Assessment of Intraoperative OCT Imaging in a Simulated Micro-surgical Task

Checkpoint Presentation

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Project Background

Main Goals:

- Assess efficacy of intraoperative OCT for locating epiretinal membranes
  - Design an experimental task
  - Develop a phantom
  - Obtain IRB approval
  - Conduct study and analyze data
- Improve the user interface/GUI
- Implement smart OCT processing & color enhancements

Update on Milestones

- Design of micro-surgical task to simulate ERM detection (3/12/12 -> 3/21/12)
- Working phantom (3/12/12 -> 4/1/12)

IRB approval (3/19/12 -> 4/4/12)

- Advertisement and incentive for subject recruitment (3/19/12->)
- Completion subject trials (4/16/12->4/25/12)
- Statistical analysis of data from subject trials (4/16/12->4/25/12)
- Time-space correction (4/9/12->4/16/12)
- Color enhancement (4/9/12->4/30/12)
- ~~Annotation of anatomical landmark~~
- GUI improvement (4/9/12->4/30/12)

Deliverables: revised

Old

Minimum

- Phantom
- IRB approval
- Subject experiment
- Refined mScan user interface

Expected

- Functional demo of GUI
- Results from executed experiments
- Statistical analysis of results
- OCT image enhancement

Maximum

- Automatic scanning
- Time-space differences correction
- Publication
- Robot integration

New

Minimum

- Phantom
- IRB approval
- Subject experiment
- Robot integration

Expected

- Results from executed experiments
- Statistical analysis of results
- OCT image enhancement
- Time-space differences correction

