APPENDIX

A. The visualization of APPMs and abdominal dataset

Fig.A1 displayed the visualization results of APPM for head and neck small organs. Fig.A2 showed the visualization of APPM for abdominal small organs. APPM contained anatomical prior information such as the relative position, size, and shape of organs. The brighter a position in the APPM, the greater the probability that the voxel in that position in the training data set belonged to the foreground category.

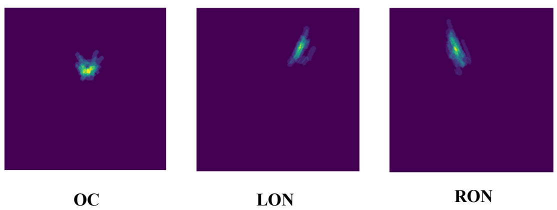

Fig. A1. The APPM of head and neck small organs.

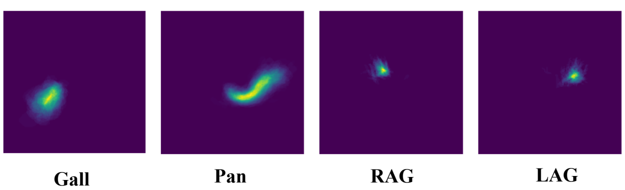

Fig. A2. The APPM of abdominal small organs.

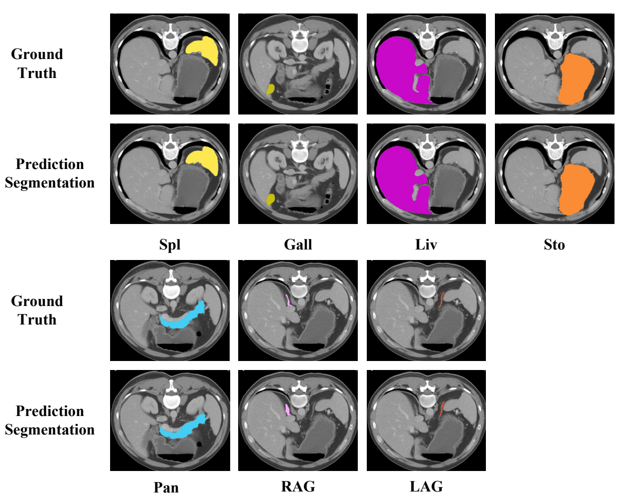

Fig. A3. Visualizations of segmentation results of the MHL-Net on AMOS2022 dataset.

The axial plane visualization results of abdominal multi-organ segmentation were shown in Fig.A3. From the visualization results, although under-segmentation and over-segmentation, the proposed method could accurately locate and segment all organs and had transferability.

B. Statistical validation

1) Ablation Study: As for the MDCA module, taking the method without the MDCA module as the benchmark, the difference between the proposed method and other methods was verified. From table B1, when the MDCA was added to the encoder and decoder, the difference between the methods was not significant ($p \geq 0.050$). Only when the MDCA module was added to the skip connection, the segmentation results of some organs were improved significantly (p<0.050).

Taking the method with the original input image as the benchmark, table B2 summrized the p-values of the small organ DSC with different SlocNet inputs. Both the MsegNet prediction segmentation and APPM were important for improving the DSC. But when the prediction segmentation and APPM were combined, the p-values were smaller, and the difference was more significant.

TABLE B1
P-VALUES OF THE DSC OF HNOAR SEGMENTATION WITH MSEGNET IN FIVE CASES.

Positions \HNOAR	BS	OC	LON	RON	LPG	RPG	LSG	RSG
Without MDCA	\	\	\	\	\	\	\	\
Encoder	0.053	0.160	0.094	0.105	0.051	0.050	0.052	0.058
Decoder	0.054	0.178	0.131	0.137	0.055	0.060	0.059	0.057
Encoder +decoder	0.050	0.099	0.094	0.010	0.056	0.058	0.052	0.053
Skip connection	<0.010	0.086	0.083	0.084	0.010	<0.010	0.012	0.011

TABLE B2
P-VALUES OF THE DSC OF SMALL ORGANS SEGMENTED BY SSEGNET WHEN SLOCNET USED DIFFERENT INPUT IMAGES FOR LOCALIZATION.

Input Image \HNOAR	OC	LON	RON
Origin input image	\	\	\
With prediction	0.044	0.047	0.043
With APPM	0.042	0.045	0.044
With prediction and APPM	0.013	0.011	0.014

TABLE B3
P-VALUES OF THE DSC AND HD95 OF SMALL ORGANS SEGMENTED BY SSEGNET UNDER DIFFERENT CONDITIONS.

