# ASSESSMENT OF INTRAOPERATIVE OCT IN A SIMULATED MICROSURGICAL TASK

ANDREA CORREDOR & AMRITA GUPTA
MENTOR: MARCIN BALICKI

## THE PROBLEM

Retinal disease, among them epiretinal membranes (ERMs) formation, is a leading cause of blindness. Surgical removal of ERMs is confounded by

- small size
- transparency
- sparse location

Intra-operative OCT imaging can

- greatly facilitate ERM localization
- provide up-to-date information during surgery

Incorporation of OCT imaging with an assistive robot can address issues like accuracy, hand tremor and safety.
This project addresses the need for:

- a quantitative assessment of surgical performance improvements achieved with the intraoperative OCT imaging system
- conversion of depth vs time Mscans to more useful depth vs space images

## THE SOLUTION

In order to test the efficacy of the OCT imaging system we designed a subject experiment that would directly compare performance on the same task with and without the aid of the system, while resembling most closely a real surgical scenario.
This required us to:

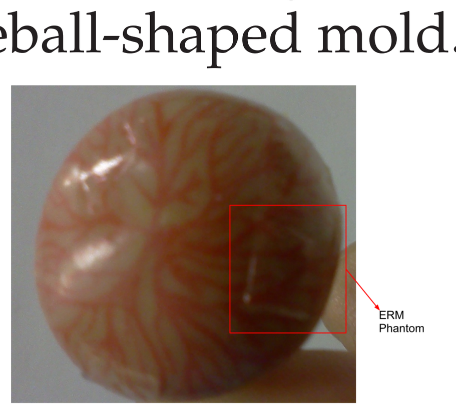
- obtain IRB approval
- develop a retina and ERM phantom that would mimic a real ERM in its small dimension and difficulty in visualization

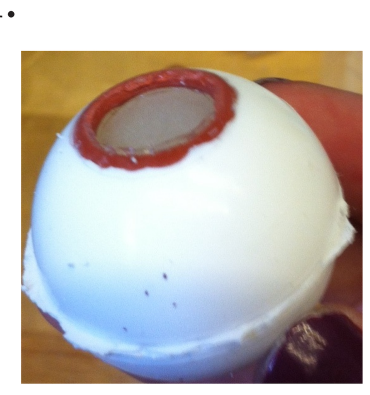
To address the time-space distortions inherent to the OCT Mscan we wrote two scripts based on two methods:

- similarity coefficient
- time-interval scaling

## THE PHANTOM

- Retina: $\sim 9$ layers of latex paint on which vessels and a macula are drawn.
- ERMs: thin layers of household adhesive sealant (silicone) applied with a razor.
- Eye: hardening silicone mix made using eyeball-shaped mold.



