Laparoscopic Image Guidance via Conoscopic Holography

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Spatially registered 3D preoperative medical images can improve surgical accuracy and reduce reliance on memory and hand-eye coordination by the surgeon. They enable visualization of internal structures within the anatomy of a patient on the operating table. In the case of biopsy, for example, this would allow the surgeon to guide the needle tip to a tumor though opaque tissue. It has been well established that for soft tissues, image registration can be performed by aligning the preoperative image with a cloud of points that describe the surface of an organ [1]. Collecting this point cloud can be challenging, generally requiring open surgery to permit line-of-sight access for laser triangulation (e.g., the system of Pathfinder Therapeutics, Inc.). We present a conoscopic holography-based system for collecting a point cloud less invasively-through a laparoscopic port. The system consists of a commercial conoscopic (Optimet, Inc., Probe Head Mk3), designed for precision machine-shop linear measurements, that is tracked (the surgical tool is also tracked) with an optical tracking system (Claron Micron Tracker H3-60). The conoscopic laser beam can, in principle, be aimed through a laparoscopic port. The 1 degree of freedom linear distance measurements it returns are converted into a point cloud using optical tracker information. Proof-of-concept for obtaining point clouds via conoscopic holography and registering them to known shapes is provided in [2]. However, the procedure for collecting these point clouds requires the surgeon to manually ‘paint’ the surface of the organ with the laser beam, aiming it at many points on the surface by manipulating the conoscopic base unit, thus pivoting the tube in the laparoscopic port. It would be desirable to relieve the surgeon of this task by creating a system for automatically aiming the laser beam from a stationary conoscopic. We hypothesize that this can be done with a suitably designed actuated mirror assembly at the tip of the laparoscopic tube. To assess whether a conoscopic can make an accurate distance measurement when reflected by a mirror, we conducted a set of experiments. We placed a front-silvered mirror at a fixed 45 degree angle relative to the conoscopic, 12 cm in front of it. Total beam length was 185-315 mm measured in 10 mm increments. The results were similar to direct measurements of the same distance without a mirror. We recorded a standard deviation of error of less than 0.01 mm in each 10 mm increment. A second experiment was then carried out to assess the effect of mirror angle. The laser was swept across a flat surface 105 mm from the mirror by rotating the mirror. The standard deviation of the data points from a true line was less than 0.1 mm along a 175 mm line segment. These experiments indicate the feasibility of using a mirror to aim a conoscopic holographic laser, paving the way for an automatic laparoscopic laser, paving the way for an automatic laparoscopic point cloud collection device to be developed in future work.

Development of Photoinitiated Nitric Oxide Releasing Polymer Films for Controlled Drug Delivery

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Nitric Oxide (NO) is small, free radical gas that has been shown to have a wide variety of physiological functions, including the ability to hinder tumor angiogenesis at high, but non lethal, concentrations. Previous work suggests that if NO could be effectively delivered in vivo to tumors of patients currently undergoing chemotherapy treatments at the appropriate levels, less damaging chemotherapy treatments could be used against cancer. This could increase the overall survivability of cancer patients, especially in those prone to the harmful effects of chemotherapy: children, elderly, and those of weak immune systems. If NO is especially necessary to have tumorcidal effects on specific cancer cells. If NO is especially necessary to have tumorcidal effects on specific cancer cells.