



How to measure image quality in tissue-based diagnosis (diagnostic surgical pathology)

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Abstract

Background: Automated image analysis, measurements of virtual slides, and open access electronic measurement user systems require standardized image quality assessment in tissue – based diagnosis.

Aims: To describe the theoretical background and the practical experiences in automated image quality estimation of colour images acquired from histological slides.

Theory, material and measurements: Digital images acquired from histological slides should present with textures and objects that permit automated image information analysis. The quality of digitized images can be estimated by spatial independent and local filter operations that investigate in homogenous brightness, low peak to noise ratio (full range of available gray values), maximum gradients, equalized gray value distribution, and existence of gray value thresholds. Transformation of the red-green-blue (rgb) space into the hue-saturation-intensity (hsi) space permits the detection of colour and intensity maxima/minima. The feature distance of the original image to its standardized counterpart is an appropriate measure to quantify the actual image quality. These measures have been applied to a series of H&E stained, fluorescent (DAPI, Texas Red, FITC), and immunohistochemically stained (PAP, DAB) slides. More than 5,000 slides have been measured and partly analyzed in a time series.

Results: Analysis of H&E stained slides revealed low shading corrections (<10%) and moderate gray value standardization (10 – 20%) in the majority of cases. Immunohistochemically stained slides displayed greater shading and gray value correction. Fluorescent stained slides often revealed to high brightness. Images requiring only low standardization corrections possess at least 5 different statistically significant thresholds, that are useful for object segmentation. Fluorescent images of good quality only possess one singular intensity maximum in contrast to good images obtained from H&E stained slides that present with 2 – 3 intensity maxima.

Conclusion: Evaluation of image quality and creation of formally standardized images should be performed prior to automated analysis of digital images acquired from histological slides. Spatial dependent and local filter operations as well as analysis of the rgb and hsi spaces are appropriate methods to reproducibly evaluate formal image quality.

Keywords: Image quality, tissue-based diagnosis, virtual slides, colour space, image standardization.