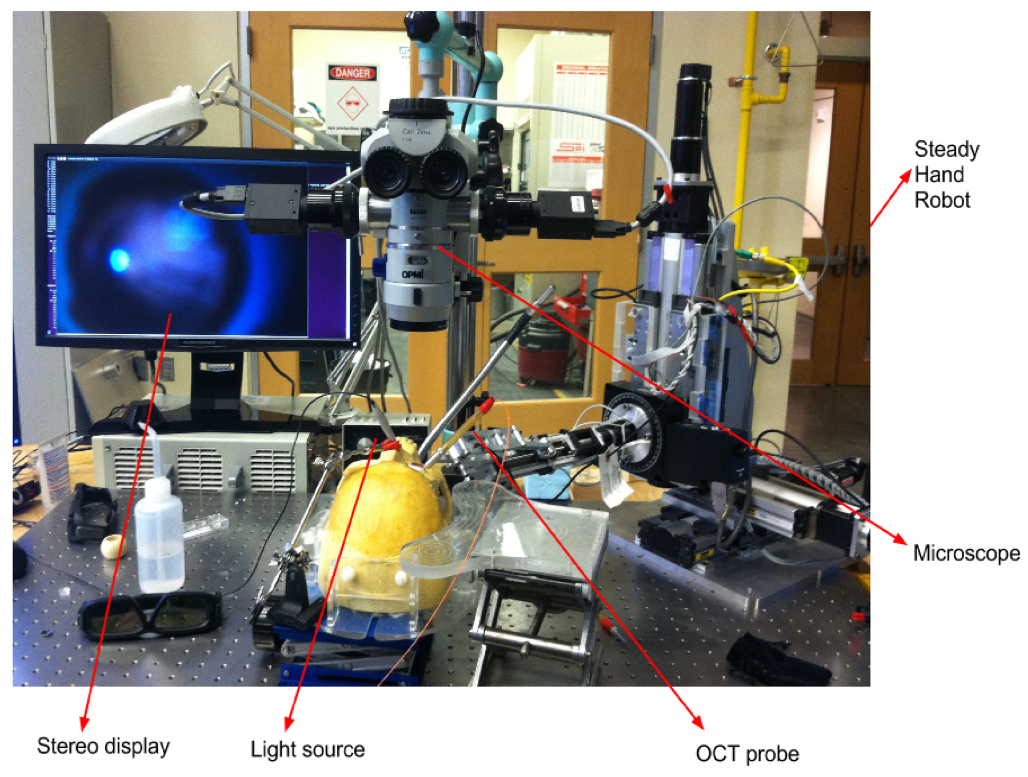
## REFERENCES

[1] I. Fleming, S. Voros, B. Vagvolgyi, Z. Pezzementi. J. Handa, R. Taylro, G. Hager. GraphTrack: Intraoperative Visualization of Anatomical Targets in Retinal Surgery In *CVPR '11*

[2] M. Balicki, J. Han, I. Iordachita, P. Gelbach, J. Handa, J. Kang, R. Taylor. Single Fiber Optical Coherence Tomography Microsurgical Instruments for Computer and Robot-Assisted Retinal Surgery.

## EXPERIMENTAL DESIGN

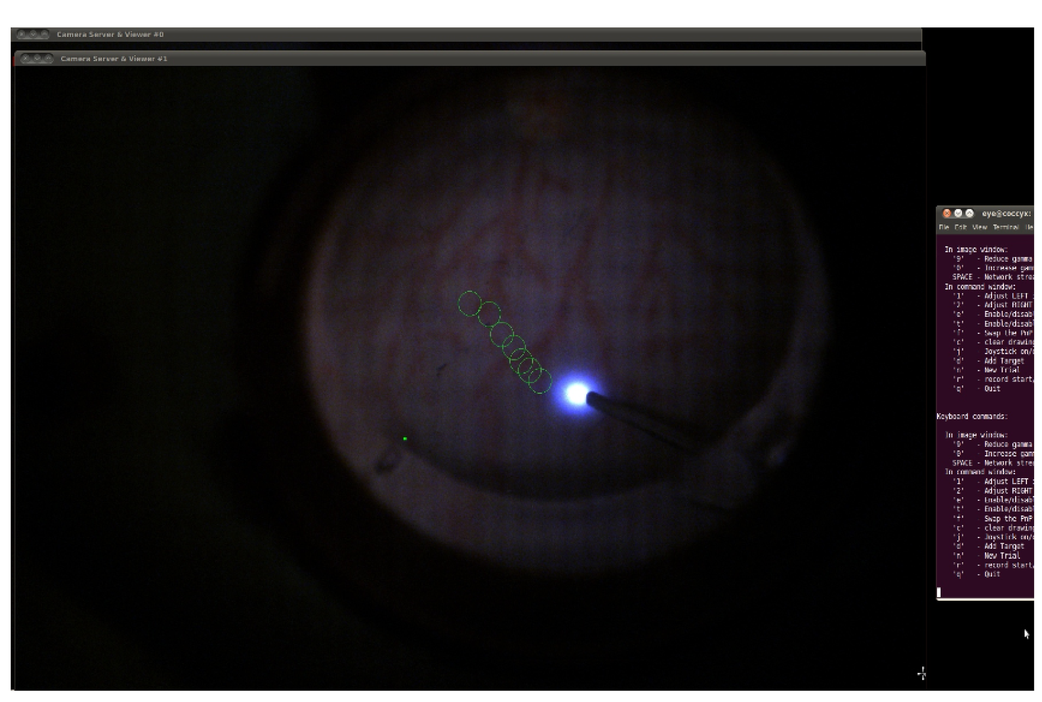
The experimental set-up is the following



