1), 135 (2017).