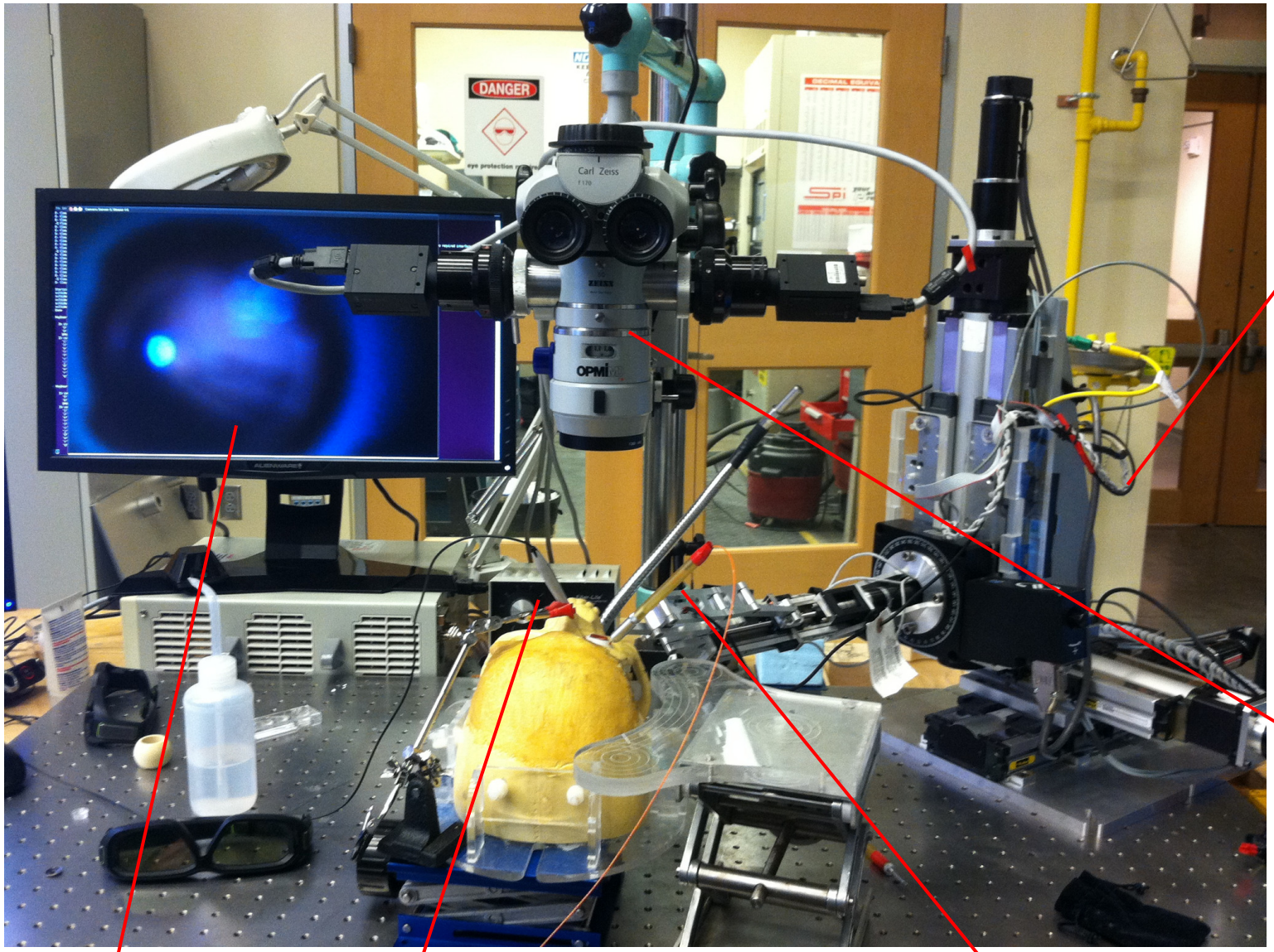
Maximum

- ~~Automatic scanning~~
- ~~Publication~~ (Paper -> Report)
- Refined mScan user interface
- Functional demo of GUI

Experimental Task

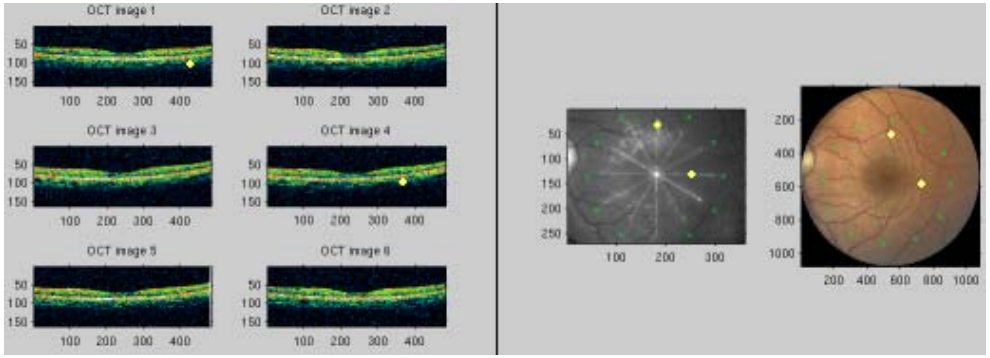
Experimental set-up:

- An eye phantom mounted on an adjustable platform
- Two probes inserted into phantom via trocars—one for the light source and one for the pipette/probe tool—held either freehand or with a steady hand robot
- Visualization through microscope or 3D stereo display


DANGER
Carl Zeiss
OPMI
Steady
Hand
Robot
Microscope
Stereo display
Light source
OCT probe

