

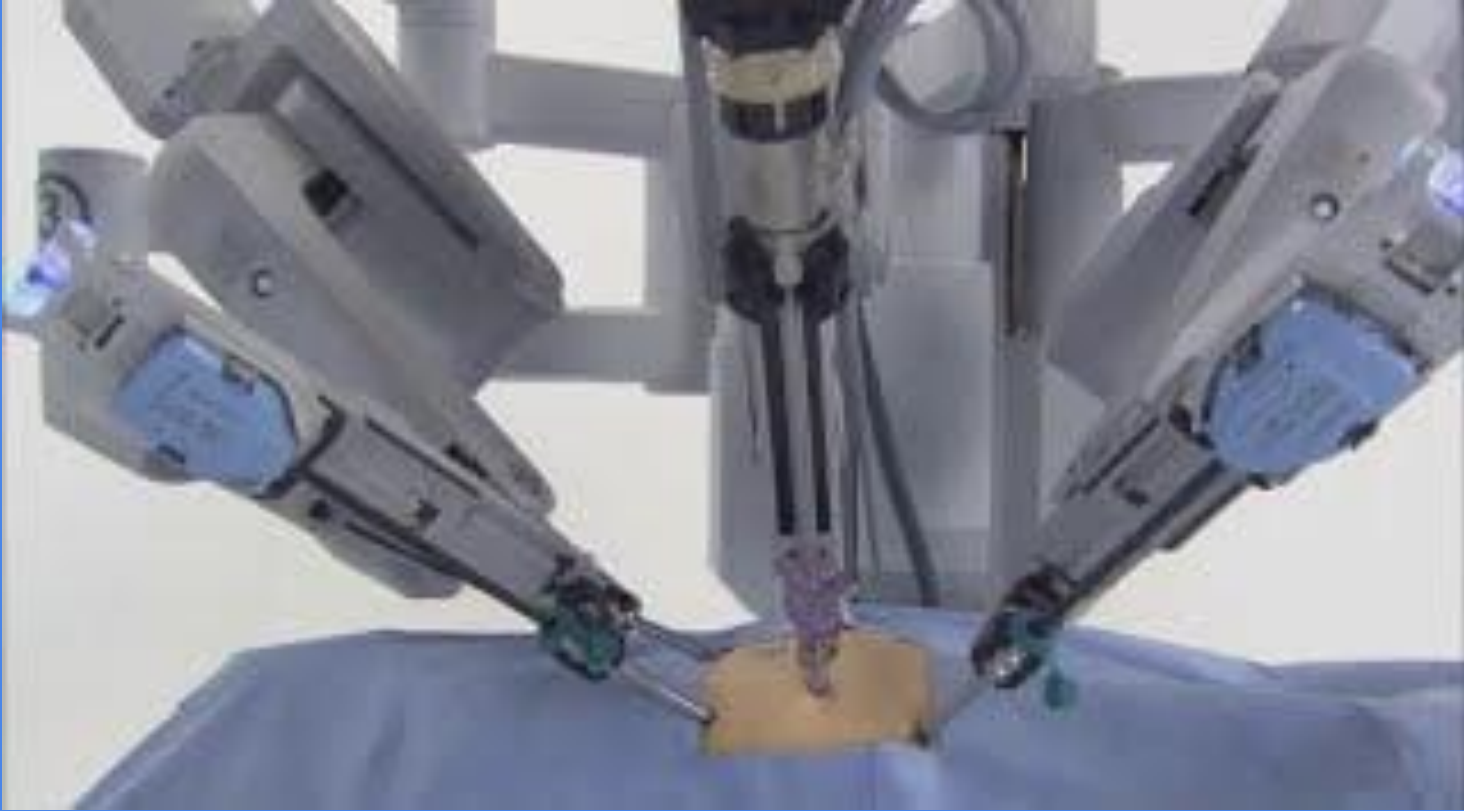


Enhancing Surgical Education: The Role of AI Instructor in Robotic Surgery Training

Team

Kishlay Kumar
Pratyay Prakhar
Syed Abdul Khader
Vanshu Saini

Robotic Surgery in Action



Challenge



Doctor's Presence



Auto Evaluation



Hypothesis

The reliance on doctors' intervention during student's training can be eliminated while maintaining a high level of accuracy in artery identification.



