Vasculature Assessment & Measurement Platform for Images of the REtina

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Background

The black void behind the pupil was optically impenetrable before the invention of the ophthalmoscope by von Helmholtz over 150 years ago. Advances in retinal imaging and image processing, especially over the past decade have opened a route to another unexplored landscape, the retinal neurovascular architecture and the retinal ganglion pathways linking to the central nervous system beyond. Exploiting these research opportunities requires multidisciplinary teams to explore the interface sitting at the border between ophthalmology, neurology and computing science. It is from the detail and depth of retinal phenotyping from which novel metrics and candidate disease biomarkers are likely to emerge. Unlocking this hidden potential requires integration of structural and functional datasets, i.e. multimodal mapping and longitudinal studies spanning the natural history of the disease process. And with further advances in imaging, it is likely that this area of retinal research will remain active and clinically relevant for many years to come.

The Project

It is against this backdrop that the VAMPIRE project was conceived. It is led by an interdisciplinary team of imaging scientists and clinicians from the Universities of Edinburgh and Dundee and features collaborative input from 10 other research centres in Italy, Singapore, Australia, Japan and the US. Our aims are:

1. Establish a world-class Scottish group/centre for retinal image analysis research, integrating computational and clinical research
2. Create software enabling studies involving retinal biomarkers, by allowing efficient and accurate measurements of the retina

Software

We translate cutting-edge image processing and analysis to the clinical research environment to deliver software that users without specialist knowledge can apply easily to their images to generate valuable data that they normally would not have been able to obtain. Our team has expertise in working with fundus camera and Scanning Laser Ophthalmoscope images to measure the retinal vasculature. We are currently expanding this to include Optical Coherence Tomography for quantification of the different tissue layers at the back of the eye.

To date, our software has been used to analyse more than 10,000 images in studies investigating retinal biomarkers for cardiovascular disease, diabetes, stroke, MS, cerebral malaria, and age-related cognitive change. VAMPIRE has been the first software ever to analyse retinal images in the UK Biobank.

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Figure 1: Pathological changes in the retinal vasculature often reflect similar processes occurring in the cardiovascular system and the brain. Thus the retina represents an accessible site for the study of systemic and neurological disease.

Figure 2: Non-invasive observation of the retinal vasculature is possible with a fundus camera or Scanning Laser Ophthalmoscope, while Optical Coherence Tomography reveals the tissue layers which permits study of the structure and pathology of the central nervous system.

Figure 3: VAMPIRE software identifies retinal features (e.g. blood vessel patterning, tissue layer thickness) that reveal abnormalities which may mark the early onset of disease, enable monitoring of disease progression, and indicate a patient’s response to treatment.