



Image quality improvement algorithm for digital histology slides

Ole Eichhorn, Cynthia Perz

Aperio Technologies, Inc. 1430 Vantage Court, Ste. 106, Vista, CA 92081, USA.

ole@aperio.com

Abstract

Introduction: Digital Pathology slide scanning, viewing, managing, reporting and archiving—is gaining acceptance in clinical laboratories, research facilities and medical centres. Digital pathology is commonly thought of as a technology that replaces current workflow tasks but does not offer improvements that facilitate the work of the pathologist. This paper presents an algorithm that is designed to advance the pathologist's review of digital slides beyond what is possible with a conventional microscope.

Methods and results: Review of digital slides on a virtual microscope today is not very different from review of glass slides on a conventional microscope. Given the stained histology tissue on the digital slide, a diagnosis is decided while panning and zooming about the image. The pathologist works with the slides provided. An algorithm, named IQ for Image Quality (IQ Image Enhancement Algorithm ©Aperio Technologies, Inc. 2008, Patents Pending), has been developed that enables the pathologist to adjust the stains to preferential settings with the goal of improving the visualization of the image and therefore the speed, accuracy and certainty in diagnosis. IQ operates in real time, processing and presenting the results synchronously as the pathologist navigates the image.

Discussion: IQ is founded on the concepts presented in [1] using colour deconvolution to separate the composite image into its individual stain images. Rather than quantifying the stains, however, IQ provides image adjustment controls for each of the stain images and then recombines them back into a new composite image. Figure 1 illustrates this with an H&E sample where the original image is decomposed into its Haematoxylin image (and adjusted) as well as into its Eosin image (and adjusted) then recombined into the image presented to the pathologist.

IQ adjustments can be defined once for a given sample/stain pair and stored. The virtual microscope could then automatically apply the settings when that sample/stain is viewed. The definition is performed with an interactive GUI control that displays the effects of stain adjustments on either the selected individual stain image or the composite image in real time. The user may adjust the concentration or dilution of a stain, may opt to accentuate the cellular detail, modify the intensity of all stains, or remap the stain colours. Figure 2 presents the GUI operating on the Haematoxylin image of a triple stained H, E and DAB sample.

IQ provides another opportunity not available with conventional microscopy. A sample may be stained as an H&E with a single marker and each stain image can be extracted, adjusted, and recombined into stain pairs: an H&E image and an H&DAB image. They can be reviewed side by side as illustrated in figure 3.

Conclusions: Virtual microscopy is a fertile field for the development of new techniques to enhance and view digital slides. The IQ algorithm provides one method that enables the pathologist to tune the stain to personal preferences, to accentuate features of interest, to compensate for stain variations and poor staining and to view the individual stain images or combined stain images.

Keywords: Colour deconvolution, image processing, visualization, digital pathology, virtual microscopy, histology, immunohistochemistry.

Acknowledgements

The author would like to acknowledge Dr. Peter Banks, Director of Hematopathology at Carolinas Medical Center in North Carolina, USA, and Dr. John Spinoso, Chief of Staff-Elect at Scripps Memorial Hospital in La Jolla, CA, USA for their support.