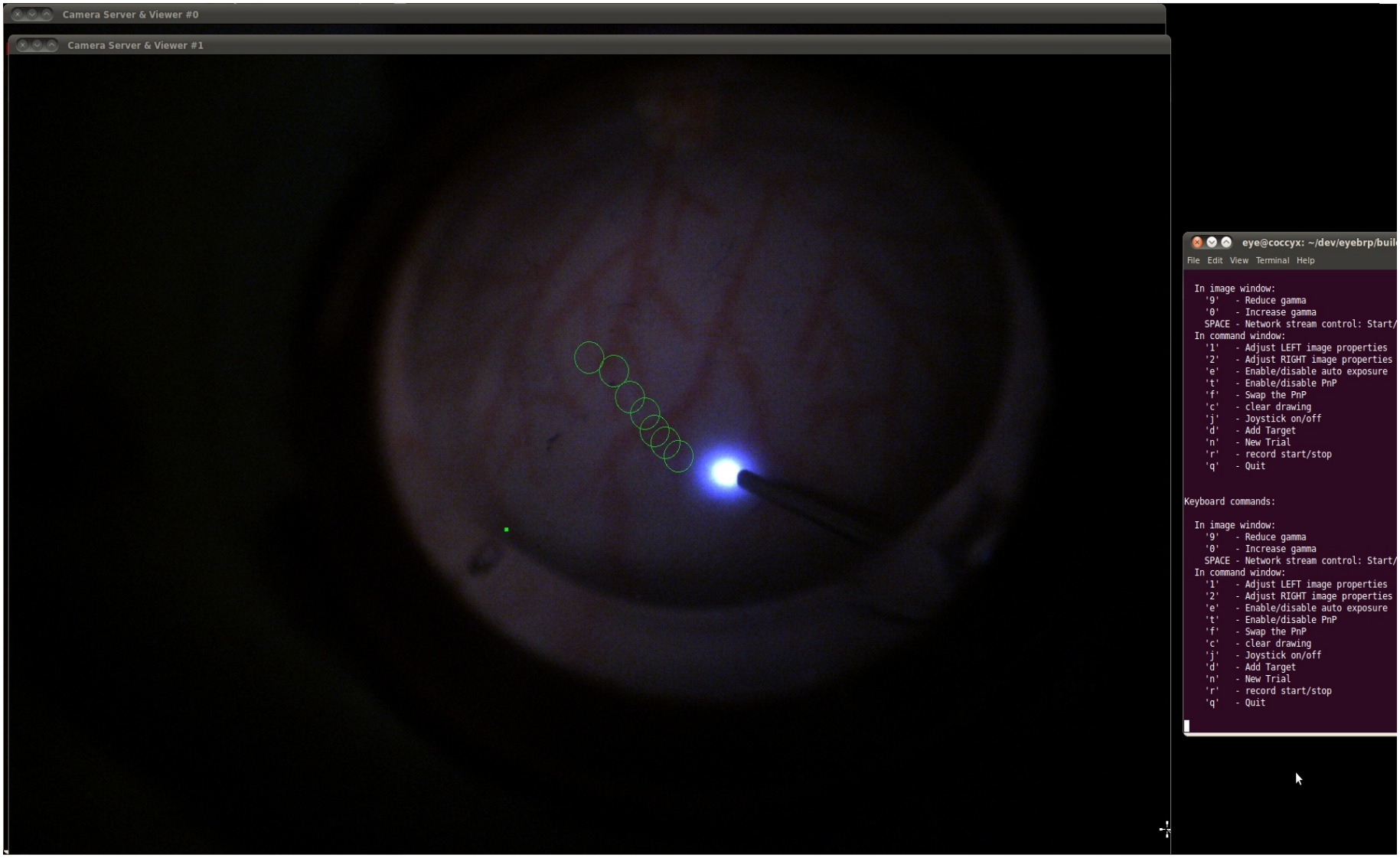
Experimental task

- Two segments: intraoperative OCT imaging assisted vs unassisted (control), preceded by demo and practice
- Segment order alternated between subjects to account for learning curve
- 3 to 5 phantoms per segment depending on time constraints
- Provide pre-operative OCT images in a radial pattern along with 'fundus' image indicating location of each scan



Experimental task

- Unassisted segment: locate ERM edge by closely inspecting microscope/stereo image
- Assisted segment: additional overlays display data from the OCT probe, scan path, ability to select landmark in OCT image and have it highlighted in scan path
- 2 to 5 mins per phantom to demarcate as much of the ERM edge as possible, using at least 5 points
- When edge is found a circle will be drawn around it, inside which no more points can be selected



