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From Image Tiles to Web-Based Interactive Measurements in One Stop

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Several advanced microscopes have the capability to acquire overlapping image tiles automatically. Such automated acquisitions provide a way to image a large spatial coverage of a specimen and to take measurements at multiple physical length scales. However, there is a need to assist imaging scientists with computational solutions that convert raw image tiles to calibrated, stitched, and viewable Giga-pixel images with interactive measurement tools.

In this work, we addressed the problems of (1) designing image calibration and tile stitching algorithms, (2) prototyping a workflow of computational steps to form Giga-pixel images, and (3) enabling interactive viewing and measurements over Giga-pixel images. The goal of the work is to allow scientists to upload a set of image tiles and then receive a URL with a Google Map like interface for viewing large images together with web-enabled measurement tools. The challenges are primarily related to (a) automation of tile stitching, (b) applying automated algorithms to images larger than RAM, (c) minimizing execution times of pre-processing algorithms, and (d) managing on-demand image viewing and measurements over Giga-pixel images to enable interactivity of image explorations.

The overall system is overviewed in Figure 1. Our approach to the automation of image tile stitching is derived from existing direct image alignment methods [1][2]. Specifically, the stitching algorithm is based on the Phase Correlation Image Alignment Method [3]. The computational workflow is constructed with a flat field calibration step, followed by tile stitching and multi-resolution image pyramid building. The multi-resolution image pyramid has been previously used in the context of "Virtual Microscopy" [4], and it allows for efficient transmission and viewing of large images. We made an extensive use of OpenSeadragon [5], a JavaScript library for pyramid-based visualization of images on the web. We added to OpenSeadragon a set of measurements tools such as scale bars, rulers, and image sub-setting options. These tools were designed as pluggable widgets which can be enabled based on image type and have been contributed to the open source OpenSeadragon project. One challenge was to build a pyramid out of stitched images (see Figure 2) which each is larger than the available system memory. This was solved by building a multi-resolution pyramid directly from input image tiles and positions generated by the image tile stitching software. Another challenge with on-demand stitching and visualization as a service is the execution time associated with each step of the processing pipeline. This was solved by parallelizing the algorithms to run either on hybrid CPU and GPU platforms (stitching) and on a computer cluster (calibration and pyramid building). The current capabilities are being tested on the NIST intranet.

Disclaimer: Commercial products are identified in this document in order to specify the experimental procedure adequately. Such identification is not intended to imply recommendation or endorsement by NIST, nor is it intended to imply that the products identified are necessarily the best available for the purpose.

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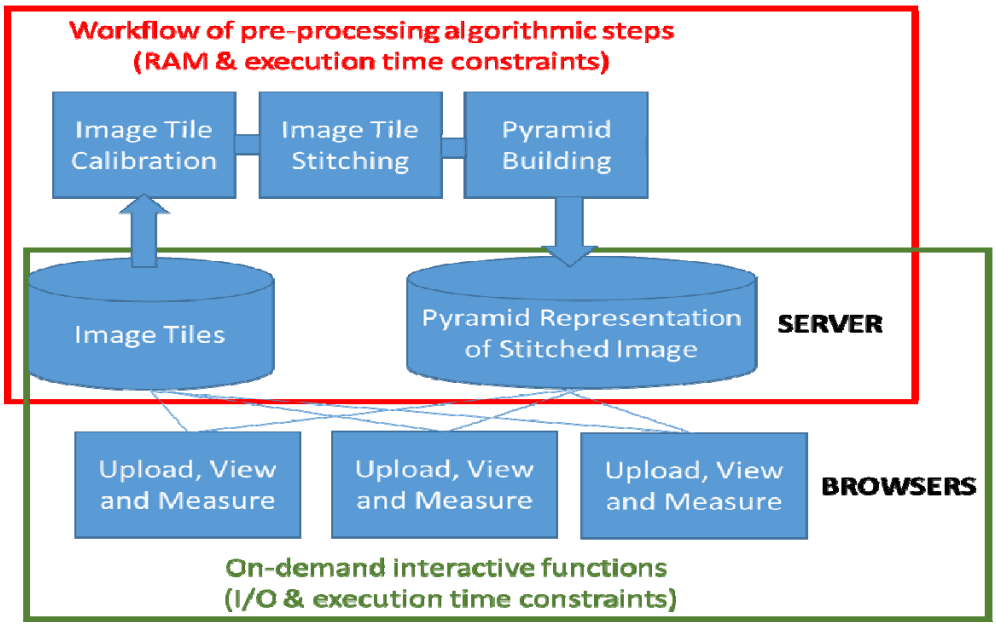

Figure 1: Overview of the designed system.

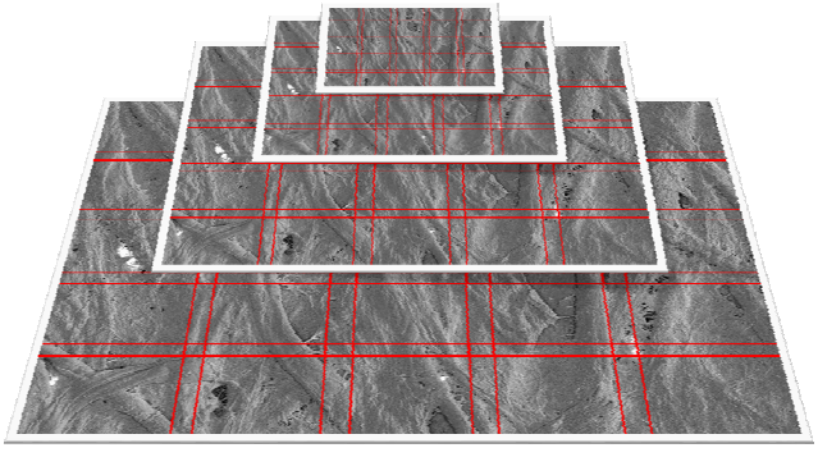

Figure 2: An illustration of multi-resolution image pyramid representation.