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Blur Quantification of Medical Images: Dicom Media, Whole Slide Images, Generic Images and Videos

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Introduction/ Background

We have designed a quality assurance tool to quantify blur by quantifying the sharpness of custom-sized tiles composing an image, generating global results, detailed exchangeable logs and sharpness-maps regardless of their dimensions, quantity or acquisition rate [1]. We have now integrated the programming libraries and the standalone program we built to existing workflows and software, in order to improve quality assurance procedures.

Aims

When integrated in an acquisition workflow, the ability to map the quality of local areas inside an image allows to re-acquire parts of the image that were not scanned properly, or discard and re-acquire images when the global results fall under the thresholds set by the users. When integrated in an image analysis software, the regions of interest can be automatically chosen or suggested to the user according to the quality-map of the image to analyze, reducing the amount of incoherent analysis results. When integrated as a library in an image management platform, or as a standalone program in a storage server, a systematic quality check can detect de-calibration of the acquisition software, failed acquisitions that may be automatically deleted and users can be notified to re-acquire the images when below their quality-thresholds profiles. A quantified quality score can be inserted in each image's metadata for traceability purposes. When integrated as a library in a local or remote image viewer, the best quality tiles can be sent first to the viewer, and magnification levels can be dynamically resampled for a better render.

Methods

One notable implementation, using our Java library, is inside the FlexMIm project [2], which includes 27 pathology laboratories in the Paris area (coordinated by APHP), research laboratories from University Paris 6 Paris 7, as well as 3 companies: TRIBVN, PERTIMM and Orange. All Whole Slide Images are systematically analyzed and mapped as they enter the platform. The focus map may be displayed on the web interface next to the thumbnail link to the WSI, or in the viewer as a semi-transparent layer over the WSI, or over the WSI map.

During the test phase and first integrations in laboratories and hospitals as well as in the FlexMIm project, more than 5000 whole slide images of multiple formats (Hamamatsu NDPI, Aperio SVS, Mirax MRXS, JPEG2000 …) as well as hundreds of thousands of images of various formats (DICOM, TIFF, PNG, JPEG ...) and videos (H264) have been analyzed using our standalone software or our C, C++, Java and Python libraries. Using default or customizable thresholds' profiles, WSI are sorted as "accepted", "to review", "to rescan". In order to target the samples contained inside each WSI, special attention was paid to detecting blank tiles. Dynamic blank tile detection based on statistical analysis of each WSI was built and successfully validated for all our samples.

Results

More than 20 trillion pixels have been analyzed at a 3.5 billion pixels per quad-core processor per minute speed rate. Quantified results can be stored in JSON formatted logs or inside a MySQL or MongoDB database) or converted to any chosen data structure to be interoperable with existing software, each tile's result being accessible in addition to the quality map and the global quality results. This solution is easily scalable as images can be stored at different locations, analysis can be distributed amongst local or remote servers, and quantified results can be stored in remote databases.
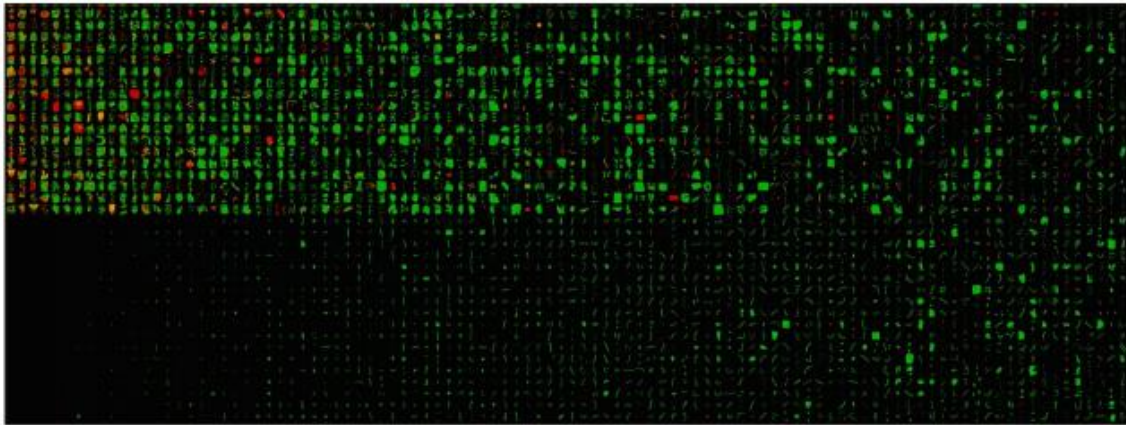

