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Clinical features for AI based pancreatic tumor detection

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GOAL

In this work we investigate the benefits of using features, which are relevant for clinicians in tumor localization, for AI based tumor detection in computed tomography (CT) scans.

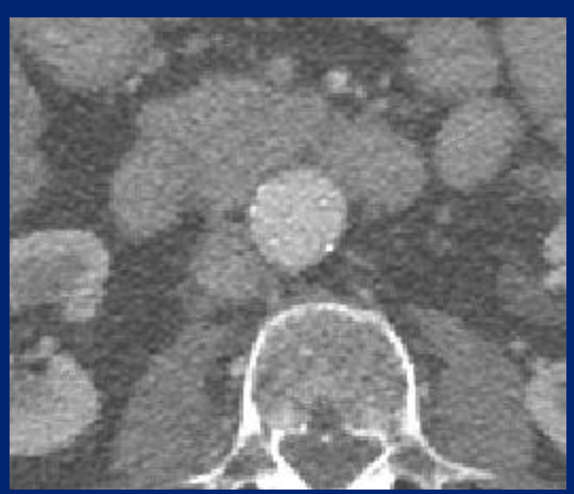
PROBLEM STATEMENT

Pancreatic cancer is a rare type of cancer, of which Pancreatic Ductal Adenocarcinoma (PDAC) is the most prevalent. Pancreatic cancer diagnosis using artificial intelligence (AI) model faces additional difficulties due to the small-scale datasets that are publicly available. The disease is also difficult to recognize in the images because of its low contrast between the tumor and the surrounding tissues, as seen in Figure 1. In order to locate early-staged tumors in a CT scan, clinicians use several secondary features in the scan, for example dilation of bile duct due to obstruction by the tumor, as shown in Figure 2.

In this project we improve AI based early-staged PDAC detection by utilizing these clinical features.

Figure 1: CT scan image of pancreatic tumor, the low contrast between tumor and surroundings make it difficult to locate.

A: CT scan over abdomen.



B: Circled tumor region

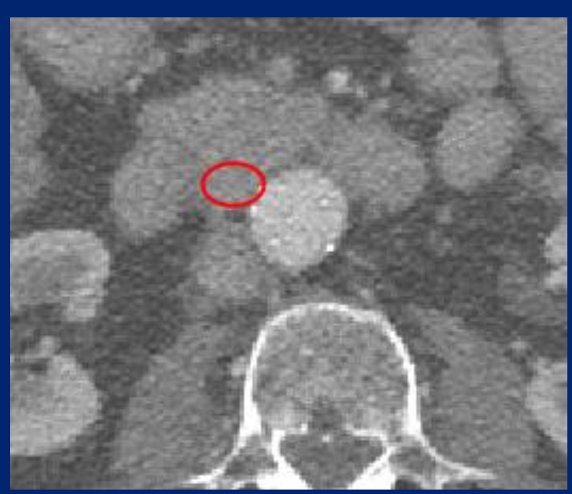
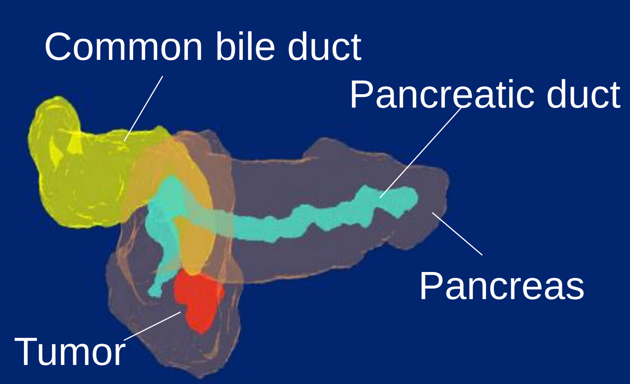
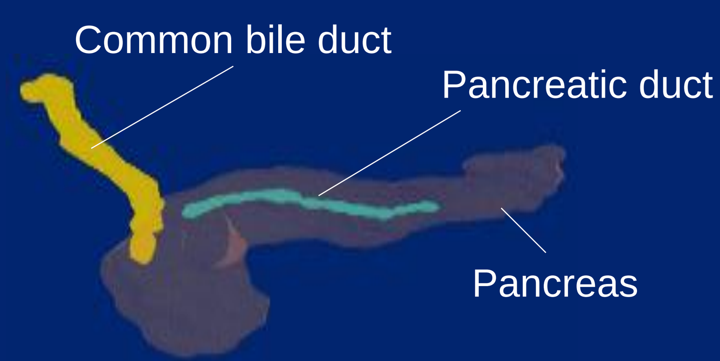


Figure 2: 3D illustration of pancreas, tumor and bile ducts of two different patients.

A: Illustration of case in Figure 1 with dilated bile ducts



B: Illustration of pancreas and bile ducts of patient without PDAC, for comparison.



