

Assessment of Intra-operative OCT Imaging in a Simulated Micro-surgical task

Andrea Corredor and Amrita Gupta

Mentors: Marcin Balicki, Dr. Russell H. Taylor



February 23, 2012



Outline

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Project Summary

We aim to assess the efficacy of Intra-Operative OCT imaging as an aid in vitreoretinal surgery, in particular for peeling epiretinal membranes (ERMs). We intend to investigate this using a simulated micro-surgical task.



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Background

- **Retinal Disease & Vitreoretinal Surgery**
 - Retinal disease is one of the leading causes of blindness
 - Inherent difficulties of vitreoretinal surgery
 - Manipulation of delicate 1-100 μm structures
 - Risk of retinal damage due to tremor and lack of force feedback
 - **Visualization difficulties**

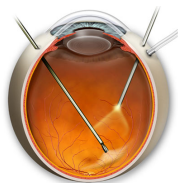


Figure: www.eyemdl.com



Background

- **Epiretinal Membranes**

- Pathology of the eye in which a membrane of scar tissue grows on the macula. As the membrane tightens it deforms and progressively contracts the macula, affecting vision.
- Are usually surgically removed



Figure: <http://www.retinaeye.com/epiretinalmembrane.html>



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Motivation

- Intra-Operative imaging greatly facilitates location of ERMs, and allows for obtaining updated images of tissue operated upon

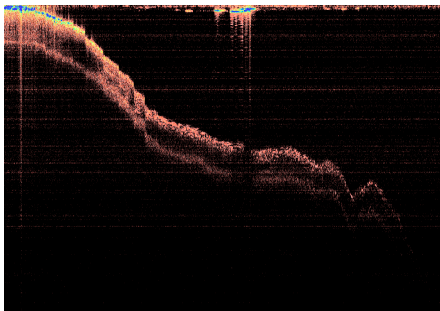


Figure: M Balicki et al



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Background continued

- **What is Optical Coherence Tomography Imaging?**
OCT provides micron-scale images of anatomical structures within a given tissue. It can display the depth of different tissue layers (A-mode), as well as cross-sectional images (B-mode).
- **Fiber Integrated Surgical Pick**
OCT fiber is incorporated directly into ophthalmic instrument, allowing for imaging of structures ahead of the instrument.

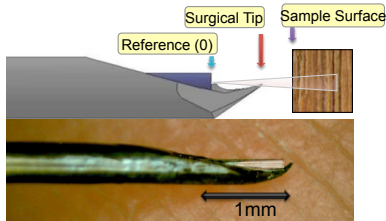
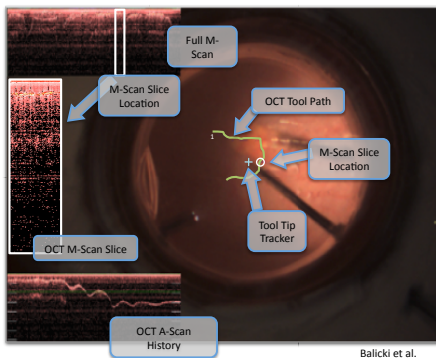


Figure: M Balicki et al



- **Visual Tracking and Annotation**

Registration of the position of intraoperative retinal imaging with stereo video microscope, and annotation on the video feed.



Balicki et al.

Figure: M Balicki et al



- **Areas for improvement**

- User interfacing/GUI
- OCT image quality
 - Color enhancement
- Smart OCT processing
 - Correct for time-space differences
 - Automatic Scanning



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Technical Approach

- **Experimental Validation of Intra-Operative OCT for locating ERMs**
 - Phantom Design
 - Thin
 - Transparent
 - Non-reflective
 - Experimental Task Design
 - Data Analysis



