

Mcat: A toolkit for deep learning-based segmentation and automated analysis of MSOT image data

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Mcat: A toolkit for deep learning-based segmentation and automated analysis of MSOT image data

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Multispectral Optoacoustic Tomography and Limitations of Current Analysis Approaches

- based on light pulse illumination and thermo-elastic expansion of tissue
- gathers functional tissue information
- resolves multiple photoabsorbers in one scan
- high spatio-temporal resolution
- enables longitudinal measurements
- non-invasive allows *in vivo* studies

4-dimensional images $x \times z \times t$ photoabsorber channels

ICG – Indocyanine green
Hb – oxygentated blood
HbO₂ – deoxygentated blood

fails to identify differences between healthy (Sham) and septic (PCTO) animals

even small positional changes lead to highly different intensity values

Issue-oriented analysis prone to user bias and often not reproducible

Deep Learning-based Segmentation of MSOT Images

- Identify sample outlines from MSOT Images
- Deep learning (DL) approach based on Cellpose^[1] neural network architecture
- retrained from scratch with manual MSOT annotations of three experts using JIPipe^[2]
- pairwise Dice score shows high concordance of DL-based segmentation with experts

1. manual annotation
2. training of neural network
3. segmentation of images
4. validation of segmentation

image adapted from [3]

Application in Quantification of Liver Function

- pre-processing eliminates motion artifacts and inter-scan intensity differences
- ROIs retrieved with DL-based segmentation
- signals signal intensities from whole sample
- signal-oriented approach

plaid-wave clustering with k-means, identifies regions of similar signal kinetics

Provides:

- information about pharmacokinetics
- spatial biomarker distribution

Signal-oriented analysis of MSOT images

- pre-processing eliminates motion artifacts and inter-scan intensity differences
- ROIs retrieved with DL-based segmentation
- signals signal intensities from whole sample
- signal-oriented approach

plaid-wave clustering with k-means, identifies regions of similar signal kinetics

Provides:

- information about pharmacokinetics
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MSOT Cluster Analysis Toolkit - Mcat

- implementation as ImageJ plugin
- graph-based algorithm structure
- graphical user interface (GUI)
- optimized data archive structure
- easily applicable
- easily expandable

Two main sections:
1. data import and handling
2. parameter definition

multiple options to obtain ROIs
easily adaptable for various MSOT data
multiple parameter sets in one run
facilitates parameter estimation

Github <https://github.com/applied-systems-biology/Mcat>

References

- [1] Krieg et al. 2021, Nat Methods, 18:100–106
- [2] Gerst et al. www.jipipe.org
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- [4] Zeng, 2021, BioRxiv Thesis
- [5] Press et al. 2021, EMBO Mol Med, 13:e14436

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