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Fully Automated Methods for the Detection and Segmentation of Mitochondria in Microscopy Images

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Abstract : The detection and segmentation of mitochondria from fluorescence microscopy are crucial for understanding the complex structure of the nervous system. However, the constant fission and fusion of mitochondria and image distortion in the background make the task of detection and segmentation challenging. In the literature, a number of open-source software tools and artificial intelligence (AI) methods have been described for analyzing mitochondrial images, achieving remarkable classification and quantitation results. However, the availability of combined expertise in the medical field and AI required to utilize these tools poses a challenge to its full adoption and use in clinical settings. Motivated by the advantages of automated methods in terms of good performance, minimum detection time, ease of implementation, and cross-platform compatibility, this study proposes a fully automated framework for the detection and segmentation of mitochondria using both image shape information and descriptive statistics. Using the low-cost, open-source python and openCV library, the algorithms are implemented in three stages: pre-processing, image binarization, and coarse-to-fine segmentation. The proposed model is validated using the mitochondrial fluorescence dataset. Ground truth labels generated using a Lab kit were also used to evaluate the performance of our detection and segmentation model. The study produces good detection and segmentation results and reports the challenges encountered during the image analysis of mitochondrial morphology from the fluorescence mitochondrial dataset. A discussion on the methods and future perspectives of fully automated frameworks conclude the paper.

Keywords : 2D, binarization, CLAHE, detection, fluorescence microscopy, mitochondria, segmentation
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