

INTRODUCTION

Ever since Newton's somewhat gruesome experiments on his own eye, the human eye has attracted particular interest from those who work in the field of optical physics and engineering. The primary function of the eye as an imaging instrument provides a unique opportunity for the optics researcher to apply those techniques developed for imaging in other fields (such as microscopy and astronomy) to probe the function and structure of this complex biological organ. Since the eye is prone to disease (as well as reductions in visual function as a consequence of the natural aging process), a major motivation for imaging in the eye is detection, diagnosis and treatment of these diseases; in particular, cataract, glaucoma, diabetic retinopathy and macular degeneration. Furthermore, features of the neural and vascular components of the eye can mirror those of the whole body so that imaging in the eye can provide a convenient window on general body function and health.

There is a complex interplay between the imaging performance of the eye and the ability of the human visual system to exploit information in the scene. Imaging aberrations arise from imperfections in the form of the refracting surfaces of the eye and these are dynamic, particularly the tear film over the corneal surface. Mas et al. (pp. 94–102) describe a technique for video-rate measurement of the shape of the cornea enabling time-resolved measurement of these aberrations. Castro et al. (pp. 103–106) show how binocular ability is related to the similarity in the imaging performance of the two eyes (in terms of their Strehl ratios). Wu et al. (pp. 107–114) that by incorporation of ocular aberrations into an artificial intelligence model of human vision a more accurate model of recognition by the human visual system is obtained.

An important role of imaging in the eye is screening for detection and characterization of retinal disease through characterization of morphological, structural or spectral signatures in the retina. Various interferometric techniques have been developed for retinal shape measurement. Of particular interest is a requirement for accurate measurement of the deformation of the optic nerve head since this is an indicator of chronic high intraocular pressure which can lead to

glaucoma. This is addressed by Potcoava et al. who describe on pages 115 to 123 the application of digital interference holography for this purpose. Early detection of retinal diseases is key to effective treatment and image processing has an important role in enabling low-cost and efficient screening of retinal images, particularly by the development of automated detection and classification of retinal features associated with disease. Sopharak et al. (pp. 124–135) describe a machine-learning approach to automated detection of the exudates which accompany macular degeneration. Automated and reliable detection of major features and landmarks of the eye enables automated parameterization and contextualisation of features in the eye that underpin the application of many automated screening techniques. This is the motivation of Perez-Rovira and Trucco in their description of a technique for automated detection of the optic disc (pp. 136–144) and of Lin et al. (pp. 145–151) in their description of a control system for improved imaging of the anterior of the eye.

Incorporation of imaging technology into the eye can improve ocular performance as is described by Felipe et al. (pp. 152–158) who describe an intra-ocular Galilean telescope that yields a magnified image on the retina so as to mitigate the reduction in acuity caused by macular degeneration, the major cause of blindness in the Western world.

It can be appreciated from the articles described in this special issue, that imaging in the eye is a broad and multi-disciplinary field that is most effectively progressed when teams of scientists, engineers and clinicians combine forces to develop techniques. This special issue has arisen from a series of *Institute of Physics* meetings on *Imaging in the Eye*, that aim to bring these groups together and to explore the rich potential of this field.

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