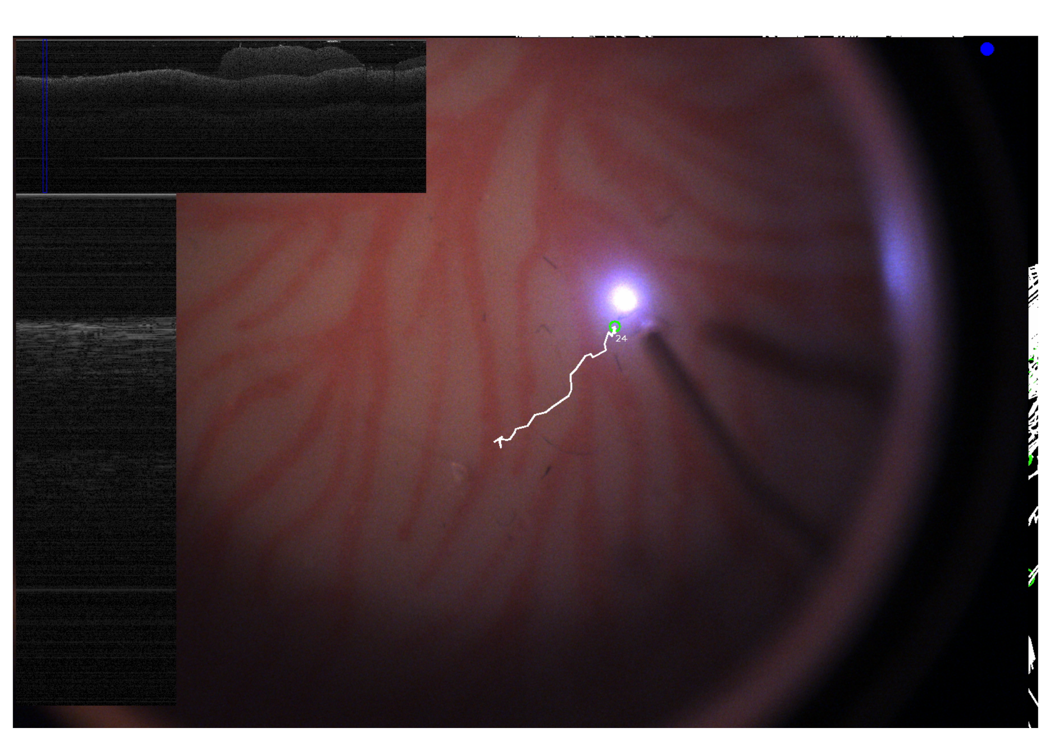

The experiment consists of two segments, preceded by a demo and practice:

- Unassisted (control): locate ERM edge by closely inspecting microscope/stereo image.
- Intraoperative OCT imaging assisted: additional overlays display data from the OCT probe, scan path, ability to select landmark in OCT image and have it highlighted in scan path.

There are 3-5 phantoms per segment, and 2-5 mins per phantom to demarcate as much of the ERM edge as possible, using at least 5 points. When an edge is found a circle is drawn around it, inside which no more points can be selected. For both segments pre-operative OCT images are available.



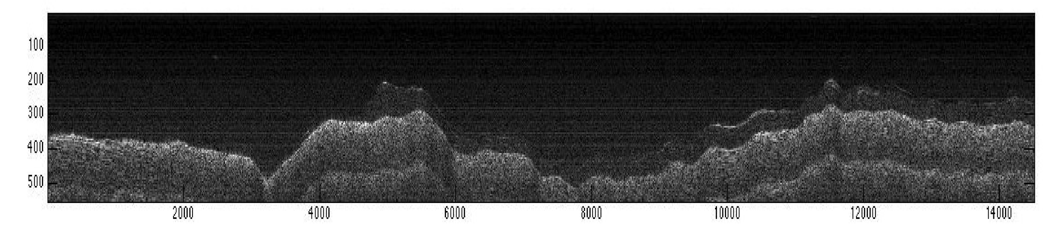
For each point the shortest distance to the true location of the membrane edge is computed. To obtain the true location of ERMs the EyeRobot is scans area containing membrane to obtain 3D image of tissue.