Validated by a group of 4 esteemed doctors from



Problem



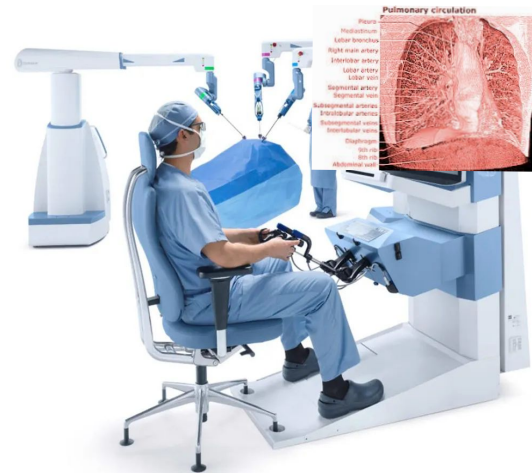
Presence of Doctor required for training residents during simulated operations

Proposed Solution

Intelligent software system to accurately detect and identify arteries in real-time, enhancing surgical safety and training efficacy



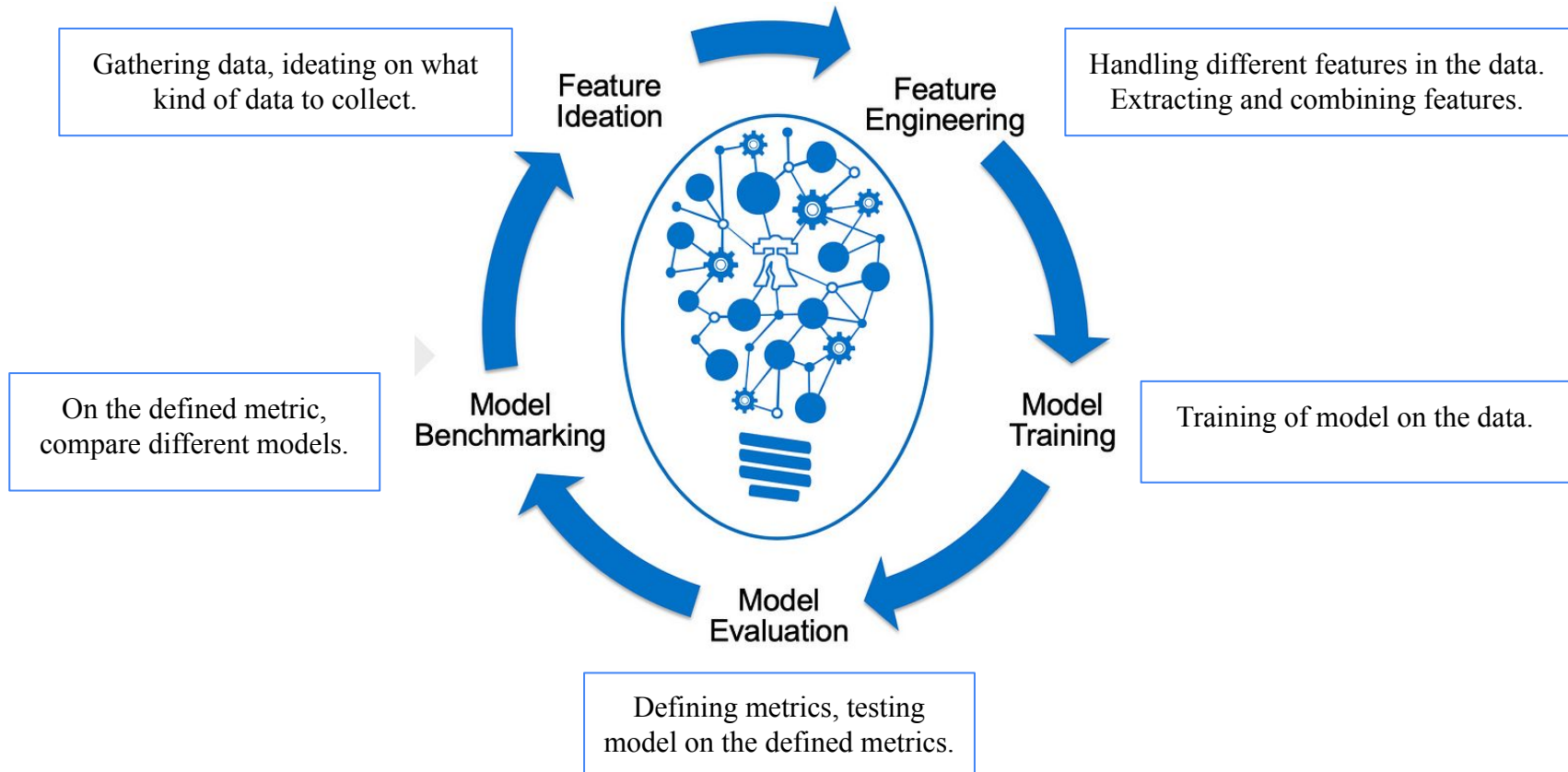
SCOPE
Thoracic Surgery
&
Educational
Purpose





