



Microsurgical Tool Tracker

Computer Integrated Surgery II
Spring 2013

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Introduction

Ophthalmic surgery has a number of difficult procedures due to the delicacy of the eye and limited work space. The project goal was to develop a prototype of an optical tool tracker as a proof-of-concept. The device was designed to view the eye environment with four cameras without interfering the surgical work space. RGB cameras were used to locate a tool tip and three trocars. The performance of the tracking was evaluated by tests of static and dynamic image capture under different lighting conditions.

The Problem

Ophthalmologic surgery has the highest number of incorrect procedures within the operating room[1]. This is because microsurgery requires a level of precision, accuracy, and stability that is difficult to achieve with current surgical methods. Current methods have limited success due to hand tremor, the narrow field of view from 2-channel microscopes, and poor interpretation of qualitative data that leads to poor decision making.

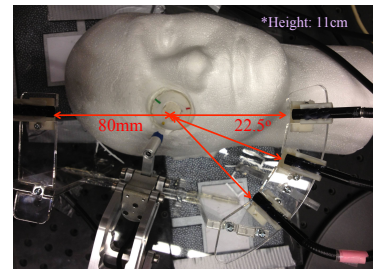
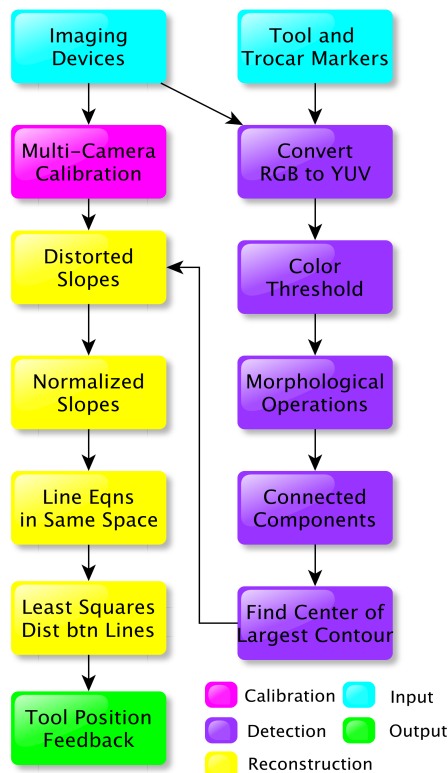


Figure1. Final Prototype, Face and Eye Phantoms

The Solution



Credits

Sue Kulason – software development
Yejin Kim – mechanical device design

Citation

1. J.-P. Hubschman, J. Son, B. S. D. Schwartz, and J.-L. Bourges, "Evaluation of the motion of surgical instruments during intraocular surgery," *Eye* (London, England), vol. 25, no. 7, pp. 94753, Jul. 2011.
2. Bradski, G. "The OpenCV Library". Dr. Dobb's Journal of Software Tools, 2000. ID: 2236121
3. J. Y. Bouquet. Camera Calibration Toolbox for Matlab. 2008 http://www.vision.caltech.edu/bouquet/calib_doc/

Outcomes and Results

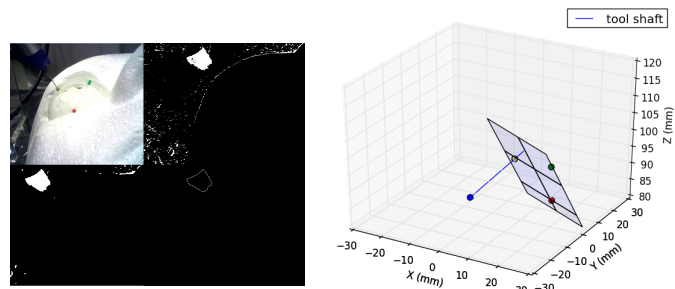


Figure2. Detection and 3D Reconstruction

Test	Average Percent Error(%)	
Target	Tool Tip	Trocar
Static, Light 1	19.3	16.5
Static, Light 2*	20.4	22.3
Dynamic, Light 1	5.547	4.479
Dynamic, Light 2	10.146	10.169
Test	Average Deviation in slope (mm)	
Dynamic, Light 1	0.508	0.556
Dynamic, Light 2	0.398	0.379

*Excluded one outlier

Future Work

- Implement real-time tracking
- Improve efficiency of tracking
- Implement 4-camera calibration
- Synchronize cameras
- Improve device design

Lessons Learned

- Standard software is not currently designed to stream four videos at once.
- Plan ahead to use group-owned equipment.
- A thorough investigation of dependencies is key.

Acknowledgements

Thank you to Dr. Russell Taylor for providing funding and CISST for access to imaging software and the Eye Robot 2.1.

