Karlsruhe Institute of Technology

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Institute for Automation and Applied Informatics

IAI

Master‘s Thesis

Endothelial Cell Segmentation and Tracking in Human Cornea

Scope of this project with the Institute of Toxicology and Genetics and the Uniklinik Freiburg is to study the rearrangement of endothelial cells in the human cornea after a laser induced damage. Therefore, 3D data (different focal planes) were acquired over time resulting in a 3D+t data set. Due to the limited image quality, sophisticated image analysis methods are required.

So far, 56 slices of the 3D+t data have been labeled with a labeling tool (Fig.1). Several deep learning models have been trained and the raw predictions look promising. However, the combination of related slices can be ambiguous and result in wrongly split or merged cells (Fig.2). The post-processing consists of simple maximum intensity projections, adaptive thresholding and morphological closing. Especially near the damage region the segmentation needs to be improved (Fig.3).

Tasks:

- Expansion of the existing post-processing to reduce artifacts which can occur by combining the information of different related slices (Fig.2).
- Feature extraction for single cells.
- Investigation whether an Euclidean distance transformation or extracted information from the time series (features) can be used to reduce wrongly split and merged cells.
- Verification of a model for the rearrangement of the cells after the damage.
- In case of interest: apply transfer learning and weighted loss functions to improve the raw predictions.

Requirements:

- Interest in image analysis and deep learning
- Prior knowledge or interest in working with Python and PyTorch

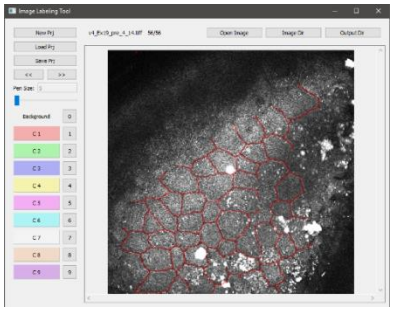

Fig.1: Image labeling tool

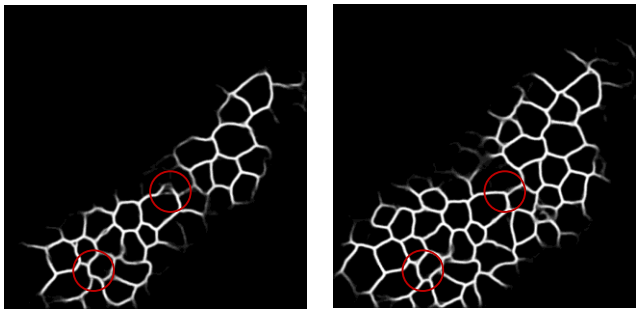

Fig.2: Raw predictions of slices which need to be combined

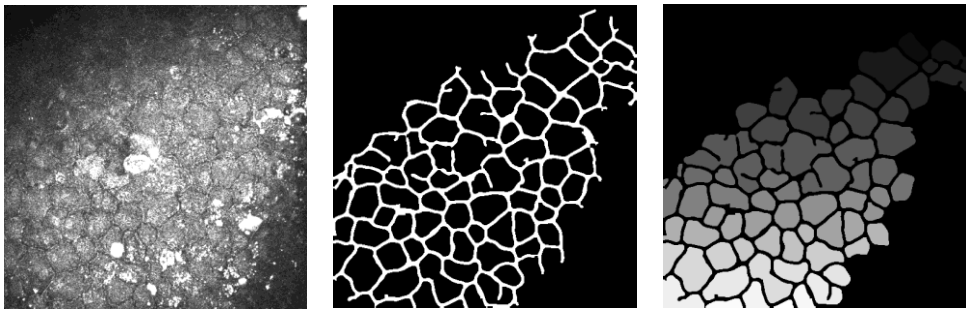

Fig.3: Maximum intensity projection, post-processed prediction, and final segmentation

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