Complex system and future technologies in neuroscience – CSFTN'25

CSFTN-25-10

Quantitative analysis of images of biological objects using macros in the FIJI environment

Timofey Inozemtsev✉, Dmitry Myagkov, Dmitry Tuktarov, Ivan Fedosov, Oxana Semyachkina-Glushkovskaya

Saratov State University, Saratov, Russia
✉Inoztim@gmail.com

The rapid development of automated microscopy technologies has led to an exponential increase in the volume and complexity of biological imaging data, which required the development of effective computational tools for quantitative analysis. Traditional manual image processing methods are not only time-consuming, but also subject to subjective bias, which limits their applicability in high-performance research. In this study, these problems are solved by developing a customizable macro for batch processing and quantitative analysis of biological images using Fiji (ImageJ), a widely used open source platform for imaging biological objects.

The macro automates important steps such as image preprocessing (including noise reduction and contrast enhancement), creating a binary mask using adaptive threshold adjustment, and particle analysis, allowing you to extract key metrics such as area, average brightness, intensity distribution, and object density. Using the capabilities of Fiji scripting and built-in functions, the proposed solution significantly reduces manual intervention, while increasing the reproducibility and accuracy of large-scale image analysis.

For the subsequent development of this area, several areas were studied to optimize quantitative image analysis, such as parallel processing for more efficient processing of large amounts of data, which reduced the calculation time, dynamic background subtraction for greater image contrast.

This work highlights the transformative potential of computational methods in standardizing and accelerating bioimaging processes. By combining automation with advanced optimization strategies, the developed macro not only increases efficiency, but also opens up new opportunities for data-driven discoveries in cell biology, neuroscience, and related fields.

Keywords: bioimage analysis, Fiji (ImageJ), macro development, threshold value, batch processing, machine learning, parallel computing, 3D reconstruction, quantitative analysis

Acknowledgements: The research was supported by the Russian Science Foundation (project No. 23-75-30001).