CONSTRUCTING THE LARGE DATASET TO DEVELOP NOVEL ARTIFICIAL INTELLIGENCE SYSTEMS IN LAPAROSCOPIC HEPATO-BILIARY-PANCREATIC SURGERY.

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Aims

In recent years, there have been a number of reports on the application of computer vision, AI technology using deep learning, to laparoscopic surgery[1-5].

However, there are only a few reports of computer vision in hepato-biliary-pancreatic surgery, especially liver and pancreatic surgery.

To generate a deep learning model of computer vision , large annotated dataset is needed.

The aim of the study is to construct the large dataset in hepato-biliary-pancreatic surgery.

Moreover, we aimed to develop novel deep learning models of computer vision by using this dataset, and to examine the feasibility of the models.

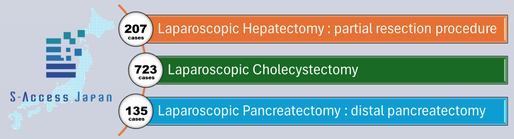
Methods

The dataset was constructed as a part of ''S-access Japan'', the project supported by the Japan Agency for Medical Research and Development (Grant Number 20he2102001h0002).

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S-Access Japan

The dataset contains 207 cases of laparoscopic hepatectomy (LH), 723 cases of laparoscopic cholecystectomy (LC), and 135 cases of laparoscopic pancreatectomy (LP) collected from 22 high volume center of laparoscopic surgery in Japan.

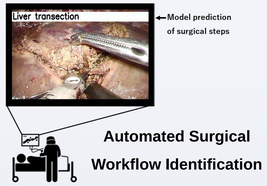


By using this dataset, we developed deep learning model of computer vision in laparoscopic hepatectomy and pancreatectomy.

Laparoscopic Hepatectomy

We developed the model of automated surgical workflow identification with 40 operative videos.

40 LH videos

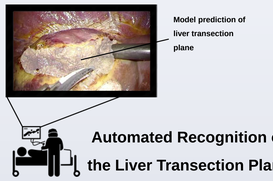


	model 1			model 2		
Step	Precision	Recall	F1 score	Precision	Recall	F1 score
1: Port insertion	0.819	0.745	0.780	not applicable		
2: Lysis of adhesion	0.905	0.959	0.921	0.905	0.959	0.921
3: Identification of the target lesion using laparoscopic ultrasound and marking the resection line	0.961	0.919	0.939	0.961	0.919	0.939
4: Encircling of the hepatoduodenal ligaments and hepatic inflow-occlusion	0.899	0.934	0.916	0.899	0.934	0.916
5: Mobilization of the liver	0.947	0.937	0.942	0.947	0.937	0.942
6: Liver transection	0.960	0.974	0.967	0.960	0.974	0.967
7: Specimen extraction and closing of the surgical incision	0.828	0.726	0.774	not applicable		
8: Other actions	0.564	0.596	0.579	not applicable		
IP: Invalid Procedure	not applicable			0.899	0.866	0.882
Overall accuracy	0.891			0.937		

$F_{1score} = 2 \cdot \frac{Precision \cdot Recall}{Precision + Recall}$

We developed the model of automated recognition of the liver transection plane with 20 operative videos.

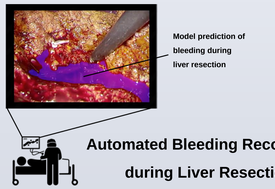
20 LH videos



Positive Predicted Value	0.89
Sensitivity	0.86
DC Score*	0.88

We developed the model of automated bleeding recognition during liver resection with 44 operative videos.

44 LH videos

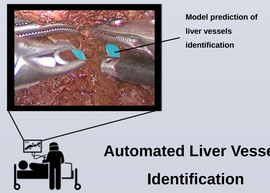


DC score* = 0.76

*DC Score: *(2 * Area of Overlap)/(total pixels combined)* =

We developed the model of automated liver vessels identification with 48 operative videos.

48 LH videos

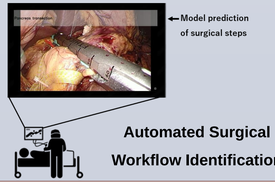


	DC*	
	Hepatic vein	Glissonean pedicle
1st validation	0.636	0.559
2nd validation	0.627	0.443
3rd validation	0.623	0.459
4th validation	0.646	0.520
5th validation	0.625	0.430
Average	0.631	0.482

Laparoscopic Pancreatectomy

We developed the model of automated surgical workflow identification with 40 operative videos.

40 LP videos



Step	Positive Predictive Value	Sensitivity	F1 score*
1 Ports insertion and Preparation	0.80	0.79	0.79
2 Opening omental bursa and Dissection to the left side	0.67	0.78	0.72
3 Supra-pancreatic lymph node dissection and Splenic artery division	0.81	0.79	0.80
4 Dissecting the inferior border and Tunneling of the pancreas	0.78	0.72	0.75
5 Pancreas transection	0.96	0.93	0.94
6 Splenic vein division	0.80	0.34	0.47
7 Dissecting the pancreas from the posterior abdominal wall	0.63	0.65	0.64
8 Specimen extraction and Drain insertion	0.74	0.77	0.75
Overall Accuracy: 0.75			

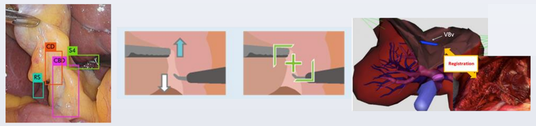
Results

Discussion

We constructed the large dataset and developed several deep learning models of computer vision in hepato-biliary-pancreatic surgery.

This dataset and models can be applied to generate further novel applications which contribute to the construction of computer-assisted-surgery systems as below.

- Automated surgical assisting system



- Automated surgical skill assessment



- Automated surgical robot and automated laparoscopic camera



Conclusion

We constructed the large dataset in hepato-biliary-pancreatic surgery. This dataset can be applied to generate further novel deep learning models of computer vision.

References

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