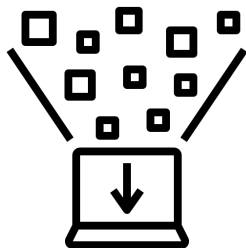
APPROACH

AGILE ML CYCLE



Step 1: Data Collection & Annotation

Data Collection



- There are no surgical video datasets labelled with anatomy like arteries and veins.
- We have data from twelve patients collected from the Thoracic Left Lower Lobe surgery.

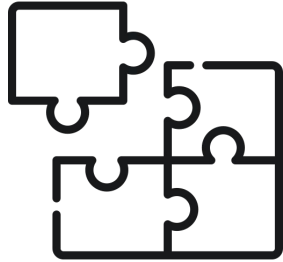
Data Annotation

- Training data can be initially annotated using medical students' expertise.
- The entire video spans 1 hour 30 minutes, snippets for 1-5 minutes were taken from the video, where the arteries are exposed, and each frame was annotated.



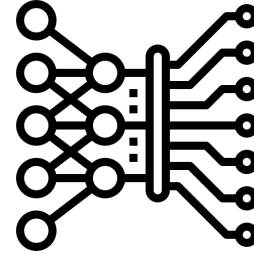
Step 2: Exploration and Research

Feature Extraction



- SIFT detector was used to extract interesting features from each frame and match them along the frames to track and segment the artery.
- This can be used as a baseline.

Model Training



- Off the shelf Mask-RCNN model was used to train for each frame on 80% of the data and remaining 20% for testing and validation.
- Using pre-trained backbone (ResNet50) with ImageNet weights, can give better results compared to training from scratch.

Step 3: Evaluation and Benchmarking

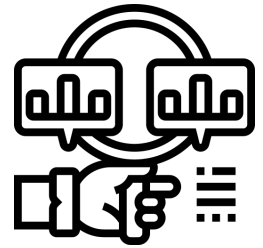
Model Evaluation



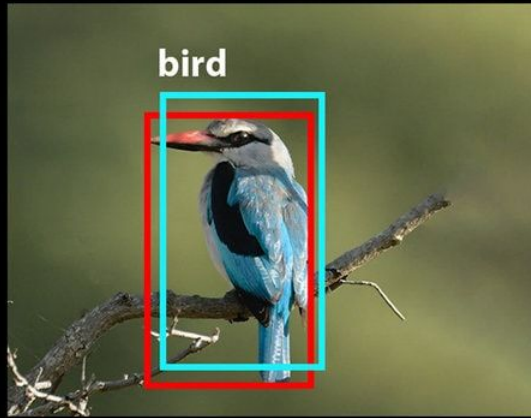
- To evaluate the model, Intersection over Union (IoU) metric can be used for both Object Detection and Segmentation.
- Generalizability over different patients and over different operation types can also be measured through IoU.

Model Benchmarking

- After initial training, different hyper parameter tuning and heavy data augmentations was performed to improve the performance
- Another model, X-Mem which is capable of remembering the past frames in memory helping in better tracking performance was used.

