A Topological Framework for Semi-Automoatic Neuron Tracing in Virtual Reality

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Abstract

Researchers in the field of connectomics are working to reconstruct a map of neural connections in the brain, in order to understand at a fundamental level how the brain processes information. Constructing this wiring diagram is done by tracing neurons through high resolution image stacks acquired with fluorescence microscopy imaging techniques. While a large number of automatic tracing algorithms have been proposed, these frequently rely on local features in the data and fail on noisy data or ambiguous cases, requiring time consuming manual correction. As a result, manual and semi-automatic tracing methods remain the state-of-the-art for creating accurate neuron reconstructions. We propose a new semi-automatic method which uses topological features to guide users in tracing neurons and integrate this method within a virtual reality (VR) framework previously used for manual tracing. Through evaluation with experts we find that our topologically guided approach is able to accurately trace neurons and improves trace time compared to both manual tracing in VR and existing semi-automatic tracing methods. Furthermore, users reported the topology guided tool to be less fatiguing, and more helpful when resolving noisy or low resolution regions.