

JYNIA: 4D ANALYSIS OF DENDRITIC SPINE PLASTICITY

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1. ABSTRACT

Cognitive processes, as well as neuropsychiatric diseases, involve functional modification of neuronal networks through the structural remodeling of existing synapses. Most excitatory synapses in the brain are located on small membranous protrusions called dendritic spines. 4D analysis of dendritic spines involves several major challenges: 1) how to handle time-dependent changes in 3D spine shape, 2) efficient registration of 3D volumes over multiple timestamps, 3) how to design an interactive tool to segment individual spines from the 3D images of dendrites, and 4) how to quantitatively assess the morphometry of individual spines.

We have developed a new software named JyNIA, to address the aforementioned issues. For 3D segmentation of the spines, multiscale opening algorithm [1] has been implemented in the shared intensity space. Effective morphological features are implemented for individual dendritic spine plasticity analysis [2].

The JyNIA software consists of two major modules: 1) 4D Analysis and 2) 3D Analysis. 4D module implements a novel 3D registration algorithm to register successive 3D volumes over multiple timestamps. Interactive seeding enables easy selection of individual spines from the 4D module. 3D Analysis module ensures accurate segmentation of individual spines and subsequent extraction of the morphometric features like spine length, volume, head width, neck width etc. Several other supporting modules are also integrated in the software such as Preprocessing and ROI selection, Intensity thresholding and Seed selection, Multiscale segmentation and Quantitative morphological feature extraction.

Results of segmentation and morphological analysis of dendritic spines are designed for different visualization and imaging methods including fluorescent confocal microscopy and high-resolution two-photon microscopy obtained from *in vitro*, *ex vivo*, and *in vivo* models. The software is freely available, and windows installer can be obtained from: <https://jynia.org/>.

2. REFERENCES

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