

Automated segmentation and tracking of non-rigid objects in time-lapse microscopy videos of polymorphonuclear neutrophils.

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Abstract

Time-lapse microscopy is an important technique to study the dynamics of various biological processes. The labor-intensive manual analysis of microscopy videos is increasingly replaced by automated segmentation and tracking methods. These methods are often limited to certain cell morphologies and/or cell stainings. In this paper, we present an automated segmentation and tracking framework that does not have these restrictions. In particular, our framework handles highly variable cell shapes and does not rely on any cell stainings. Our segmentation approach is based on a combination of spatial and temporal image variations to detect moving cells in microscopy videos. This method yields a sensitivity of 99% and a precision of 95% in object detection. The tracking of cells consists of different steps, starting from single-cell tracking based on a nearest-neighbor-approach, detection of cell-cell interactions and splitting of cell clusters, and finally combining tracklets using methods from graph theory. The segmentation and tracking framework was applied to synthetic as well as experimental datasets with varying cell densities

implying different numbers of cell-cell interactions. We established a validation framework to measure the performance of our tracking technique. The cell tracking accuracy was found to be >99% for all datasets indicating a high accuracy for connecting the detected cells between different time points.

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Leibniz-HKI-Autor*innen



Susanne Brandes

[Details](#)



Fabian Essig

[Details](#)



Marc Thilo Figge

[Details](#)



Kerstin Hänniger

[Details](#)



Oliver Kurzai

[Details](#)



Zeinab Mokhtari Asl

[Details](#)

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