A Two-Stage Solution for Organ-at-Risks Segmentation

Zhong Yunxin, Liu Shuolin, Han Bing

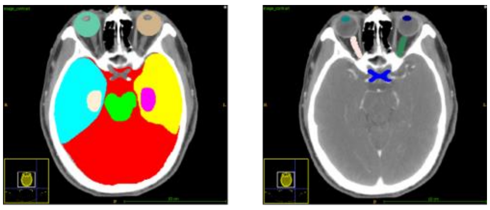
CANON MEDICAL SYSTEMS (CHINA) CO., LTD, Beijing, China

Introduction

Background

- The delineation of organs at risk(OAR) in radiotherapy is crucial for accurate and safe radiation treatment planning.
- Manual OAR delineation is very time consuming, but deep learning models can significantly reduce the physician's workload.

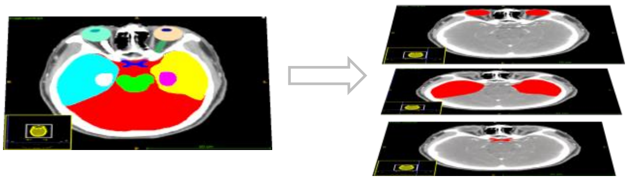
Challenges



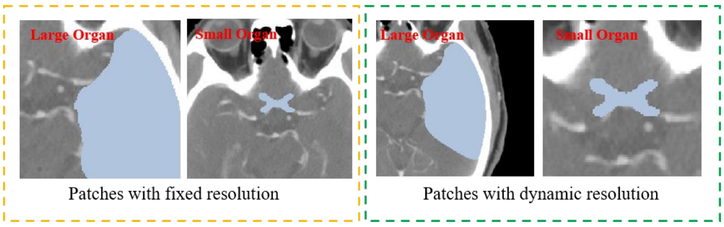
Large structures Small structures

- Complexity of the anatomical structures (eg. overlap between structures)
- Extremely imbalanced size between large and small structures.

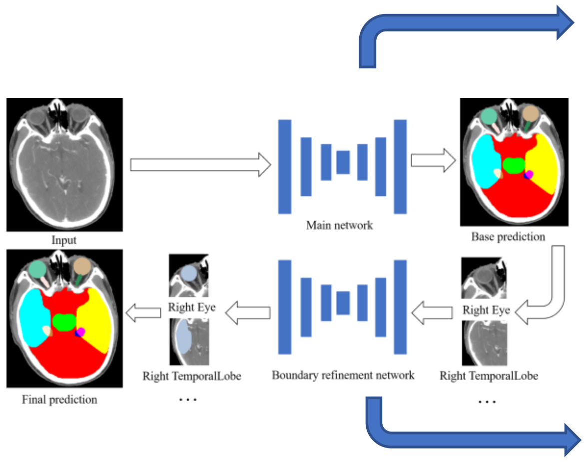
Methodology

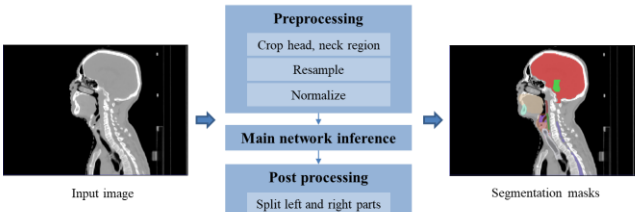


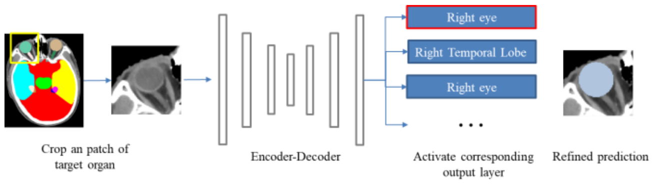
Reduce number of training targets according to anatomical relationships (45 to 29 classes)



Boundary refinement with dynamic resolution







Result

Table 1. DSC and NSD score of different augmentation methods

Methods	Flip X	Flip Y,Z	DSC	NSD
Augmentation 1	✓	✓	0.8818	0.9013
Augmentation 2			0.8854	0.9121
Augmentation 3		✓	0.8894	0.9134

Table 2. DSC and NSD score of different inference methods. Only the organs that sent to boundary refinement network are evaluated.

OAR	w/o boundary refinement		w boundary refinement	
	DICE	NSD	DSC	NSD
Esophagus	0.8837	0.8819	0.8913	0.8984
Hippocampus$_L$	0.8164	0.7522	0.8198	0.7620
Hippocampus$_R$	0.8154	0.7591	0.8166	0.7666
TemporalLobe$_L$	0.9516	0.8247	0.9539	0.8359
TemporalLobe$_R$	0.9537	0.8218	0.9564	0.8352
Eye$_L$	0.9507	0.9437	0.9529	0.9458
Eye$_R$	0.9418	0.9286	0.9426	0.9280
Mandible$_L$	0.9522	0.9459	0.9525	0.9517
Mandible$_R$	0.9534	0.9475	0.9549	0.9601
Parotid$_L$	0.9316	0.8581	0.9338	0.8689
Parotid$_R$	0.9249	0.8439	0.9267	0.8533
Average	0.9159	0.8643	**0.9183**	**0.8733**

Conclusion

- In this study, we propose a robust segmentation method for dealing with multiorgan segmentation. It is expected to provide a powerful tool for radiotherapy planning.
- Our experiments show that the boundary refinement network can improve the accuracy of most organs.

Reference

- 1. Gao, Y., et al.FocusNetv2: Imbalanced large and small organ segmentation with adversarial shape constraint for head and neck CT images. Medical Image Analysis 67, 101831 (Jan 2021).
- 2. Isensee, F., et al.: nnU-Net: a self-configuring method for deep learning-based biomedical image segmentation. Nature Methods 18(2), 203–211 (Feb 2021).
- 3. Ronneberger, O., et al. : U-Net: Convolutional Networks for Biomedical Image Segmentation. In: Navab, N., Hornegger, J., Wells, W.M., Frangi, A.F. (eds.) Medical Image Computing and Computer-Assisted Intervention –MICCAI 2015, vol. 9351, pp. 234–241. Springer International Publishing, Cham (2015).
- 4. Xiangde Luo, et al. : Segmentation of Organs-at-Risk and Gross Tumor Volume for Radiotherapy Planning of Nasopharyngeal Carcinoma Challenge 2023 (Apr 2023).