

Supplementary Materials

Implementation of deep learning-based gauze detection in pancreatic laparoscopic and robotic surgery: an exploratory multicenter evaluation

Lu Ping^{1,2,#}, Rui Ding^{3,#}, Hebin Wang^{4,#}, Meng Yuan^{5,#}, Jialin Li^{6,#}, Junyi Gao¹, Zhihong Wang¹, Hu Zhou¹, Jile Shi^{1,7}, Wenming Wu^{1,2}, Zhengcai Liu³, Renyi Qin⁴, Chunhui Yuan⁵, Xianjun Yu⁶, Surong Hua⁸

¹Department of General Surgery, Peking Union Medical College Hospital, Chinese Academy of Medical Sciences, Beijing 100730, China.

²State Key Laboratory of Complex, Severe and Rare Diseases, Peking Union Medical College Hospital, Chinese Academy of Medical Sciences, Beijing 100730, China.

³Department of Hepatobiliary Surgery, The Xijing Hospital of The Fourth Military Medical University, Xi'an 710032, Shaanxi, China.

⁴Department of Biliary-Pancreatic Surgery, Affiliated Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan 430030, Hubei, China.

⁵Department of General Surgery, Peking University Third Hospital, Beijing 100191, China.

⁶Department of Pancreatic Surgery, Fudan University Shanghai Cancer Center, No. 270 Dong'An Road, Xuhui District, Shanghai 200032, China.

⁷8-year MD program, Peking Union Medical College and Chinese Academy of Medical Sciences, Beijing 100730, China.

⁸Department of General Surgery, Beijing United Family Hospital, Beijing 100015, China.

[#]These authors contributed equally to this work.

Correspondence to: Prof. Wenming Wu, Department of General Surgery, Peking Union Medical College Hospital, Chinese Academy of Medical Sciences, Beijing 100730, China. E-mail: doctorwuu@126.com; Prof. Zhengcai Liu, Department of Hepatobiliary Surgery, The Xijing Hospital of The Fourth Military Medical University, Xi'an 710032, Shaanxi, China. E-mail: liuzhc@fmmu.edu.cn; Prof. Renyi Qin, Department of Biliary-Pancreatic Surgery, Affiliated Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan 430030, Hubei, China. E-mail: ryqin@tjh.tjmu.edu.cn; Prof. Yuan Chunhui, Department of General Surgery, Peking University Third Hospital, Beijing 100191, China. E-mail: ychdoctor@163.com; Prof. Xianjun Yu, Department of Pancreatic Surgery, Fudan University Shanghai Cancer Center, No. 270 Dong'An Road, Xuhui District, Shanghai 200032, China. E-

mail: yuxianjun@fudanpci.org; Prof. Surong Hua, Department of General Surgery, Beijing United Family Hospital, Beijing 100015, China. E-mail: huasurong@tsinghua.org.cn

Supplementary Table 1. Sensitivity and precision under different IoUs

	IoU = 0.1		IoU = 0.3		IoU = 0.5	
	Sensitivity	Precision	Sensitivity	Precision	Sensitivity	Precision
Model 1 [*]	87.17%	71.99%	83.30%	68.79%	73.97%	63.09%
Model 2 [#]	92.02%	70.25%	88.72%	67.72%	81.52%	62.23%

^{*}Model 1: Baseline Model; Test set: XJH test set.

[#]Model 2: Model 1+XJH Training Set; Test set: an independent XJH real-patient test set (not included in analyses in Table 2).

Supplementary Table 2. Computational complexity, performance and inference latency comparison of the final model and other CNN models

Model	Parameter /M	FLOPS	Sensitivity[*]	Precision	Latency
		/GFLOPs			(ms/frame)[#]
Our model	12.09	25.04	89.76%	81.03%	29.04
YOLOv3	61.56	98.83	Not available ^{\$}	Not available	45.98
SSD_512	23.75	205.64	81.18%	78.25%	64.25
FasterRCNN_r50	41.53	129.96	94.24%	70.66%	84.93
YOLOX-s	8.94	33.88	85.04%	80.88%	20.45

^{*}Sensitivity and precision were tested using training and test sets of all 5 centers.

[#]Running environment: NVIDIA Tesla_P40 GPU.

^{\$}Sensitivity and precision for the original YOLOv3 were not available because a controlled evaluation of the original YOLOv3 on the same held-out test set and under the same training and preprocessing protocol was not performed.

This comparison evaluates the overall computational complexity and inference latency of the final integrated model. It was not designed to isolate the independent contribution of each architectural modification.