PAST-FR

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Platform: Linux

Prerequisites: None

PAST-FR: SUMMARY

Our approach to cell tracking is based on the theory of deformable models. It permits a precise analysis of the cell shape, in addition to keeping cell identity and determining its center of mass. Each cell contour is pre-detected automatically in the first image of each video, then optimized by minimizing an energy-functional composed of various terms related either to the image (homogeneous regions, image gradients, etc.) and regularization terms (contour smoothing, shape constraints, etc.). This process is then repeated for every subsequent frame, while the pre-detection step is re-used to detect objects entering the field of view. Therefore, our method does require that a minimal overlap exists between the successive positions of each cell. While active contours are known to be computationally demanding, we implement a discrete formalism, whereby the contour is defined as a closed polygonal line to enable fast computations and small memory footprint [1, 2].

PAST-FR: PREPROCESSING

First, the high intensity variations in the image data are reduced by capping the lower and upper *nI%* pixel values. Second, median filtering within a neighborhood of radius *rM* is performed.

PAST-FR: SEGMENTATION AND TRACKING

The analysis of each frame involves three steps. First, the cells are pre-detected using a hierarchical k-means approach [3] that involves smoothing using a Gaussian filter with a large radius *rG*, quantization of image intensities into 10 classes, and extraction of connected components in each class in the ascending order, the size of which falls within a pre-defined size range [*aMin*, *aMax*]. Next, a contour of spatial sampling *s* for each previously unknown cell is initialized. Finally, all contours are deformed according to image gradients (weighted by *wg*), image homogeneity (weighted by *wh*) and regularization (weighted by *wr*), while division events are automatically detected and tracked when a contour splits.

PAST-FR: POST-PROCESSING

No post-processing step is performed.

REFERENCES

1. Zimmer C, Olivo-Marin JC. Coupled parametric active contours, *IEEE Transactions on Pattern Analysis and Machine Intelligence* **27**, 1838-1842 (2005).
2. Dufour A, Thibeaux R, Labruyère E, Guillén N, Olivo-Marin JC. 3D active meshes: Fast discrete deformable models for cell tracking in 3D time-lapse microscopy. *IEEE Transactions on Image Processing* **20**, 1925-1937 (2011).
3. Dufour A, Meas-Yedid V, Grassard A, Olivo-Marin JC. Automated quantification of cell endocytosis using active contours and wavelets, In *Proceedings of the 19th International Conference on Pattern Recognition* (2008).