MATHEMATICAL MODELLING FOR CALCULATION OF EPIDERMIS CELLS WITH STAINED NUCLEI

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The process of calculating stained cell nuclei when analyzing microscopy images is well known for the large amount of time required for it [1]. That is why automating this process would be a significant innovation, since it would allow to speed up the calculations enormously, while keeping the error rate low enough, too.

The goal of the research is automated calculations of epidermis cells of L929 cell line which have their nuclei stained.

The process of nuclei calculation [2] implies several serious challenges to overcome, among which there are:

- the presence of stained noise which does not belong to actual nuclei;
- separated stained nucleus parts which actually belong to the same nucleus.

In this work, traditional approaches were reviewed, as well as their combinations. It was concluded that most of the traditional segmentation approaches, including classical detectors, may not perform well due to the multiple obstacles, such as noise presence, image quality etc. Another issue was the noisy nature of nucleus staining, which meant that the watershed algorithm could not be fine-tuned properly, either. Thus, the main challenge was to develop an algorithm which would be able to consider these issues and still work well enough.

The resulting baseline algorithm is a combination of classical computer vision algorithms used for image pre-processing and fine-tuned clustering method for nuclei differentiation. The algorithm is able to differentiate between separated nuclei well enough, while uniting separated nucleus subparts together, too. Besides, the algorithm is also able to detect noise (if presented) and mark it as not belonging to any nuclei on the image given, thus improving the quality significantly. It can be summarized that, although requiring the data to be of corresponding quality, the algorithm showed good performance on the validation subset. After being fine-tuned on a larger dataset the algorithm is hopefully of great help for scientists in the area of biology.

References:

1. Zahangir Alom, Microscopic nuclei classification, segmentation, and detection with improved DCNN, 2022.

2. Yu Peng, Mira Park, Min Xu, Suhuai Luo, Yue Cui, Clustering nuclei using machine learning techniques, 2021.