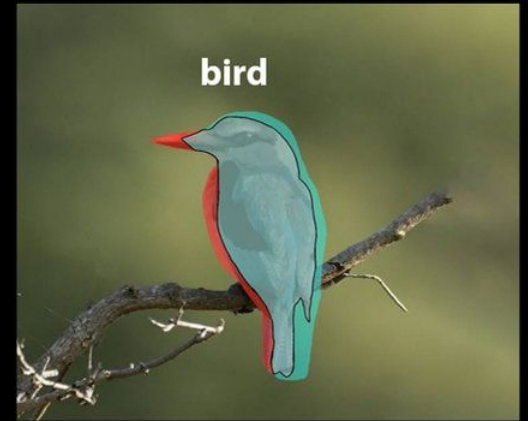


WHY IOU

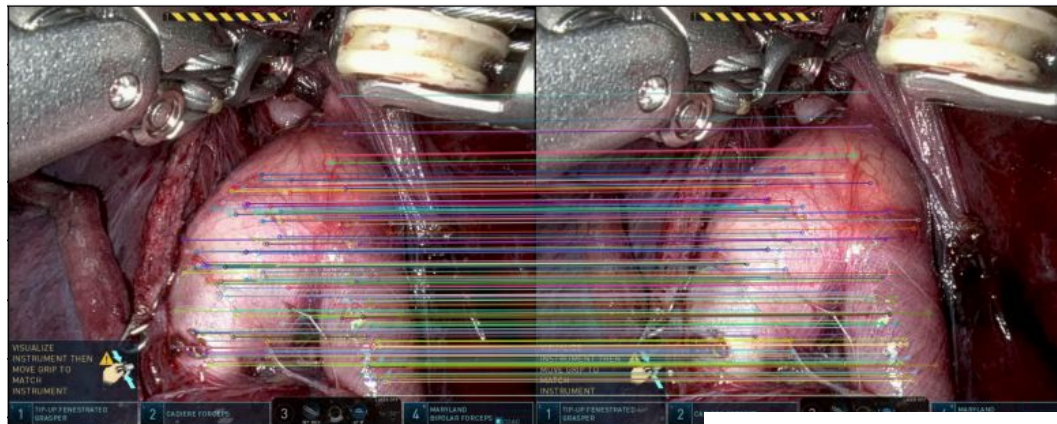


IoU

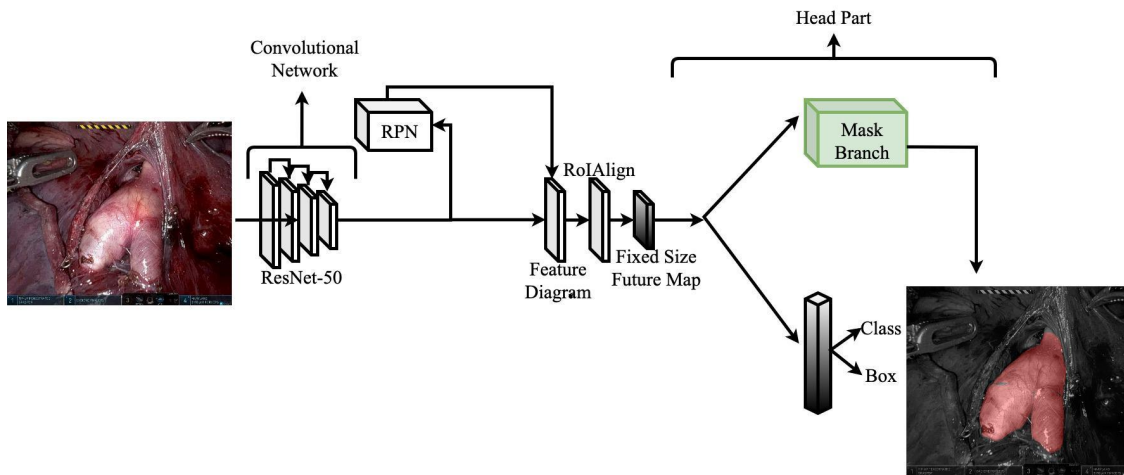
$$= \frac{\text{Area of Overlap}}{\text{Area of Union}}$$

