Quantifying image quality of whole slide images for digital pathology

Company information
At Philips we combine our unique clinical expertise with human insights to develop meaningful innovations that help to improve the quality of people’s lives. We develop solutions that deliver value throughout the care cycle: from disease prevention to screening, treatment, monitoring and health management. Already a world leader in imaging systems, radiology information systems (RIS), and picture archiving and communication systems (PACS), Philips has established the Digital Pathology venture to develop digital pathology solutions that are designed around the needs of pathologists, easy to use and fit seamlessly into existing workflows. By digitizing the images that pathologists normally view through a microscope, Philips’ goal is to offer integrated solutions that help to enhance the operational efficiency and productivity of pathology departments as well as improving diagnostic confidence. For the effective translation of new digital pathology concepts into clinical practice, we collaborate with leading academic, clinical and industrial partners – one of the underlying principles at the heart of Philips’ policy of open innovation.

The problem
Designed around the needs of pathologists, Philips offers an integrated Digital Pathology Solution. The solution comprises of the Philips Ultra Fast Scanner (UFS) and the Philips Image Management System (IMS). The UFS is easy to use and creates whole slide images of exceptional quality in less than 60 seconds per slide (40x equivalent, 15 x 15 mm scan area). The UFS can make whole slide images of standard pathology tissue slides, which are 75x25mm in size and each contain a 3 to 10 micrometer thick slice of tissue. The tissues are coloured by means of one of many available histochemical staining methods.

As with any digital image capture device, for the Philips UFS, the image quality of the whole slide images is of paramount importance. Because digital pathology is a new field, objective, quantitative and well recognized methods for the assessment of the image quality of a digital slide are not available.

The challenge
Devise methods to quantitatively assess the quality of digital whole slide images from pathology samples. Quality is defined as suitability and accuracy for diagnosis, either by reading from the screen, or by computer algorithms.

There are many factors influencing the quality of the final digital whole slide images. Factors in the digital image capture device itself, such as: optics, the light source, the cameras, operating temperature, image processing and image compression. Factors in the tissue sample, such as tissue thickness, cover slip quality (plastic/glass/dirty/scratches), slide preparation quality (folds, stretch-marks). And finally in the image quality is affected by factors in the display showing the digital slide image, such as: screen performance (brightness, contrast, color fidelity, dynamic range), and viewing conditions in the room where the screen is placed.
For this challenge known methods for image quality assessment can be utilized, however not all methods will be equally suitable, and many may need adaptation to be applied to the assessment of image quality of digital pathology whole slide images. A non exhaustive list of methods that (in adapted form) may be useful for this task:

- Physical image forming parameters can be measured with calibration targets
- MTF (resolving power of digital microscope)
- Contrast, Signal to Noise ratio, Color reproduction
- Subjective image quality can be assessed by perception tests (on pathologists)
- Actual diagnostic performance
- Perceived image quality
- Diagnostic algorithms may be used to assess image quality relevant for diagnosis
- Measure quantitative image quality on phantoms that model actual samples
- Model image quality based on phantoms with known geometry, diffractive index, etc.
- Determine metrics such as contrast, resolution, color fidelity on phantom measurements