Weakly supervised lung cancer detection via label-free microscopy

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Nonlinear microscopy and Al might help with intraoperative cancer detection

- HHGM can image biopsies in minutes, and AI analyzes images in seconds
- Self-supervised pretraining increases AUC with +35%
- Attention map may help with interpretability

Higher harmonic generation microscopy (HHGM) images cells and interfaces, collagen, and elastin in 2D or 3D. The portable microscope can be can be transported to the operating room.





HHGM may improve on rapid on-site evaluation (ROSE)¹ by decreasing the time needed for analysis and apply AI on a digital image on site.



Self-supervised pre-training with DINO² seems to outperform SimCLR³. ImageNet weights can adapt to HHGM data, but training from random weights is best. CLAM⁴ attention maps highlight patches important for image level prediction, but attention maps are hard to interpret.





Abstract

Higher harmonic generation microscopy (HHGM) enables labelfree on-site imaging of fresh tissue, potentially allowing a new means of pathology assessment for disease diagnosis. We investigate the potential of using self-supervised learning (SSL) in combination with weakly-supervised, attention-based, clustering constrained multiple instance learning (CLAM) to detect lung cancer in HHGM images. First, we tailor encoders to HHGMspecific data domain via both SimCLR and DINO SSL. Second, we train a CLAM classifier with and without an SSL feature extractor on 100 HHGM images acquired during bronchoscopy procedures. We show that SSL pre-training with random initialization and CLAM are beneficial to intraoperatively detect lung cancer in HHGM images.

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