Fused 3-Stage Image Segmentation for Pleural Effusion Cell Clusters

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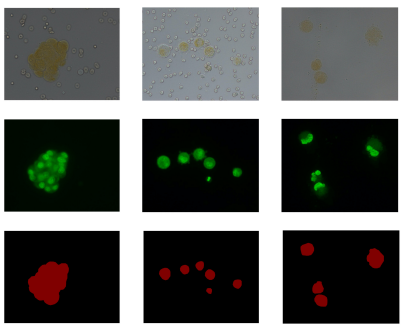
Problem

The appearance of tumor cell clusters in pleural effusion is usually a vital sign of cancer metastasis. Segmentation, as an indispensable basis, is of crucial importance for diagnosing, chemical treatment, and prognosis in patients. However, accurate segmentation of unstained cell clusters containing more detailed features than the fluorescent staining images remains to be a challenging problem due to the complex background and the unclear boundary.

Datasets

We have established a dataset of pleural effusion tumor cell cluster images. To ensure the diversity of pleural effusion cell data, the dataset includes three groups: clinical group, simulation group, and cancer cell group. The dataset with a total number of 107 sets of cell cluster images is established, within each set, there is an unstained (original) image, a fluorescent stained image, and a ground-truth image where each column consisting of 3 images represents a set).



Contribution

- **POINT 1**

The data acquisition and labelling of tumor cell clusters in pleural effusion are difficult. We establish a dataset of cell clusters with ground truth, by collaborating with health professionals.

- **POINT 2**

Existing cell recognition algorithms usually focus on the characteristics of individual cells, and tumor cell metastasis is more efficient than tumor cells when pleural effusion tumor cell clusters fall off into the blood. Tumor cell clusters suggest a worse prognosis. We propose a fused segmentation algorithm CMF for cell clusters to obtain accurate segmentation boundaries.

CMF algorithm

a) Coarse Segmentation

The fluorescence-stained image is subjected to the maximum inter-class variance method (OTSU algorithm) to determine the maximum variance between the cell area and the background in the cell image. As a threshold value, the binarization operation is performed on each pixel in the image. So it can to extract region of interest (ROI) of the suspicious cell area.

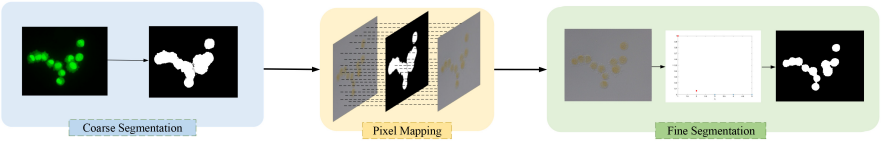
b) Pixel Mapping

After achieving the ROI of the stained image, the ROI is mapped to the corresponding unstained image to obtain the ROI of the unstained image (UI-ROI) according to formula. The UI-ROI is then achieved to realize the preliminary cell area segmentation.

$$O_{p(x,y)} = \begin{cases} 1 & p(x,y) \in F_r \\ 0 & p(x,y) \notin F_r \end{cases}$$

c) Fine Segmentation

It is considering that the sample image size in the dataset is 1280×1024, which belongs to a large-scale image and contains many pixels, which may lead to the problem of memory overflow. using improved automatic fuzzy clustering framework (AFCF) on the UI-ROI to get precise cell cluster boundaries.



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