# The OCT-Penlight: In-situ image display for guiding microsurgery using optical coherence tomography (OCT)

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## Introduction:

- A new image-based guidance system for microsurgery under optical coherence tomography (OCT)
- Presents a real-time virtual image in its correct location inside the scanned tissue
- Applications include surgery of the cornea, skin, and other shallow targets, with or without low-power magnification

## Background:

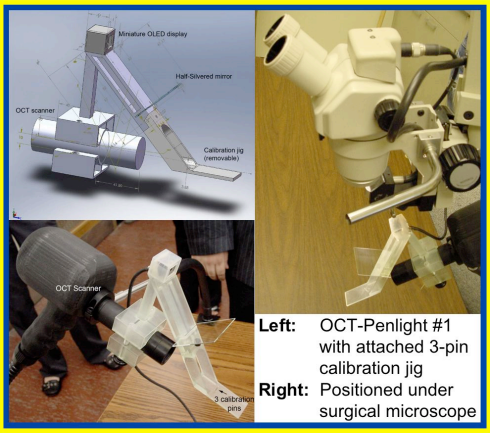
- Spectral domain OCT (SD-OCT) provides real-time high-resolution (2 micron) images at video rates within the first two millimeters of soft tissue.
- SD-OCT is suitable for guidance to shallow targets such as Schlemm's canal in the eye or melanoma in the skin.
- We previously built an in-situ real-time visualization device for clinical ultrasound, named the Sonic Flashlight.
- Our lab's research shows that in-situ image guidance is better than traditional ex-situ image guidance[1].
- We are now working on in-situ real-time SD-OCT for microsurgical guidance.
- Microsurgery often requires magnification, using either a stereoscopic surgical microscope or loupes, but magnification imposes specific design challenges.

## Prototype 1:

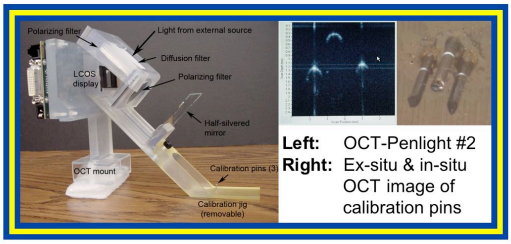
- Used a miniature organic light emitting diode (OLED) display
- Benefits: Color display and optically simple design
- Weaknesses: Insufficient brightness to view under a microscope, and pixel-size was large (20 micron)

## Prototype 2:

- Used an Liquid Crystal on Silicon (LCoS-type) reflective display.
- Benefits: Use of external illumination allows for sufficient brightness to be visible under a microscope, and pixel-size is small (8 micron).
- Weaknesses: Use of a reflective LCD requires more complex optics, and the device is monochromatic.




**Left:** OCT-Penlight #1 with attached 3-pin calibration jig
**Right:** Positioned under surgical microscope




**Left:** OCT-Penlight #2
**Right:** Ex-situ & in-situ OCT image of calibration pins

## Results:

- The geometrical arrangement between the OCT scanner and display optics permits surgical access.
- OCT-Penlight prototype 2 was of sufficient resolution and intensity to be useful under magnification.

## Conclusion:

- We are encouraged by our initial success.
- We are planning a third prototype based on a custom display technology that combines the advantages of the previous versions while improving resolution.

## References:

1. R. Klatzky, B. Wu, D. Shelton, G. Stetten, *Efficacy of Image-Guided Action is Controlled by Perception*, Journal of Vision, 2005

## For More Information:

www.vialab.org