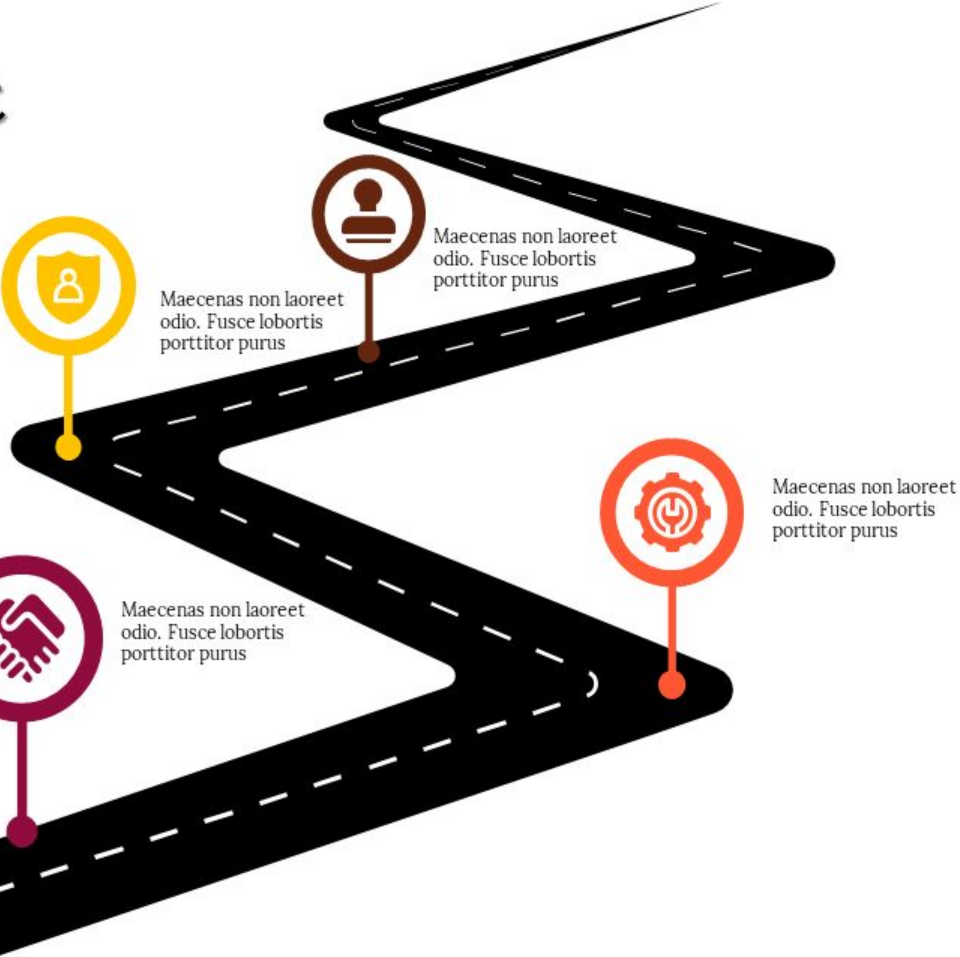


MODEL DETAILS



Mask RCNN Architecture





PRODUCT ROADMAP

SCRUM FRAMEWORK



Extremely agile 2 week-long sprint



Sprint Planning

Work to be accomplished in the upcoming sprint

Every second wednesday



Daily Standup

Updates on their progress, discuss any impediments

Everyday



Sprint Retrospective

Reflect on the recent sprint, identifies what went well and areas for improvement

Every second Thursday



Sprint Review

Showcase the completed work to stakeholders, gather feedback

Every second Tuesday

Tools



Jira



Confluence

SAMPLE USER STORY

Outcome Focused

Projects / TEST-POC / Add epic / TP-5

Efficient Artery Annotation and Correction Tool for Enhanced Productivity and Accuracy

Attach Add a child issue Link issue ...

User Empathy

Description

Normal text B I ... A ...

User Story: As an annotator, I want an application that allows me to review and correct the boxes and labels for arteries, so that my time is saved by automating the majority of the process and requiring manual intervention only when errors or inaccuracies occur.

- Steps:**
- Develop the front end application with the option to view the images and correct the boxes or label names
 - Develop an end to end pipeline to store the image feed in the google cloud storage bucket for efficient retrieval during the review process

Acceptance Criteria

Definition of Done: We will know we have succeeded when the UI and the backend parts of the application are ready for deployment and testing.

🔒 👁 1 👍 🔗 ...

To Do Actions

Details

Assignee: Unassigned
[Assign to me](#)

Labels: [#research](#)

Sprint: [TP Sprint 1](#)

Story point estimate: **2** ————— **Estimated using Plan IT Poker**

Reporter: Pratyay Prakhari

Created 14 minutes ago Updated 14 minutes ago Configure

MANAGING SPRINTS

Projects / TEST-POC

AD Sprint 5

Finetune the model for better performance

   0 days remaining

[Complete sprint](#)



Label 

GROUP BY

None 

 Insights

TO DO 1 ISSUE

Efficient Artery Annotation and Correction Tool for Enhanced Productivity and Accuracy



#research


 TP-5 2 

IN PROGRESS 1 ISSUE

Finetune the model for improved accuracy




#dev

 TP-6 

DONE 1 ISSUE 

Test the model performance against the test cases for quality assurance

#qa

 TP-7  



Backlog refinement to capture all the requirements and suggestions

▼ Backlog (3 issues)

