Efficient Manual Neuron Tracing in Big 3D Images

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An efficient manual tracing tool for neurons and filamentous structures in 3D images needs to overcome several challenges. Given that the screen cursor provides a 2D input, it is not trivial how to map it to a 3D position within the image volume. Also, the neuron of interest may be “behind” other neurons, making it difficult to see and trace it. Moreover, if the input provided by the user is imprecise and off-center, this may give the wrong results. To overcome these challenges, we have developed a unique combination of algorithms that allows users to simply move the screen cursor along a neuron rendered on a 2D screen to achieve a 3D tracing of a neuron.

When a 3D image is visualized on a 2D screen and the screen cursor is used to trace a neuron, there is an inherent ambiguity regarding the “depth” of the tracing. To resolve this, we describe an algorithm which computes the correct 3D position of the neuron from 2D on-screen cursor input. In addition, to avoid the strenuous need to precisely hit the center of neurons during tracing, we have developed a “snap to neuron” functionality which repositions the cursor on the neuron when the user slips slightly off the center.

Most importantly, to improve the visual perception of the user during tracing, we have created a tool that adapts the 3D rendering so that the neuron of interest can be easily identified, and the tracing greatly improved. This is achieved by adapting the rendering to highlight regions “around” the current 3D position of the user’s tracing. By doing this, other neurons “in front of” the neuron that is being drawn become transparent, exposing the neuron of interest for visualization and allowing the user to clearly see where to draw.

Taken together, these algorithms greatly simplify manual tracing of neurons in 3D images. We will describe each of the algorithms involved and we will demonstrate the tools in action.