VIP Capstone Project Pitch :

Deep Retinal Surgery Segmentation with Epiretinal Membrane Detection

Team and Mentorship

Faculty Mentor: Prof. Eungjoo Lee, University of Arizona
Clinical Mentor: Dr. Felipe Carrasco, University of Arizona
Student Researchers: VSI Lab group including Saurav Verma and two collaborating graduate students.

Motivation and Problem Statement

Epiretinal membrane (ERM) surgery demands precise handling of instruments and careful distinction of retinal layers. Deep-learning–based segmentation of both surgical tools and retinal structures can help quantify surgical videos, support phase recognition, and assist in predicting surgical outcomes.

Objectives

- Curate a high-quality dataset from retinal surgery videos, extracting and pre-processing frames.
- Annotate surgical instruments and epiretinal membranes using pixel-level masks.
- Develop and train deep-learning segmentation models (e.g., U-Net, MedSam) on the curated dataset.
- Evaluate model accuracy and explore clinical utility of the segmentation results, ensuring reproducibility through shared code and data.

Proposed Approach and Methodology

- Data Preparation: Extract frames at a clinically and computationally appropriate rate (e.g., 2 fps), removing duplicates and blur to optimize dataset quality; crop to remove non-retinal regions and black borders using automated scripts.
- Annotation: Use Supervisely to annotate surgical instruments and epiretinal membranes with high-fidelity masks and record surgical phase tags.
- Model Development: Train deep-learning models for multi-class and binary segmentation, incorporating on-the-fly data augmentation (flip, rotate, brightness/contrast).
- Evaluation: Perform train/validation/test splits to measure Dice and IoU metrics and ensure clinical relevance.
- Collaboration: Store all curated data and code in a shared Google Drive and GitHub repository for reproducibility and team collaboration.

Expected Outcomes and Impact

- A high-quality annotated retinal surgery dataset.
- A reproducible preprocessing and training pipeline.
- Deep-learning segmentation models capable of accurate surgical tool and membrane detection.
- These resources will support future clinical decision-support systems, surgical training, and further machine-learning research.

Resources and Support

This project will use GPU-enabled computing resources, Python-based deep learning frameworks (e.g., PyTorch), and Supervisely for annotation. The team will collaborate closely with Prof. Eungjoo Lee and draw on the clinical expertise of Dr. Felipe Carrasco to guide labeling standards and evaluate results.

Approval and Sign-off : Email attachment dated Sep 27, 2025.

Prof. Eungjoo Lee, University of Arizona

Saturday, September 27, 2025 at 7:45:46 PM Mountain Standard Time

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Subject: Re: Request: Email approval for Capstone Project Pitch for D2L Submission (Deadline Oct 1)
Date: Saturday, 27 September 2025 at 18:21:20 Mountain Standard Time
From: Lee, Eungjoo - (eungjoolee)
To: Verma, Saurav - (sauravverma)

Hi Saurav,

The proposal looks good to me.

Best,
Eungjoo

From: Verma, Saurav - (sauravverma) <sauravverma@arizona.edu>
Sent: Saturday, September 27, 2025 8:24:05 PM
To: Lee, Eungjoo - (eungjoolee) <eungjoolee@arizona.edu>
Subject: Request: Email approval for Capstone Project Pitch for D2L Submission (Deadline Oct 1)

Hello Professor Lee,

Following the VIP – capstone project allowance for a shorter submission, I have attached my one-page capstone pitch: *Capstone Project Pitch – Deep Retinal Surgery Segmentation with ERM Detection*.

To meet the **October 1st D2L deadline**, I require your formal approval.

Could you please reply to this email with a brief confirmation (e.g., "I approve this capstone pitch")?

I will then combine your reply with the pitch into a single PDF for the D2L submission.

Many thanks & Regards,
Saurav