

Kenneth R Sloan: ImageJ support for high-resolution histology of human macula

Abstract

We have developed several ImageJ plug-ins in support of imaging, measurement, and annotation of human retina. High-resolution microscopic sections through macula are digitized by a whole slide image-stitching system (Olympus CellSens). We use a custom ImageJ plug-in to mark the center of the image (selected by the observer); some images requiring rotation are oriented (a hand drawn line segment defines "horizontal"); a scale bar included in the original image is measured. This information allows us to put all images into a common coordinate system (up to translation and rotation - scale is stored as meta-information). This makes it easy to examine, measure, and annotate each image in a set of standard locations referenced to anatomic landmarks in the retina.

The retina is part of the central nervous system. Due to its precise lamination, well-characterized neuronal cell types, and organized system of support cells and vasculatures, the thicknesses of constituent retinal layers are an important part of understanding the biological processes that they subserve. The outer retina and its vasculature, consisting of photoreceptors, retinal pigment epithelium, and choroid, is affected by age-related macular degeneration (AMD), a prevalent cause of vision loss in the elderly.

The thicknesses of 21 constituent chorioretinal layers are measured and annotated to indicate features of AMD pathology at 25 standard locations in each section. The plug-in computes each standard location in turn and overlays a vertical line to assist in measurement; the observer indicates layer boundaries and provides annotations by selecting from a menu of terms gleaned from the pathology literature. Navigation buttons allow the observer to step to the next measurement location. Other tabs permit measurement of lesions characteristic of AMD (called drusen), and annotation with free-form comments. Measurements and annotations are output as CSV and XML files for further analysis and display.

Finally, we create a DeepZoom version of the image and use the GoogleMaps API to create a browsable, multi-resolution web based viewer. This allows the viewer to navigate and examine the image at any resolution, and to ask for markers to point out various interesting features (and the annotations). We also generate a separate multi-resolution pyramid of TIFF images, independent of the DeepZoom structure. The original images are on the order of 20,000 x 10,000; they are filtered and down-sampled by a linear factor of 2 (iterated until the "thumbnail" size is reduced by a linear factor of 64). The viewer, and all images, measurements and annotations will be made available on a website which is currently under construction: Project MACULA (MACulopathy Unveiled by Laminar Analysis). The anticipated website audience is ophthalmologists, vision scientists, instrumentation engineers, medical illustrators, and the public. This website (ProjectMACULA.uab.edu) should be available in the 4th quarter of 2012.

Keywords

Histology, Retina, Measurement, Annotation, DeepZoom

Administrative data

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