1  

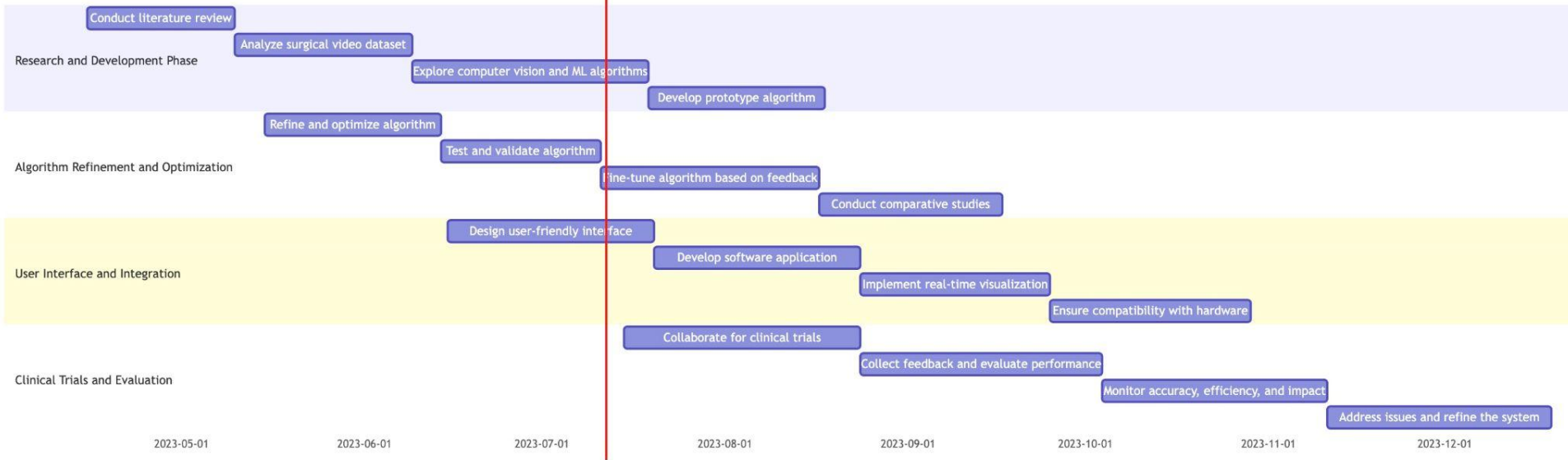
[Create sprint](#)

 TP-3	1.02 Take updates from the team regarding the PoC design work	 - TO DO 
 TP-2	1.01 Start the onboarding process for User 2	1 TO DO 
 TP-1	1.01 Start the onboarding process for User 1	TO DO 

+ [Create issue](#)

PRODUCT ROADMAP

Intelligent Artery Detection System Project





MVP

VIDEO DEMONSTRATION

Red Overlay

Wrong Predicted Part

Green Overlay

Correct prediction

(Prediction == Ground
Truth)

Blue Overlay

Ground Truth

(not predicted by model)

A hand is holding a white ruler vertically next to a stack of seven wooden blocks. The blocks are stacked vertically and spell out the word 'SUCCESS' from top to bottom. The background is a light blue gradient.

S
U
C
C
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S

MEASURING
SUCCESS

PRODUCT METRICS



- **Diagnosis Accuracy**, how accurately can the model predict and how well it aligns with expert doctors.
- **Adoption Rate**, among the doctors and medical institutions.

BUSINESS METRICS



- **Time saved by doctors**, which would be spent in training surgeons residents.
- **Change in Learning Experience**, the change in experience of students due to availability of constant supervision via automation.



VALUE PROPOSITION

Our software empowers doctors with accurate artery detection during robotic thoracic surgeries, reducing complications, improving surgical efficiency, and enhancing training outcomes.



PERFORMANCE INDICATORS

Measure the accuracy of the trained model in correctly detecting arteries in the operation videos.
Assess the model's ability to generalize across different patients and operation types.
Measure the efficiency of the model during inference in real-time



ORGANIZATION

Mass General Hospital



DATA & TECHNOLOGY

Data – Annotated surgical data from twelve patients collected from the Thoracic Left Lower Lobe surgery.

