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The OCT-Penlight: In-Situ Image Display for Guiding Microsurgery Using Optical Coherence Tomography (OCT)

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We have developed a new image-based guidance system for microsurgery under optical coherence tomography (OCT) that presents a virtual image in its correct location inside the scanned tissue. Applications include surgery of the cornea, skin, and other surfaces below which shallow targets may advantageously be displayed for the naked eye, or for low-power magnification by a surgical microscope or loupes (magnifying eyewear). OCT provides real-time high-resolution (3 micron) images at video rates within the first two millimeters of soft tissue, and is therefore suitable for guidance to various shallow targets such as the Schlemm's canal in the eye or melanoma in the skin. A series of prototypes of the so-called "OCT-penlight" have produced virtual images with sufficient resolution and intensity to be useful under magnification, while the geometrical arrangement between the OCT scanner and display optics (including a half-silvered mirror) permits surgical access. The two prototypes constructed thus far have used, respectively, a miniature organic light emitting diode (OLED) display and a reflective liquid crystal display (LCD). The OLED has the advantage of relative simplicity, satisfactory resolution (20 micron), and color capability, whereas the LCD can produce an image with superior resolution (12 micron) and higher intensity, although monochromatic and more complicated optically. We are encouraged by our initial success and are planning a third prototype that combines the advantages of the previous versions while improving resolution.