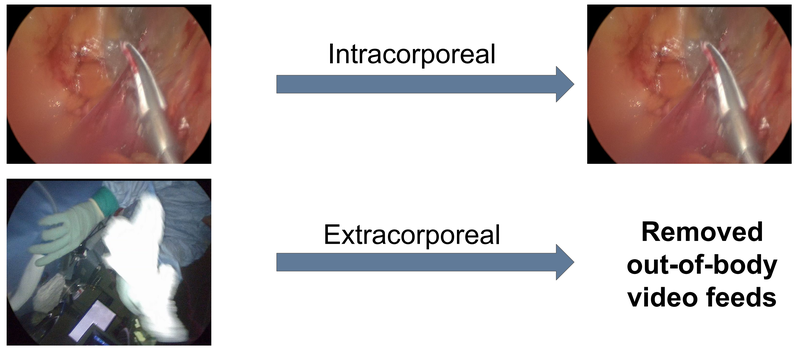
Protecting Privacy from Surgical Videos: Development and Validation of an Open-Source Artificial Intelligence-Based Pipeline for Automated Extraction of Extracorporeal Recording

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Introduction

- The rapid proliferation of surgical videos from a wide range of procedures has proven extremely beneficial for education, research and quality improvement.
- This raises significant privacy concerns. Elimination of all Protected Health Information (PHI) with anonymization of surgical data is imperative for future applications of surgical videos.
- One challenge includes systematically eliminating portions of video feeds that are out-of-body and that could potentially lead to unintended identification of both patients and providers.

We developed and validated an artificial intelligence (AI)-based pipeline for automated identification and removal of extracorporeal scenes in surgical videos.

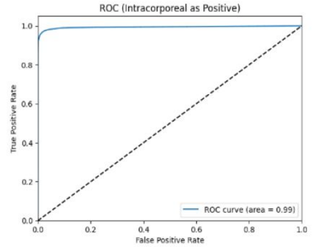


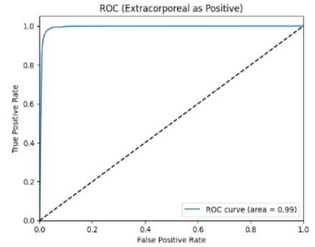
Methods and Procedure

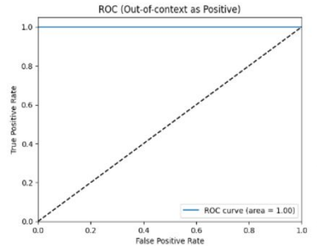
- An initial dataset of minimally-invasive procedures was used to train the AI model.
- Every frame of each surgical video was annotated according to the following classes:
  - extracorporeal,
  - intracorporeal (includes intra-trocar view) or
  - out-of-context (e.g. color bars).
- After initial testing, the model was validated against a larger and more diverse multicenter dataset of surgical videos.
- The final data pipeline includes the AI algorithm that runs inference on each individual frame and subsequently applies a script that either extracts or blurs the frames that are classified as extracorporeal.

Results

- A total of 10,008 frames from 9 right laparoscopic and retroperitoneoscopic adrenalectomy videos (total 9:00 hours footage) were used to train a model based on the EfficientNetV2 architecture
- Initial testing included a Dice score of **0.96** for the extracorporeal class and **0.99** for the intracorporeal class.







	Precision	Recall	Dice (F1-score)
Intracorporeal	0.92	0.99	0.95
Extracorporeal	0.99	0.93	0.96
Out-of-context	0.81	1	0.89

		Actual		
		Intracorporeal	Extracorporeal	Out-of-context
Predicted	Intracorporeal	27891	414	10
	Extracorporeal	2371	34376	186
	Out-of-context	0	0	835

- The validation dataset consisted of 30 laparoscopic videos of inguinal hernia repair, cholecystectomy, colectomy, distal pancreatectomy, and gastrectomy (distal and total), obtained from 20 different institutions. Weighted Dice coefficient on the validation dataset was **0.955** and weighted One-vs-One ROC AUC was **99.58%**

Conclusion

- Our pipeline successfully preserves patient and provider privacy, while preserving the innate value of surgical data.
- The AI model generalizes very well to a variety of endoscopic surgeries, despite only having been trained on adrenalectomies.