AbstractID: 2700 Title: Endoscopic Laser Projection for Image-Guided Surgery

Purpose: The goal of this work is development of an endoscopic system for three-dimensional localization of tissue surfaces during image-guided surgery. The system has the potential to track tissue movement in real time and to measure the shape of organ surfaces within the endoscopes' fields of view via localization of thousands of surface points. The system is intended to provide real-time localization of surface points as a means to guide coregistration with preoperative anatomic image sets and to provide the constraints required by deformable tissue models.

Method and Materials: A benchtop prototype of the system consisting of a pair of conventional endoscopes, a computer-controlled laser scanner, a high-speed CCD camera, and a commercial optical tracking system has been constructed in Creare's laboratory. Calibration of the prototype has been performed by verifying the accuracy of the optical tracking system used to measure the position of the endoscopes, measuring the repeatability of the laser scanner when projecting the laser through an endoscope, characterization of the distortion present in the endoscope optics, and the measurement of the maximum usable field-of-view. The accuracy of the system has been determined based on the difference between three-dimensional coordinates measured by our system with those measured by the commercial optical tracking system.

Results: The repeatability of the system to consistently localize a fixed point was determined by measuring the location of 25 points while maintaining fixed positions of the endoscopes and laser mirrors. The mean three-dimensional repeatability of the localizations was 0.08 mm with a standard deviation of 0.05 mm. The accuracy of the system was ascertained relative to measurements made with the optical tracking system and a standard six LED probe, known to have an accuracy on the order of 0.1 mm. Using a planar test phantom with machined semicircular holes, the projecting endoscope laser was steered to the center of each hole, and the position of the illuminated spot determined using the system. The position of each hole was also measured with the six LED probe, and the resulting three-dimensional error found to be 1.9 mm with a standard deviation of 0.3 mm. The system can localize approximately 400 points per second.

Conclusion: The use of a scanning laser endoscope has the potential to provide cost-effective, real-time localization of any point within the surgical field that can be simultaneously observed by two endoscopes. The initial results of our work show that points can be localized accurately and rapidly.

Conflict of Interest (only if applicable): N/A

Educational Objectives:
1. Calibration techniques for endoscopic laser projection.
2. Discussion of endoscopic localization as a means of assisting image-guided surgery.
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