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Dual-task mutual learning for weakly-supervised COVID-19 lesion segmentation from chest CT

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In this study, we designed a dual-task mutual network for weakly supervised the new coronavirus pneumonia (COVID-19) lesions segmentation based on gradient-weighted class activation mapping (Grad-CAM)for coarse labels and multi-instance learning for fine labels. Various deep learning-based methods for COVID-19 image segmentation have also been proposed, but manual labeling is time-consuming and prone to label noise due to the low contrast boundary of lesions.

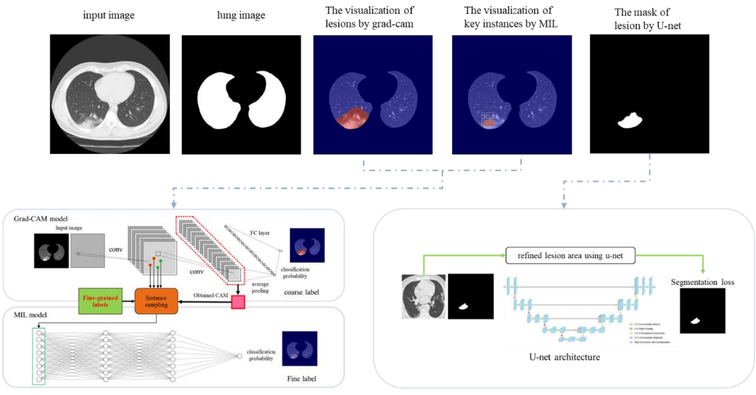

Figure 1 illustrates the dual-task mutual algorithm. First, to avoid interference with the surrounding tissue, we used threshold segmentation to obtain the lung region. Second, we trained a classification network with and without the lesions and visualized the location of lesions through Grad-CAM. In this way, the coarse label for segmentation is obtained. Then, The coarse labels are subdivided into 5*5 patches, which are used as instances for MIL tasks by gradually training the tasks from easy to difficult. The network has a high classification accuracy. Finally, we used fine labels to refine the segmentation results using supervised methods.

Table1. Quantitative results of COVID-19 segmentation on the datasets.

	Dice	**IoU**	**PPV**	**Sensitivity**	**Specificity**
DeCov[1]	0.72	0.56	0.73	0.70	0.98
AD3D-MIL[2]	0.68	0.51	0.56	0.85	0.99
Ours	0.74	0.57	0.65	0.85	0.97

We adopt typical metrics in COVID-19 lung infection quantification on the 100 CT datasets, i.e. the Dice Score, Intersection over Union (IoU), Positive Predicted Value(PPV), Sensitivity, and Specificity for evaluation in table1. The main contribution of this work is to propose a new weakly supervised segmentation model, which combines grad-cam and MIL-based measurements. The coarse-to-fine strategy could improve the segmentation performance. Finally, we demonstrate the feasibility and effectiveness of our proposed method by comparing it with published weakly supervised image classification methods.

Reference

[1] Wang X, Deng X, Fu Q, et al. A weakly-supervised framework for COVID-19 classification and lesion localization from chest CT[J]. IEEE transactions on medical imaging, 2020, 39(8): 2615-2625.

[2] Han Z, Wei B, Hong Y, et al. Accurate screening of COVID-19 using attention-based deep 3D multiple instance learning[J]. IEEE transactions on medical imaging, 2020, 39(8): 2584-2594.