METHODS

We propose a coarse-to-fine pipelined AI network to segment the pancreas and bile ducts, consisting of multiple sequential 3D convolutional neural networks (CNN) to use as input for a tumor segmentation and detection model, as seen in Figure 3. We test our method by comparing the detection sensitivity when using manual annotations of the structures and using automatically segmented structures.

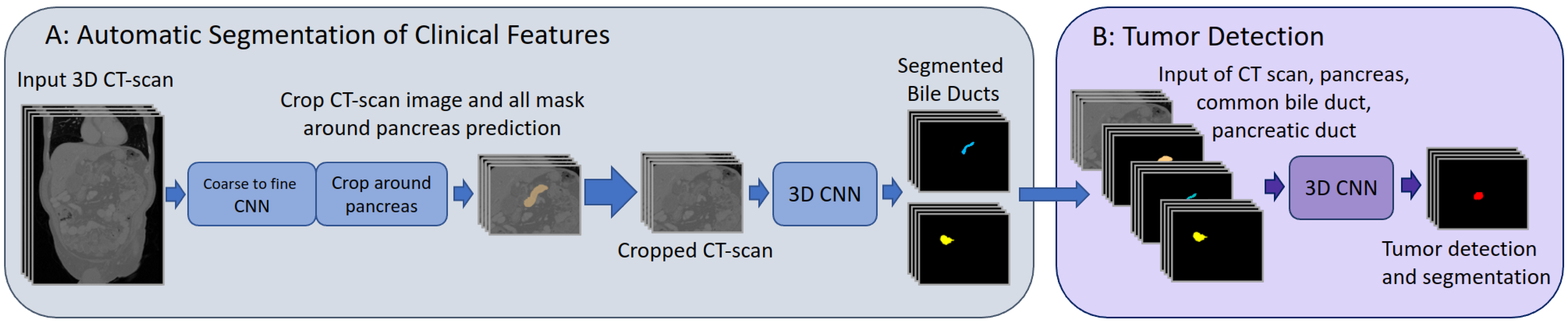


Figure 3: Illustration of the tumor detection pipelined network using clinical features

RESULTS

Using the clinical features as input to the AI an outstanding sensitivity of 100% was achieved, see Table 1. The specificity was also considerably higher than what was achieved when using only the CT scan as input. However the specificity was lower for the full pipelined network, indicating that the tumor detection model is sensitive to accuracy of the clinical feature masks, as seen in Figure 4.

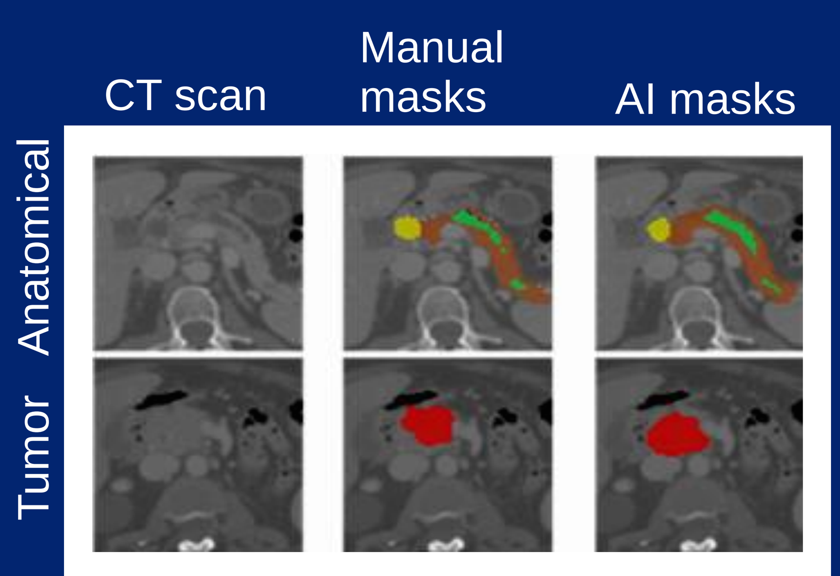


Figure 4: Segmented masks of clinical features (Pancreas, common bile duct and pancreatic duct) and tumor from model predictions

Table 1: Tumor detection Sensitivity and specificity of validation set

AI detection model	Tumor sensitivity	Tumor specificity
Input of CT only	81% ± 6%	44% ± 8%
Input of manual annotations	100% ± 0%	94% ± 4%
Input of AI annotations	100% ± 0%	75% ± 7%

CONCLUSIONS

The results of this study show the value of using features that are relevant for medical assessment in AI research. Encouraging an AI detection model to utilize these features can potentially improve the AI detection or segmentation of the disease, as it does for clinicians. In future studies, the benefit of other input clinical features should be investigated in relation to conventional CNN feature extraction.

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