MU-US (1)

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Platform: Windows (x64)

Prerequisites: MATLAB Compiler Runtime 2018a (x64)

MU-US (1): SUMMARY

Our cell tracking pipeline is based on our multi-object tracking works described in [1,2]. The pipeline consists of three main modules: image preprocessing, cell segmentation, and cell tracking described below.

MU-US (1): PREPROCESSING

Preprocessing operations performed on the input images are: 1) contrast adjustment; 2) linear and non-linear image filtering for smoothing and noise removal; 3) nonuniform illumination and background correction.

MU-US (1): SEGMENTATION

The segmentation process consists of three main steps:

Preliminary background/foreground segmentation using k-means clustering. K>2 number of clusters are used to be able to segment cells with different intensity levels. Number of clusters K is automatically adjusted per image by computing an over-segmentation index. Background is identified as the cluster with the lowest mean intensity.

Low intensity cell detection. Background region obtained in the previous step is further refined through a histogram thresholding operation to detect low intensity cells. The binary cell mask produced in this step is fused with the binary cell mask from the previous step.

Cell cluster decomposition and post processing. Connected component labeling is performed. Detected blobs are classified as individual cell versus cell cluster based on their shape, size, other appearance cues. Identified clusters are decomposed into individual cells using marker-controlled watershed segmentation. Morphological operations are used to refine the detections, operations performed include hole filling, spurious detection removal etc.

MU-US (1): TRACKING

Detection-based multi-object tracking [1, 2] is used to track the detected cells. Frame to frame local data association is used to link the cells in consecutive frames. Cells detected in frame at time t are assigned to trajectories at time t - 1. Local data association is based on spatial distance. Detection to track association is resolved using Hungarian optimization algorithm [3]. Gating is used to reduce assignment complexity by pruning improbable assignments. Kalman filter based prediction is used to recover from miss-detections. Tracks for cells entering or exiting the field of view (birth/death or appearance/disappearance) are explicitly handled. Spurious tracks are filtered based on their duration.

MU-US (1): POST-PROCESSING

No post-processing step is carried out after tracking.

REFERENCES

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3. Munkres J. Algorithms for the assignment and transportation problems. *Journal of the Society for Industrial and Applied Mathematics* **5**, 32-38 (1957).