Technologies – RCNN, SIFT, X-Mem



OPERATIONAL IMPLICATIONS

Improved surgical precision and reduced risk of complications
Streamlined Training Process and Standardized instruction for artery identification
Increased Efficiency in Surgical Workflow



AI LIFE CYCLE

1. Problem Definition
2. Data Collection and Annotation
3. Data Preprocessing and Exploration
4. Model Development and Training
5. Model Evaluation and Validation
6. Model Deployment and Integration
7. Monitoring and Iteration



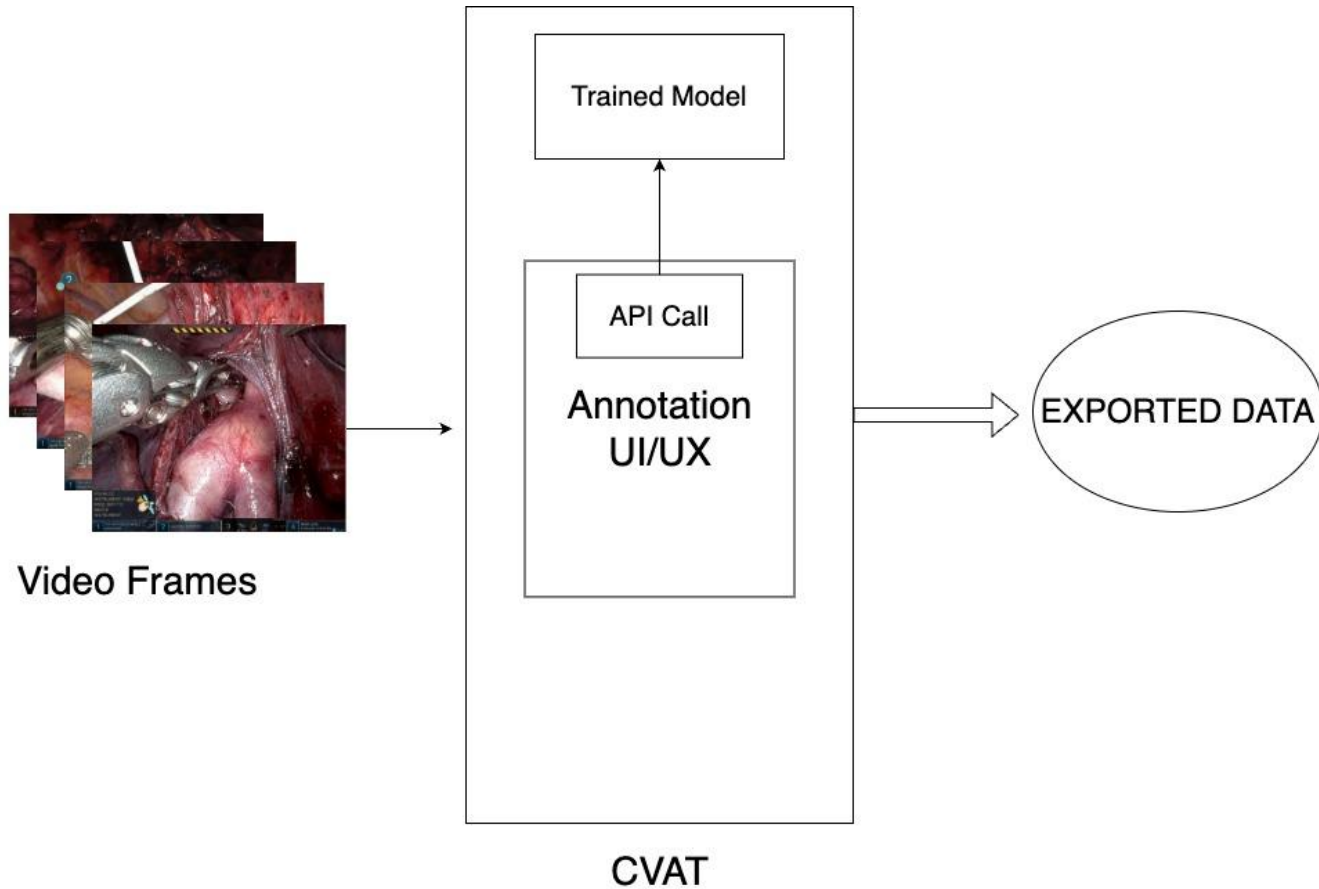
CURRENT AND FUTURE WORK

CURRENT RESULTS

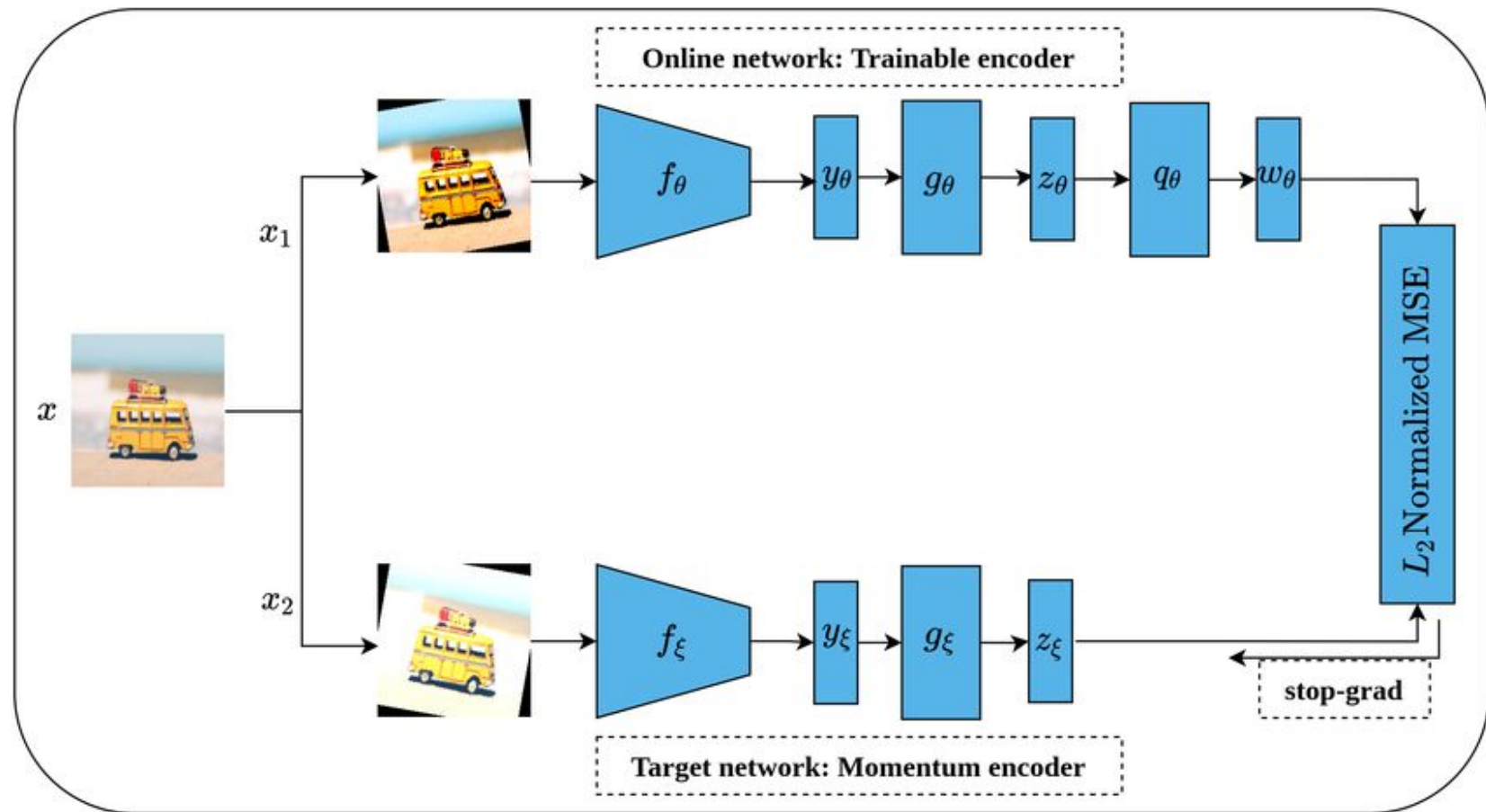
Model	Average IoU over all Patients
SIFT Tracking	7.1%
Mask-RCNN (Only 4 Patients Data)	22.6%
Mask-RCNN (without Data Augmentation)	43.01%
Mask-RCNN (with Data Augmentation)	66.59%
Pre-Trained X-Mem	66.31%
X-Mem (trained on our Data)	71%*

** Prospective Results - Final Results yet to be confirmed*

ONGOING AND FUTURE WORK



ONGOING AND FUTURE WORK



THANK YOU

