Computer Aided Alignment and Quantitative 4D Structural Plasticity Analysis of Neurons

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Abstract

The rapid development of microscopic imaging techniques has greatly facilitated time-lapse imaging of neuronal morphology. However, analysis of structural dynamics in the vast amount of 4-Dimensional data generated by in vivo or ex vivo time-lapse imaging still relies heavily on manual comparison, which is not only laborious, but also introduces errors and discrepancies between individual researchers and greatly limits the research pace. Here we present a supervised 4D Structural Plasticity Analysis (4D SPA) computer method to align and match 3-Dimensional neuronal structures across different time points on a semi-automated basis. We demonstrate 2 applications of the method to analyze time-lapse data showing gross morphological changes in dendritic arbor morphology and to identify the distribution and types of branch dynamics seen in a series of time-lapse images. Analysis of the dynamic changes of neuronal structure can be done much faster and with greatly improved consistency and reliability with the 4D SPA supervised computer program. Users can format the neuronal reconstruction data to be used for this analysis. We provide file converters for Neurolucida and Imaris users. The program and user manual are publically accessible and operate through a graphical user interface on Windows and Mac OSX.

Keyword：Weighted match, Semi-automatic method, Dynamic analysis, Structural plasticity, Neuron morphology . In vivo time-lapse imaging, Dendritedynamics