

BIOEN 509 – DEPARTMENTAL SEMINAR SERIES

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Multimodal Ophthalmic Imaging and Beyond

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Currently available optical ophthalmic imaging technologies include fundus photography, optical coherence tomography, confocal scanning laser ophthalmoscopy, and autofluorescence imaging. One common limitation of these modalities is that they generate images by detecting either back-scattered or fluorescence photons but not absorbed photons. Therefore, quantitative imaging of optical absorption properties in the eye is still beyond the reach of existing technologies.

Fundamental understanding and early detection of several irreversible blinding diseases can potentially be improved by noninvasively imaging the optical absorption of the retina. For example, if the optical absorption by retinal blood is imaged, the hemoglobin oxygen saturation can be quantified to potentially benefit the early detection of diabetic retinopathy, which is strongly associated with retinal ischemia in its early stage. If the optical absorption of melanin in the retinal pigment epithelium can be measured, early detection of age-related macular degeneration can potentially be achieved because retinal pigment epithelium cell dysfunction is often associated with melanin photo-bleaching.

We are developing a novel ophthalmic imaging technology, photoacoustic ophthalmoscopy, to quantitatively measure optical absorption in the eye. When short pulsed laser at the eye-safe energy level irradiates the retina, the absorbed optical energy is converted to mechanical vibration and then to ultrasonic waves. Photoacoustic ophthalmoscopy detects such ultrasonic waves to form an image. We are also combining photoacoustic ophthalmoscopy with spectral-domain optical coherence tomography and confocal laser scanning ophthalmoscopy to achieve multimodal imaging, which provide more comprehensive functional information of the retina for disease diagnosis.

In this seminar, I will introduce the fundamentals of photoacoustic imaging and the development of photoacoustic ophthalmoscopy. Our progress on multimodal imaging using photoacoustic ophthalmoscopy will be reported. Besides ophthalmic imaging, other research projects including label-free molecular imaging will also be briefed.

