Computer-based Quantification of Acellular Capillaries to Assess Experimental Diabetic Retinopathy

Hemmady, Anish[1,2];Tuceryan, Mihran[1]; Bhatwadekar, Ashay D[2]

Affiliations: 1) Department of Computer Science, IUPUI

2)Department of Ophthalmology, Indiana University

Indiana University-Purdue University Indianapolis (IUPUI)

Diabetic retinopathy (DR) is a disease of small blood vessels in the retina. The increase in the number of acellular capillaries is used as a marker to assess the severity of DR. The traditional approach for identifying acellular capillaries is manual counting of the capillaries either directly under the microscope or using the captured images. However, these methods are cumbersome and often involve inconsistencies among researchers. The purpose of this study is to reduce discrepancies in the enumeration of acellular capillaries using computer-based image processing algorithms. The retinas of control and diabetic mice were processed using trypsin digestion. The high resolution png format images of retinal quadrants were prepared from the trypsin digested retina. The computer programming was performed using the Python language along with open source packages such as OpenCv, Python Imaging Library (PIL), NumPy (Numerical Python) and SciPy. The images initially corrected for a Gaussian Blur and a Median blur to remove noise followed by the histogram based image segmentation. After image segmentation, a binary image was generated based on a histogram analysis. The segmentation threshold for binary image was determined and the medial axis transform (MAT) algorithm was applied to the binary image. The MAT representation was used to skeletonize the blood vessels and to detect branches and branch-points in those blood vessels. As part of the MAT computation, the distances from the skeleton to the vessel boundaries are encoded. The thin capilleries, i.e., acellular capilleries, were identified using a threshold on this distance which encodes the thickness of the vessel. Finally, acellular capillaries were counted by connected component algorithm. In conclusion, we have designed an automated computer-based system to enumerate the acellular capillaries. This computer-based automated system will help to maintain consistency in retinopathy assessment and may reduce time for analysis.