



### Position Prior Attention Network for Pancreas Tumor Segmentation

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### Introduction

- Pancreatic cancer is an abdominal malignancy with the lowest five-year survival rate of any common cancer (only 12%).
- Accurate tumour segmentation assists in early diagnosis, surgery planning and radiotherapy, as well as monitoring tumour progression.
- However, the segmentation of pancreatic tumours is difficult due to their poorly defined borders, complex anatomical location, and large individual differences.



Figure 1. Examples of the complexities of pancreas tumor segmentation.



### Overview

#### **Problems**

It is difficult to improve the performance of pancreatic tumour segmentation.However, integrating textual information has the potential to improve the accuracy of pancreatic tumor segmentation.

#### **Solution ideas**

1. Introduce text information from image reports into pancreatic tumour segmentation, but how?

2. Enhancing the model's generalization ability during training due to the limited number of training samples.

#### **Our Methods**

1. Build a multi-branch multi-task network for tumor segmentation and location classification.

2. Design a generalized classification feature extraction module to alleviate overfitting issues in the classification branch.



### Methods

Step 1. Train a 3D UNet network to generate pancreas pseudo-segmentation maps .

Step 2. Use the pancreas pseudo-segmentation map and intermediate generated pancreatic tumor probability map to predict the location of pancreatic tumors.



Figure 2. Framework of our proposed methods



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### Methods

Step 2 :



(b) Position prior attention network

#### Figure 3. Position Prior Attention Network

1. PSGM is designed based on the decoder network of FPN, which combines the deepest and shallowest features to generate pancreatic tumor probability map, and can be expressed as :

 $F_s' = f_{up}(W_{s+1}F_{s+1}) \oplus F_s$ 

$$S_{tumor} = Tanh(W_{out}F_3')$$

2. PPAM maps tumor pseudo segmentation and pancreas pseudo segmentation to the latent space z via VAE encoder  $q_{\theta}$ .  $p_{\phi}$  is the reparameterization method in VAE.

$$\begin{split} L_{prior} &= L_{CE}(S_{prior}, Y) + D_{KL}(q_{\theta}(z \mid S_{tumor}, S_{pancreas}) \mid\mid p_{\phi}(z)) \\ &+ L_{CE}(y'_{position}, y_{position}) \end{split}$$





### Datasets

Data	Institution	Cases	Tumors	Slices	Spacing (mm)	Thickness (mm)	Head/Tail/body
MSD	Kettering cancer Memorial Sloan center	281	cancer/not	37-751	0.60-0.97	0.70-7.50	-
Private	Zheyi	71	cancer	40-71	0.76	2.5	40/19/12

- The MSD dataset is a multicenter dataset with tumor and pancreas segmentation. This experiment primarily utilizes the pancreatic annotation data from MSD.
- The classification labels are obtained from the CT imaging reports, and a regular script is used to generate classification labels indicating the location of the tumor in the pancreatic head/body/tail.



### Results



Table 1. Results of ablation experiments on the Zheyi dataset

Table 1 reveals that our methods effectively enhance the segmentation ability of the model (Dice improved by a maximum of 3.39%, precision improved 2.84%, and recall improved by a max of 4.79%).

Method	Dice(%)	Precision(%)	Recall(%)
Baseline	59.01	72.40	56.14
+PSGM	<u>61.26</u>	74.70	59.18
+CAE PSGM	60.57	76.59	<u>57.83</u>
ours	62.80	<u>75.24</u>	60.93



### Results

Table 2. Comparison of SOTA methods on Zheyi dataset.

Table 2 indicates that our framework with position prior knowledge is competitive, outperforms the state-of-theart (SOTA) methods in terms of Dice and precision.

Method	Dice (%)	Precision (%)	Recall (%)
2D UNet	45.11	73.80	40.37
2D Attention UNet	52.32	69.81	49.93
2D UNet++	53.31	71.0	50.12
3D ResNet	55.13	60.12	53.40
3D nnUNet	<u>62.07</u>	<u>73.05</u>	64.98
Ours	62.80	75.24	<u>60.93</u>





## Conclusion

- The PSGM and PPAM leverage tumor position information as prior knowledge to assist in pancreatic tumor segmentation and prove the effectiveness of the method.
- The proposed network PPANet is evaluated on pancreatic patient data collected from Zheyi hospital and the experimental results demonstrate that our method is highly competitive compared to other methods.





# Thank You for your listening