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Weakly Supervised Hierarchical Multi-label Classification of Lung Cancer Types Based on Rapid On-Site Evaluation in Transbronchil Biopsy

Junxiang Chen[a], Chuanjia Gu[a], Xiaoxuan Zheng[a], Ying Li[a], Fangfang Xie[a], Shuaiyang Liu[a], Yongzheng Zhou[a], Jiayuan Sun*[a]

[a] Department of Respiratory Endoscopy, Department of Respiratory and Critical Care Medicine, Shanghai Chest Hospital, Shanghai Jiao Tong University, Shanghai, CHINA

* xkyyjysun@163.com

Background

Rapid on-site evaluation (ROSE) plays a crucial role in determining the type of lung cancer to guide optimal management during transbronchil biopsy procedure. However, its application has been limited due to the insufficient and subjectivity of cytopathologists. This study aims to validate the weakly supervised deep convolutional neural network (DCNN) in the classification of lung cancer subtypes on the ROSE slide images.

Methods

A total of 811 ROSE whole slide images stained with Diff-Quik were retrospectively collected from Shanghai Chest Hospital between July 2019 and November 2020, which were randomly assigned for training, validation, and test. Hierarchical multi-label attention model (HMLAM) based on ResNet50 was proposed for the sorting the ROSE images, three internal sub-models (N1, N2, N3) were constructed to differentiate the subtypes of lung cancer: benign vs. malignant, malignant lesions subtyping, and non-small cell lung cancer subtyping. In the test dataset, the performance of HMLAM was compared with pathologists, interventional respiratory physicians and ROSE technicians.

Results

The area under the curve of HMLAM's three sub-models (N1, N2, N3) was 0.9032 (95%CI: 0.8530-0.9543), 0.8773 (95%CI: 0.8416-0.9129) and 0.8458 (95%CI: 0.7998-0.8918), and the accuracy was 0.8678, 0.7397, and 0.6733, respectively. Human-machine controlled test show that pathologists had the highest interrater consistency and accuracy, followed by the HMLAM achieved 0.5428 kappa and 0.6494 accuracy, outperforming interventional respiratory physicians and ROSE technicians subsequently.

Conclusions

This study presented that large-scale weakly supervised DCNN has the potential to assist respiratory interventionists in the subcategories of ROSE images during transbronchial sampling. Intuitively, HMLAM is expected to partially replace the function of cytopathologists, resulting in a substantial reduction in time and expense associated with the procedure in the bronchoscopy suite.
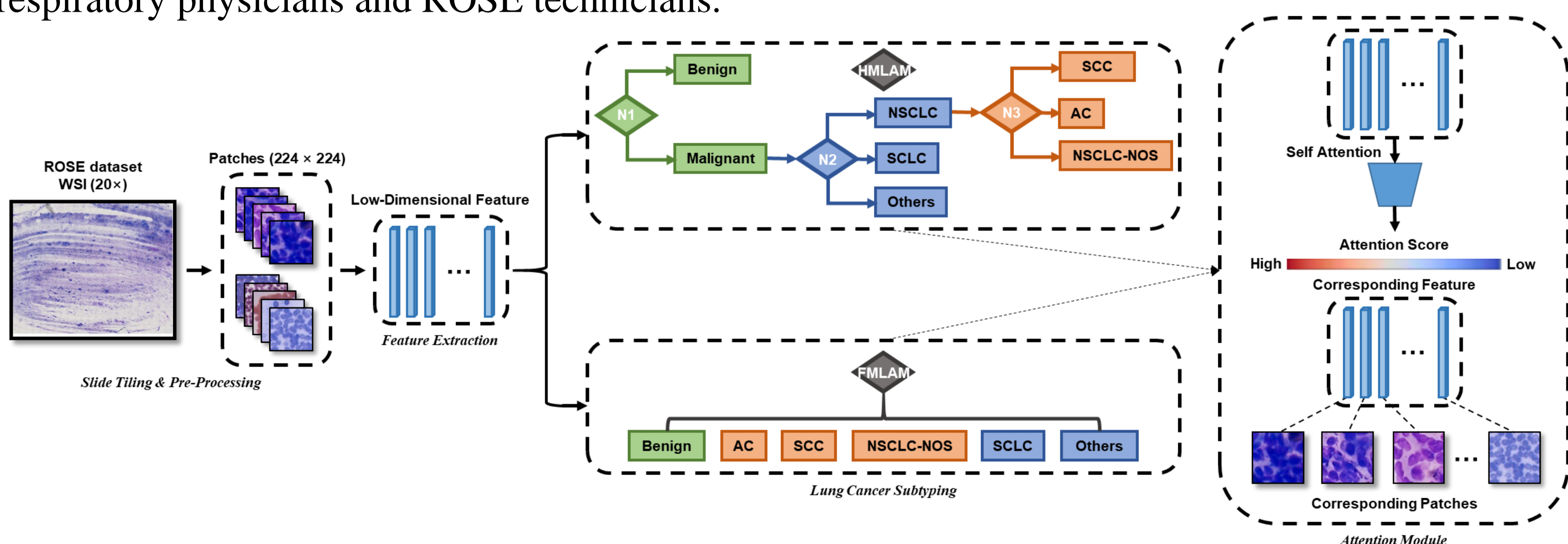
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Figure 1. The framework of hierarchical multi-label attention model (HMLAM) and flat multi-label attention model (FMLAM).