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Toward 3D Reconstructed Histology for Multiscale Brain Imaging: Challenges in Marmoset Tissue Alignment and Correction

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High-resolution histology remains essential for understanding brain microstructure, offering cellular-level insights that complement the more macroscopic perspective of Magnetic Resonance Imaging (MRI). To help bridge these scales, we are working toward 3D reconstructed histology volumes that will be co-registered with MRI in the common marmoset brain. However, several technical challenges arise in generating high-fidelity reconstructions from histological sections. Physical distortions such as shearing, tearing, and local stretching during tissue sectioning introduce spatial inconsistencies across slices. In addition, optical non-uniformities—particularly vignetting caused by the illumination profile of the microscope—lead to pixel intensity variations within individual image tiles, which must be corrected before stitching and alignment.

Our current pipeline addresses these issues through pre-processing steps including vignetting correction and tile blending, followed by deformable slice-to-slice registration. These corrections are critical for reducing artifacts that would otherwise compromise 3D reconstruction and limit meaningful integration with MRI. The goal of this work is to produce histology volumes that can be accurately aligned with quantitative MRI to explore questions such as whether regional differences in myelin, iron, or dendritic or axonal architecture contribute to variations in imaging contrast. This effort lays foundational work for future cross-scale brain atlases that integrate histological specificity with the whole-brain coverage of MRI.

Keyword-1

Keyword-2

Keyword-3

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