Smart Imaging, Restoration, and Analysis of Ophthalmic Images

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We demonstrate the advantages of utilizing image processing and photonics as an integrated technology and propose practical solutions to longstanding problems in acquiring and analyzing ophthalmic images in a clinical setting. These include introduction of a novel general application mathematical methodology based on the sparse representation framework. We demonstrate ophthalmic applications of this method by significantly enhancing the quality and improving image acquisition speed of optical coherence tomography and adaptive optics systems. On another front, we introduce objective tools to quantitatively measure novel imaging biomarkers of the onset and progression of ophthalmic diseases. Our robust global framework is demonstrated to be applicable for segmentation of virtually any anatomical or pathological feature of interest in ocular images captured with different imaging modalities with accuracy congruent with manual segmentation. As illustrative examples, we focus on applications of such methodologies in identifying and evaluating the mechanisms underlying diabetic macular edema (DME) and age-related macular degeneration (AMD) pathobiology, the leading causes of blindness in Americans. We end our discussion by proposing pathophysiology-specific therapeutic agents for ophthalmic diseases including DME and AMD.

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