HIT-Ya-CN

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Platform: Linux

Prerequisites: Python 3.6

HIT-Ya-CN: SUMMARY

The method follows the tracking by detection paradigm and combines cell detection and cell segmentation. The detection algorithm is used to locate cells in the image, the segmentation algorithm preliminarily segments the cell, and then the segmentation connected domain is combined with the detection information for fine segmentation [1]. Finally, we use an object tracker for cell tracking.

HIT-Ya-CN: PREPROCESSING

The image data is normalized, and the pixels with uneven distribution are compressed to the [-1, 1] interval. The normalized image is then sent to the detection network and segmentation network.

HIT-Ya-CN: DETECTION

We use UNet++ [2] as the detection network. We combine the current frame and the past two frames into three channel images as the input to the network [1], and the output of the network can be seen as three channels, the first channel is background, the second channel is ordinary cells, and the third channel is divided cells. Combined with the information in time domain, we can effectively detect the cell division, and get better cell detection results. In the detection network, the backbone is ResNet-50. The learning rate is 0.0001. Because of the uneven distribution of samples, we use the weighted cross entropy as the loss function. The network input is 512 $\times$ 512. The network gets a series of connected regions as the output. When the area is smaller than a certain threshold $D_{\min}$, the connected domain is considered as a distractor and eliminated.

HIT-Ya-CN: SEGMENTATION

UNet++ is used as a segmentation network. In the segmentation part, the categories are divided into two categories, the first category is background area, and the second category is cell area. When the segmented pixel value is larger than a certain threshold S, the pixel is classified as a cell region; otherwise, it is classified as a background region. The connected area is connected together when two

cells are close to each other. Therefore, we use fine segmentation [3] which combines detection information to separate them. In the training of segmentation network, the loss function uses cross entropy and most of the other training settings are the same as the detection network.

HIT-Ya-CN: TRACKING

In the tracking part, we use two kinds of deep features to track cells. The basic tracker is ECO [3]. We modified the tracker to track based on two kinds of deep features. In a new frame, the tracker returns the location information of the cell. At this time, the intersection-over-union ratio is used for data association of adjacent frame cells. Finally, some strategies are used to manage the trajectory information, such as losing more than *T* frames to terminate the trajectory.

HIT-Ya-CN: POST-PROCESSING

We applied erosion with a 3×3 structuring element to connected components of detection.

REFERENCES

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2. Zhou Z, Siddiquee MMR, Tajbakhsh N, Liang J. UNet++: A nested U-Net architecture for medical image segmentation. In *International Workshop on Deep Learning in Medical Image Analysis*, 3-11 (2018).
3. Danelljan M, Bhat G, Khan FS, Felsberg M. ECO: Efficient convolution operators for tracking. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, 6638-6645 (2017).