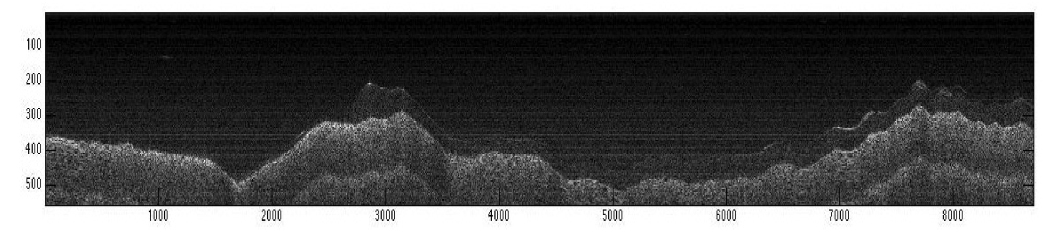
The 2D projection of this image is registered with the image containing subject guesses. The absolute shortest distance is then the numerical quantifier that allows us to gauge the extent to which the system facilitates ERM localization.

## OCT IMAGE CORRECTION

- Correlation-coefficient algorithm: spatially adjacent A-scans are highly similar and probably redundant. Only scans that are sufficiently distinct from the reference are collected to image. Works better with real tissue.

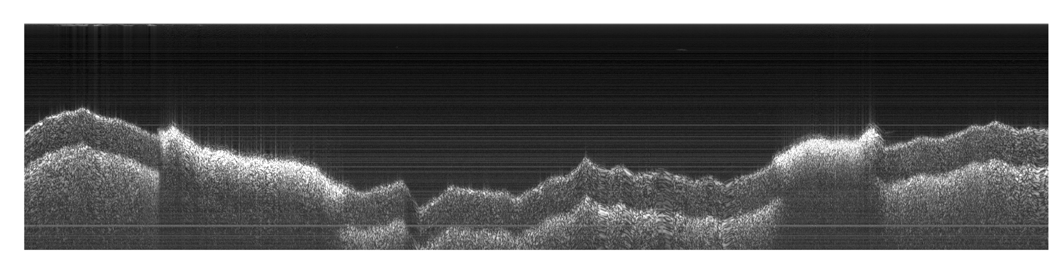


Original

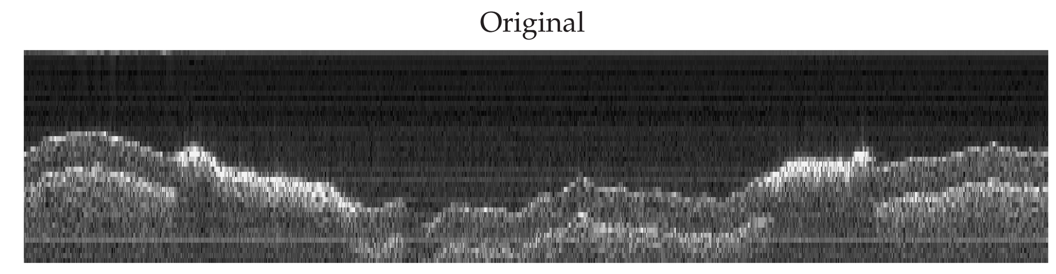


Threshold 0.9

- Distance-scaling algorithm: based on premise that width of a section of image should be proportional to distance travelled by the probe in that section. Follows these steps:
  - Divide OCT scan path into segments.
  - For each segment compute segment:path length ratio
  - Scale A-scan history corresponding to this segment by the computed ratio



Original



Corrected

## FUTURE WORK

- Carry out all 25 subject experiments, gather all resulting data.
- Statistically analyze the data.
- Improve GUI.
- Implement color enhancements to OCT image.

The statistical analysis should explore two sets of hypothesis, one for accuracy and one for time:
$H_o$: The imaging system does not improve accuracy, $\mu_{assisted} = \mu_{unassisted}$
$H_A$: The imaging system does improve accuracy, $\mu_{assisted} > \mu_{unassisted}$

$H_o$: The imaging system does not improve find time, $\mu_{Tassisted} = \mu_{Tunassisted}$
$H_A$: The imaging system does improve find time, $\mu_{Tassisted} > \mu_{Tunassisted}$

## ACKNOWLEDGEMENTS

- Many, *many* thanks to Marcin for his kind help with *everything*.
- Thanks to Dr. Taylor and Elisa for their help and guidance with the IRB.