Figure: M Balicki et al

- **GUI and OCT processing**



Dependencies

Dependency	Solution	Status	Fallback Plan
Access to Robotorium	Apply	Resolved	
Functional OCT System, probes and software	Schedule time for use	Resolve by 03/19	Re-schedule \ Simulate
Visualization system & software	Schedule time for use	Resolved by 03/19	Back-up at med campus
Marcin	Schedule weekly meetings	Resolved	
Materials and resources for phantom	Get access and funding	Resolve by 02/27	Fundraise
IRB approval	Submit application	Resolve by 03/14	Re-apply with necessary changes
Attend Vitreoretinal surgery	Ask Marcin for help scheduling	Unresolved	Discuss VR surgery with surgeons
Subject Recruitment	Fliers, Today's announcements, etc.	Resolve by 03/21	Increase incentives, try different forms of advertisement
Subject Incentive Funding	Apply for funding for T-shirts, gift cards, etc.	Resolve by 03/21	Fundraise



Deliverables

- 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



Milestones

- Design of micro-surgical task that simulates ERM peeling
- Working phantom
- IRB approval
- Completion of advertisement and incentive for subject recruitment
- Completion subject trials
- Statistical analysis of data from subject trials
- OCT enhancements
 - Color enhancement
 - Annotation of anatomical landmark
 - GUI improvement
 - Time-Space correction



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Timeline

	Week 1 13-Feb	Week 2 20-Feb	Week 3 27-Feb	Week 4 5-Mar	Week 5 12-Mar	Week 6 19-Mar	Week 7 26-Mar	Week 8 2-Apr	Week 9 9-Apr	Week 10 16-Apr	Week 11 23-Apr	Week 12 30-Apr	Week 13 7-May
Read Relevant Literature													
Plan Project													
Evaluate Success of mScan for Finding ERM Edges													
IRB Application													
IRB Training													
Attend Vitreoretinal Surgery													
Design Phantom													
Design Experimental Task													
IRB Approval													
Make Subject Incentives													
Recruit Subjects													
Perform Subject Experiments													
Analyze Data													
Develop GUI with OCT Path Overlay and mScan Display													
Improve User Interface													
mScan and OCT Path Correspondence													
Automatic Scanning													
Project Conclusion													
Poster Design													
Final Report													
Presentation													



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Management Plan

- Weekly meetings with mentor
- Assessment of progress and timeline update
- Wiki maintenance
- We will collaborate on each task and share responsibility equally
- Possible use of Redmine



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Reading List

- “Intraoperative Visualization of Anatomical Targets in Retinal Surgery” Ioana N. Fleming, Sandrine Voros, Balazs Vagvolgyi, Zach Pezzementi, Dr. Jim Handa, Russell Taylor, Gregory D. Hager
- “Single Fiber Optical Coherence Tomography Microsurgical Instruments for Computer and Robot-Assisted Retinal Surgery” Marcin Balicki, Jae-Ho Han, Iulian Iordachita, Peter Gehlbach, James Handa, Jin Kang, Russell Taylor.
- “Common-path Fourier-domain Optical Coherence Tomography with a Fiber Optic Probe Integrated Into a Surgical Needle” Jae-Ho Han, Marcin Balicki, Kang Zhang, Jae-Ho Han, Marcin Balicki, Kang Zhang, Xuan Liu, James Handa, Russell Taylor, and Jin U. Kang; Proceedings of CLEO Conference, May 2009
- “Automatic online spectral calibration of Fourier-domain OCT for robot-assisted vitreoretinal surgery” Xuan Liu, Marcin Balicki, Russell H. Taylor, and Jin U. Kang. , in SPIE Advanced Biomedical and Clinical Diagnostic Systems IX, 25 January 2011.
- “Augmented Reality Fundus Biomicroscopy. A Working Clinical Prototype.” Jeffrey W. Berger, MD, PhD; Bojidar Madjarov, MD. Arch Ophthalmol. 2001
- “Biopsy site re-localisation based on the computation of epipolar lines from two previous endoscopic images.” Allain B, Hu M, Lovat LB, Cook R, Ourselin S, Hawkes D. Centre for Medical Image Computing, University College London
- “Optical biopsy mapping for minimally invasive cancer screening.” Peter Mountney, Stamatia Giannarou, Daniel Elson, Guang-Zhong Yang. Department of Computing, Imperial College, London SW7 2BZ, UK. MICCAI



Thank You!

Questions?



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