microSurgical workstation

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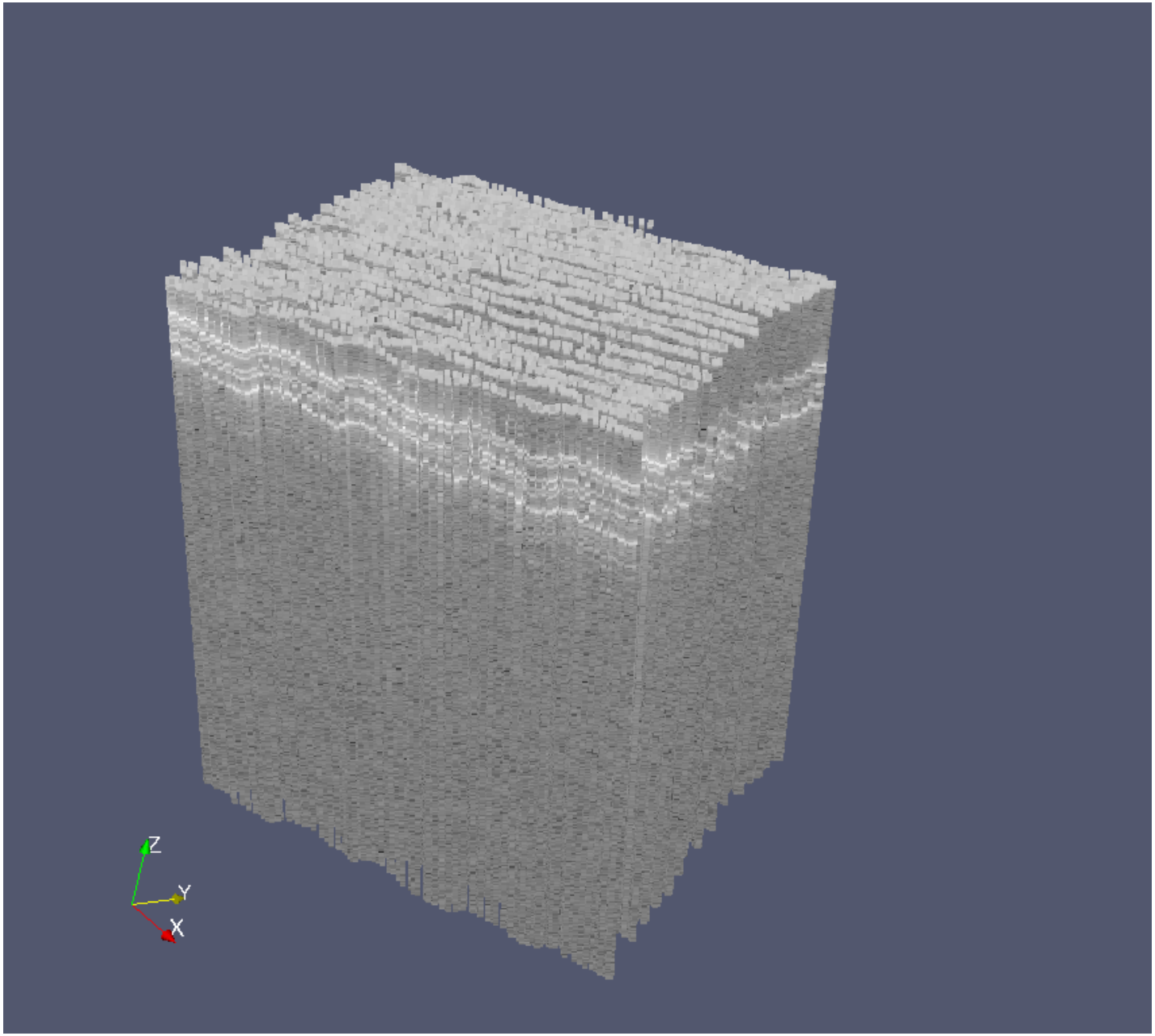
Experimental task

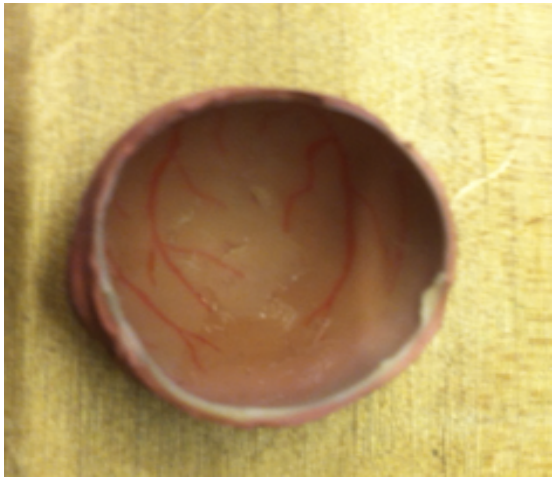
- For each point selected the shortest distance to the true location of the membrane edge will be computed
- True location of membrane:
  - Robot programmed to scan area containing membrane
  - Obtain 3D image of tissue
  - Project to obtain 2D image
  - Register with image containing subject guesses using anatomical landmarks