HNOAR \Conditions	SsegNet		Without APPM		Without BCA	
Metrics	DSC	HD95	DSC	HD95	DSC	HD95
OC	\	\	0.019	0.013	0.020	0.014
LON	\	\	0.021	0.015	0.019	0.019
RON	\	\	0.017	0.010	0.022	0.018

Table B3 conducted statistical verification of DSC and HD95. With the SsegNet as the benchmark, the p-values of the method without APPM and without BCA were all smaller than 0.050, which indicated that the APPM and the BCA were significantly important for segmenting HNOAR.

2) Comparison Study: Taking the proposed method as the benchmark, the method was combined with other comparison methods in pairs one after another for statistical verification, and the results were summarized in table B4-B9. The statistical analysis results showed that the segmentation performance of

MHL-Net was significantly improved compared with other comparison methods for most organs ($p<0.050$). Only the segmentation performance of the method of Liang et al., Guo et al., and Lei et al. had no significant difference from the proposed method for a few organs.

TABLE B4
P-VALUES OF THE DSC BETWEEN THE PROPOSED METHOD AND THE SOTA METHODS ON THE HNCPC DATASET.

Methods \HNOAR	BS	OC	LON	RON	LPG	RPG	LSG	RSG
Tang [25]	0.017	<0.010	0.020	0.011	0.015	<0.010	0.035	<0.010
Huang [3]	<0.010	0.011	0.019	0.014	0.017	0.021	<0.010	<0.010
Gao [2]	0.015	0.032	0.033	0.026	0.040	0.013	0.019	0.024
Liang [1]	0.072	0.023	0.025	0.030	0.063	0.038	<0.010	<0.010
Lei [9]	<0.010	<0.010	0.031	0.012	<0.010	0.011	<0.010	<0.010
Dai [13]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Wang [33]	<0.010	<0.010	<0.010	0.010	<0.010	<0.010	<0.010	<0.010
Wang [34]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
ours	\	\	\	\	\	\	\	\

TABLE B5
P-VALUES OF THE HD95 BETWEEN THE PROPOSED METHOD AND THE SOTA METHODS ON THE HNCPC DATASET.

Methods \HNOAR	BS	OC	LON	RON	LPG	RPG	LSG	RSG
Tang [25]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.021	<0.010
Huang [3]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.022
Gao [2]	<0.010	0.023	0.016	0.010	<0.010	<0.010	<0.010	<0.010
Liang [1]	<0.010	<0.010	0.038	0.031	<0.010	<0.010	0.014	<0.010
Lei [9]	<0.010	0.025	0.025	0.027	<0.010	<0.010	<0.010	<0.010
Dai [13]	<0.010	0.022	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Wang [33]	0.019	0.031	0.041	0.039	<0.010	0.020	0.023	0.019
Wang [34]	<0.010	0.023	0.025	<0.010	<0.010	0.019	0.020	<0.010
ours	\	\	\	\	\	\	\	\

TABLE B6
P-VALUES OF THE DSC BETWEEN THE PROPOSED METHOD AND THE SOTA METHODS ON THE PDDCA DATASET.

Methods \HNOAR	BS	OC	LON	RON	LPG	RPG	LSG	RSG
Tang [25]	0.011	<0.010	<0.010	<0.010	<0.010	<0.010	0.017	<0.010
Huang [3]	<0.010	0.015	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Gao [2]	0.013	0.022	0.017	0.025	0.021	0.028	0.033	0.041
Liang [1]	0.069	0.019	0.011	0.019	0.082	0.032	<0.010	<0.010
Lei [9]	<0.010	<0.010	0.029	<0.010	<0.010	<0.010	<0.010	<0.010
Dai [13]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Wang [33]	<0.010	<0.010	<0.010	0.010	<0.010	<0.010	<0.010	<0.010
Wang [34]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
ours	\	\	\	\	\	\	\	\

3) Generalization Study: Based on the proposed method, the statistical validation results were summarized in table B10-B13. Both the proposed method and the comparative methods have a certain generalization ability and can segment organs well on external datasets. In addition, the proposed method made full use of the anatomical prior knowledge by extracting the basic features of each organ, which further improved the robustness of the model. For the same external data set, the segmentation results of MHL-Net were better on the whole, which showed that this method mined the essential features of images and had a stronger generalization ability ($p<0.050$).

TABLE B7
P-VALUES OF THE HD95 BETWEEN THE PROPOSED METHOD AND THE SOTA METHODS ON THE PDDCA DATASET.