Figure 1: Automated tile-by-tile blur detection of 3954 WSI. Each pixel represents a 512x512 title. Blurry tiles are represented as red pixels, partially blurry tiles as orange pixels, sharp tiles as green pixels.
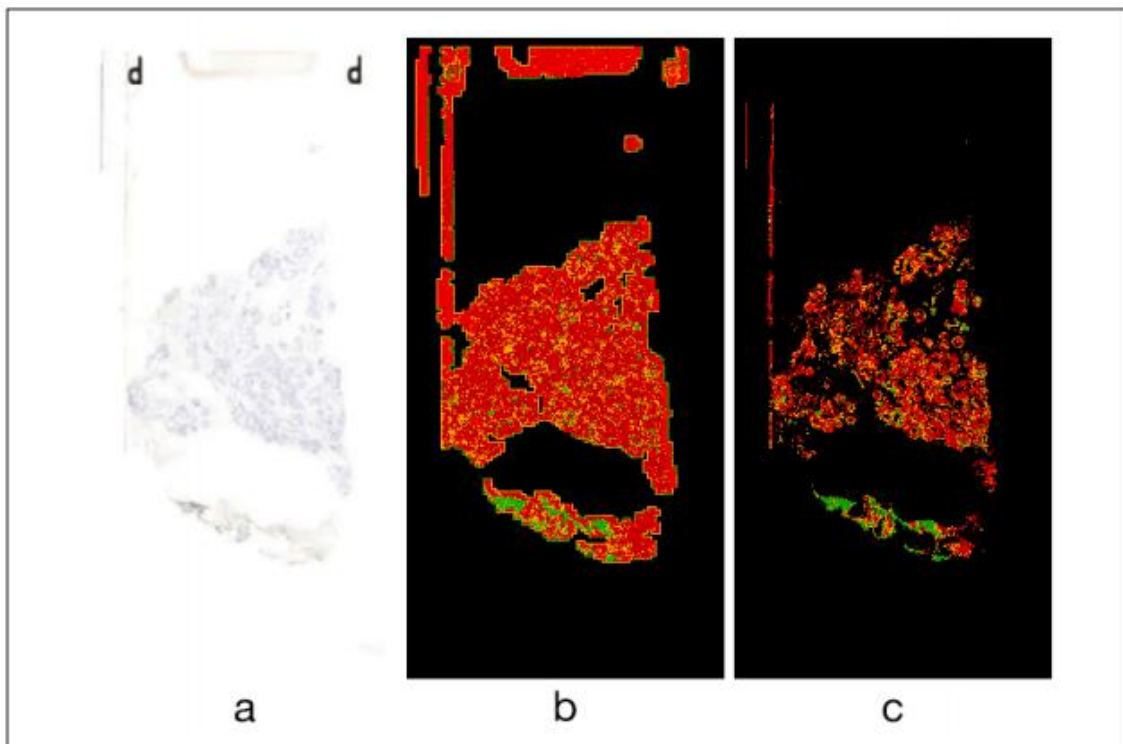

Figure 2: Non-calibrated versus calibrated blur detection: the WSI (a) is analyzed with default calibration settings (b) or with dynamic calibration (c).

References:

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