Marcin Balicki

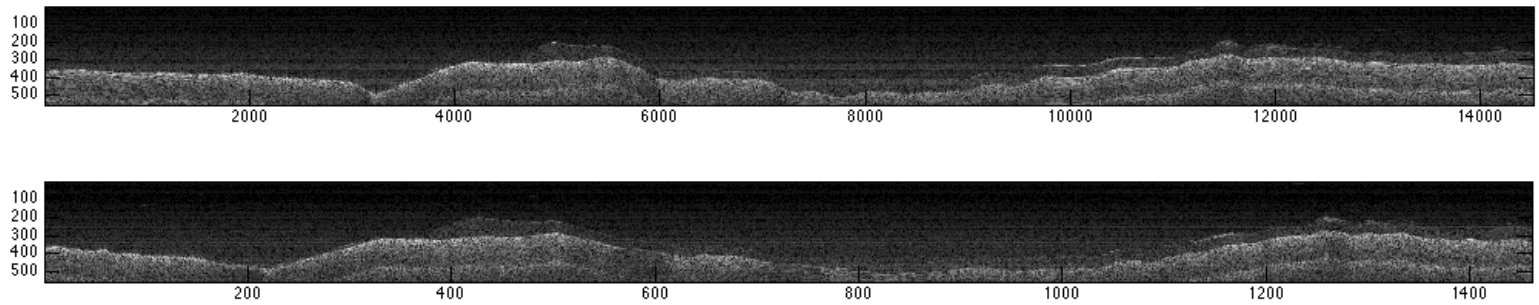
Phantom

- Plenty of failed attempts...
- Retina: ~25 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: recipe courtesy of Kevin Olds



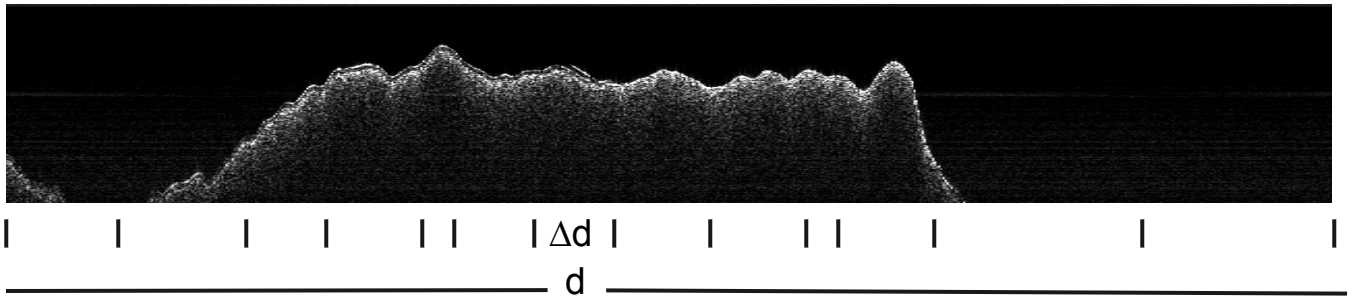
Time-space correction

- Correlation-coefficient algorithm
  - Premise: spatially adjacent A-scans will be highly similar and probably redundant
    i. Successive A-scans are compared to the latest reference
    ii. Only scans that are sufficiently distinct from the reference are collected to the image

