

Semi-Automatic Segmentation of Mitochondria on Transmission Electron Microscopy Images Using Live-Wire and Surface Dragging Methods

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Abstract : Mitochondria are cytoplasmic organelles of the cell, which have a significant role in the variety of cellular metabolic functions. Mitochondria act as the power plants of the cell and are surrounded by two membranes. Significant morphological alterations are often due to changes in mitochondrial functions. A powerful technique in order to study the three-dimensional (3D) structure of mitochondria and its alterations in disease states is Electron microscope tomography. Detection of mitochondria in electron microscopy images due to the presence of various subcellular structures and imaging artifacts is a challenging problem. Another challenge is that each image typically contains more than one mitochondrion. Hand segmentation of mitochondria is tedious and time-consuming and also special knowledge about the mitochondria is needed. Fully automatic segmentation methods lead to over-segmentation and mitochondria are not segmented properly. Therefore, semi-automatic segmentation methods with minimum manual effort are required to edit the results of fully automatic segmentation methods. Here two editing tools were implemented by applying spline surface dragging and interactive live-wire segmentation tools. These editing tools were applied separately to the results of fully automatic segmentation. 3D extension of these tools was also studied and tested. Dice coefficients of 2D and 3D for surface dragging using splines were 0.93 and 0.92. This metric for 2D and 3D for live-wire method were 0.94 and 0.91 respectively. The root mean square symmetric surface distance values of 2D and 3D for surface dragging was measured as 0.69, 0.93. The same metrics for live-wire tool were 0.60 and 2.11. Comparing the results of these editing tools with the results of automatic segmentation method, it shows that these editing tools, led to better results and these results were more similar to ground truth image but the required time was higher than hand-segmentation time

Keywords : medical image segmentation, semi-automatic methods, transmission electron microscopy, surface dragging using splines, live-wire

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