Quality-guided synchrotron-based tomographic microscopy of large lung samples

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INTRODUCTION

SYNCHROTRON-BASED tomographic microscopy is used to investigate objects at a resolution down to a voxel size of 360 nm. Until now the investigation of the three dimensional structure of an entire acinus—the functional lung unit—was either limited by the resolution of the imaging method or the sample volume. At the TOMCAT beamline [1] at the Swiss Light Source of the Paul Scherrer Institut in Villigen, Switzerland we developed a synchrotron-based tomographic microscopy method to overcome this limitation.

THE field of view (FOV) of tomographic scans can be increased in vertical direction through stacking of several acquired tomograms (figure 1(a)). To increase the FOV in horizontal direction, the acquired projection images of the sample have to be merged into one projection image covering the full FOV prior to reconstructing the sample (figure 1(b)).

CUSTOM-MADE software is used to calculate different protocols, varying in expected reconstruction quality and image acquisition time. After a suitable protocol has been chosen, the data acquisition and merging of the images is performed without user intervention.

A sequence of 19 protocols of the same distal-medial edge of the right lower lung lobe of a Sprague Dawley rat, obtained postnatally at day 21 [2] has been scanned.

RESULTS

THE calculated protocols are designed in such a way that the total scanning time—which essentially scales with the amount of obtained data—is greatly reduced. With our 19 scanned protocols, we have been able to reduce the acquisition time by 86 %. Albeit that this reduction introduced some artifacts in the dataset, an automated segmentation of the airways is still possible.

We have been able to extend the FOV of TOMCAT even more through adding a third lateral image acquisition position. A reconstruction of such an extended projection is shown in figure 3.

DISCUSSION

THE lateral FOV of TOMCAT can be greatly increased while keeping the quality of the scan at a very high level. We provide the possibility to acquire quality-guided tomographic wide field scans of arbitrary samples in an unattended, automatic way. Up to now, if a ROI of a wide sample had to be scanned with high resolution, a multi-step process was involved: an overview scan was performed at low magnification, the user had to define the ROI and finally perform a navigated high resolution scan of this ROI at TOMCAT.

The proposed scanning method will—once fully integrated in the beamline workflow—provide the possibility to scan wide samples with full resolution in one step in a very fast way and to selectively reconstruct ROIs defined by the end-user.

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REFERENCES