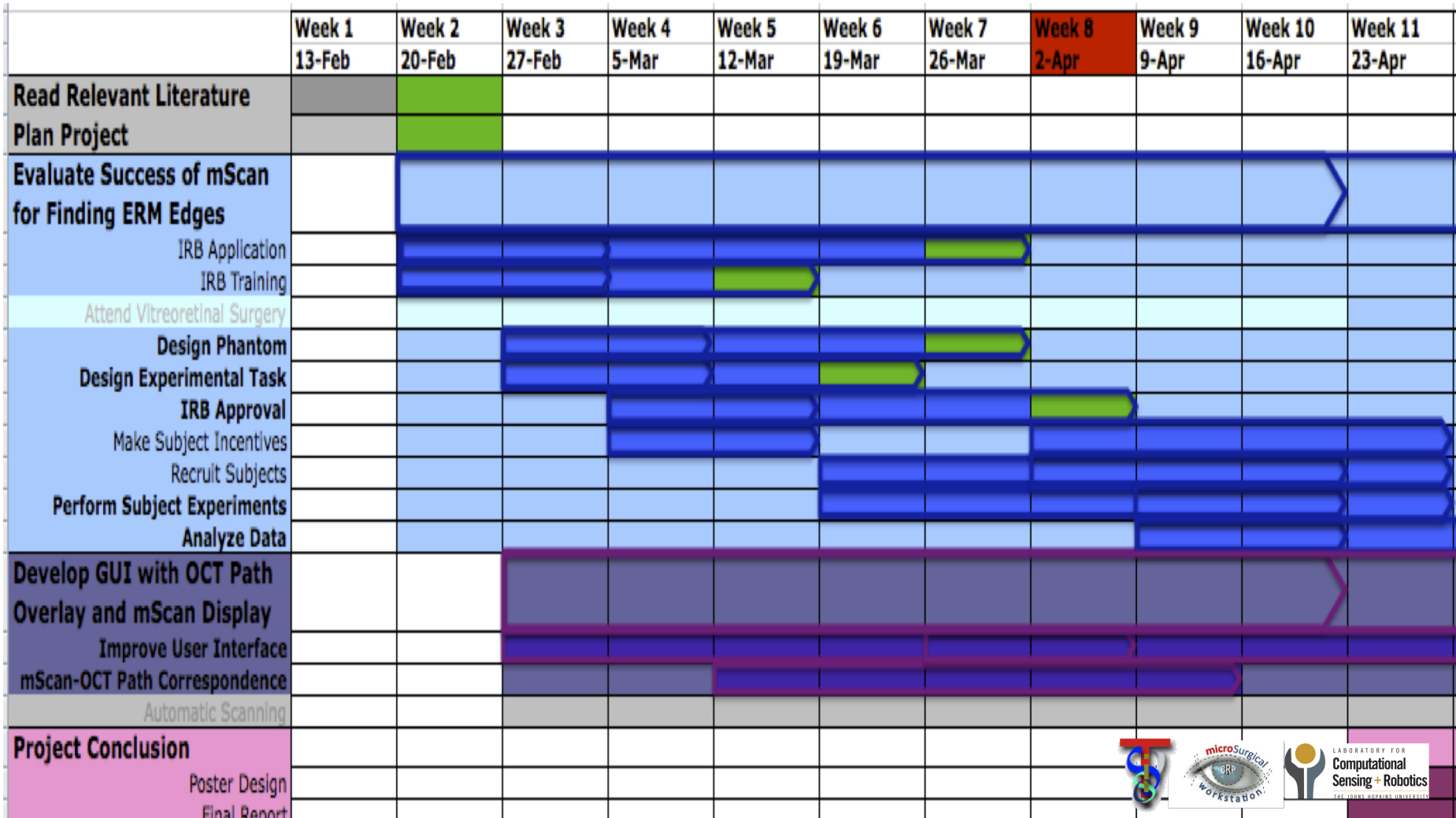


Time-space correction

- Distance-scaling algorithm
  - Premise: width of a section of the image should be proportional to distance traveled by the probe in that section
    i. Divide OCT scan path into segments
    ii. For each segment compute segment:path length ratio
    iii. Scale A-scan history corresponding to this segment by the computed ratio



Timeline: revised



Dependencies

Dependency	Solution	Status	Fallback Plan
Access to Robotorium	Apply	Resolved	
Functional OCT System, probes and software	Schedule time for use	Resolved (schedule based on subject availability)	
Visualization system & software	Schedule time for use	Resolved (schedule based on subject availability)	
Marcin	Schedule weekly meetings	Resolved	
Materials and resources for phantom	Get access and funding	Resolved (budget approved)	
IRB approval	Submit application	Resolved	
Attend Vitreoretinal Surgery	Ask Marcin for help scheduling	Unresolved	Discuss with surgeons
Subject Recruitment	Flyers, emails, etc.	Resolve by 4/12 (3/21)	Advertise more heavily
Subject Incentive Funding	Gift cards	Budget approved	

References

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Thank you!

Questions?