Methods \HNOAR	BS	OC	LON	RON	LPG	RPG	LSG	RSG
Tang [25]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Huang [3]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Gao [2]	<0.010	0.029	0.031	<0.010	<0.010	<0.010	<0.010	<0.010
Liang [1]	<0.010	<0.010	0.020	<0.010	<0.010	<0.010	<0.010	<0.010
Lei [9]	<0.010	<0.010	0.018	0.027	<0.010	0.022	<0.010	<0.010
Dai [13]	<0.010	0.020	<0.010	0.035	0.029	0.037	<0.010	0.015
Wang [33]	0.018	0.023	0.028	0.030	<0.010	0.028	0.012	0.011
Wang [34]	<0.010	<0.010	<0.010	0.033	0.021	0.031	0.029	0.017
ours	\	\	\	\	\	\	\	\

TABLE B8
P-VALUES OF THE DSC BETWEEN THE PROPOSED METHOD AND THE SOTA METHODS ON THE HNCSC DATASET.

Methods \HNOAR	BS	LON	RON	LPG	RPG	LSG	RSG
Tang [25]	0.020	<0.010	<0.010	<0.010	<0.010	0.047	<0.010
Huang [3]	<0.010	<0.010	<0.010	<0.010	0.010	<0.010	0.016
Gao [2]	0.015	0.025	0.017	0.029	0.027	0.051	0.019
Liang [1]	0.019	0.014	0.031	0.021	0.024	<0.010	<0.010
Lei [9]	<0.010	0.011	<0.010	<0.010	0.011	<0.010	<0.010
Dai [13]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Wang [33]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.013
Wang [34]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
ours	\	\	\	\	\	\	\

TABLE B9
P-VALUES OF THE HD95 BETWEEN THE PROPOSED METHOD AND THE SOTA METHODS ON THE HNCSC DATASET.

Methods \HNOAR	BS	LON	RON	LPG	RPG	LSG	RSG
Tang [25]	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	<0.010
Huang [3]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Gao [2]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Liang [1]	<0.010	0.071	<0.010	<0.010	<0.010	0.011	<0.010
Lei [9]	<0.010	0.077	0.052	<0.010	<0.010	<0.010	<0.010
Dai [13]	<0.010	<0.010	<0.010	0.035	0.014	0.017	0.019
Wang [33]	0.022	0.082	<0.010	<0.010	0.019	0.020	0.021
Wang [34]	<0.010	0.021	<0.010	0.038	0.015	0.016	0.014
ours	\	\	\	\	\	\	\

TABLE B10
P-VALUES OF THE DSC ON THE PDDCA DATASET WITH THE HNCPC MODELS.

Methods \HNOAR	BS	OC	LON	RON	LPG	RPG	LSG	RSG
Tang [25]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.035	<0.010
Huang [3]	<0.010	0.012	<0.010	<0.010	<0.010	<0.010	0.049	<0.010
Gao [2]	<0.010	0.019	0.045	0.013	<0.010	<0.010	0.031	<0.010
Liang [1]	0.019	0.016	<0.010	0.011	0.024	0.051	<0.010	<0.010
Lei [9]	<0.010	<0.010	0.041	<0.010	<0.010	<0.010	<0.010	<0.010
Dai [13]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Wang [33]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Wang [34]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
ours	\	\	\	\	\	\	\	\

TABLE B11
P-VALUES OF THE HD95 ON THE PDDCA DATASET WITH THE HNCPC MODELS.

Methods \HNOAR	BS	OC	LON	RON	LPG	RPG	LSG	RSG
Tang [25]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Huang [3]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Gao [2]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Liang [1]	<0.010	<0.010	0.025	<0.010	<0.010	<0.010	<0.010	<0.010
Lei [9]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Dai [13]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Wang [33]	0.019	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Wang [34]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
ours	\	\	\	\	\	\	\	\

TABLE B12
P-VALUES OF THE DSC ON THE HNCSC DATASET WITH THE HNCPC MODELS.

Methods \HNOAR	BS	LON	RON	LPG	RPG	LSG	RSG
Tang [25]	0.016	<0.010	<0.010	<0.010	<0.010	0.040	0.013
Huang [3]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.015
Gao [2]	0.011	0.019	0.017	0.015	0.010	0.035	0.023
Liang [1]	0.014	<0.010	<0.010	0.021	<0.010	<0.010	<0.010
Lei [9]	<0.010	0.077	<0.010	<0.010	<0.010	<0.010	<0.010
Dai [13]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Wang [33]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Wang [34]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
ours	\	\	\	\	\	\	\

TABLE B13
P-VALUES OF THE HD95 ON THE HNCSC DATASET WITH THE HNCPC MODELS.

Methods \HNOAR	BS	LON	RON	LPG	RPG	LSG	RSG
Tang [25]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Huang [3]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Gao [2]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Liang [1]	<0.010	0.043	<0.010	<0.010	<0.010	<0.010	<0.010
Lei [9]	<0.010	0.025	0.021	<0.010	<0.010	<0.010	<0.010
Dai [13]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Wang [33]	0.023	0.020	<0.010	<0.010	<0.010	<0.010	<0.010
Wang [34]	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
ours	\	\	\	\	\	\	\