

LAPAROSCOPIC ULTRASOUND TRAINING SYSTEM

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For patients who are eligible for laparoscopic surgery, laparoscopic ultrasound (LUS) offers the benefit of allowing the surgeons to see beyond surfaces of organs. LUS, however, is not in widespread use due to e.g., the non-intuitive handling of the LUS probe, and the challenging interpretation of the LUS images with respect to the patient's anatomy. Besides, there is a lack of specialized simulators for training of LUS skills. **We have developed a training system** for learning and assessing of acquired skills for advanced intraoperative image-guided therapeutic procedures with the main focus on LUS. The system consists of components that allow realistic force application and haptic feedback: a box trainer and both laparoscopic and LUS equipment. The reason for including these is the fact that the magnitude and direction of applying forces with the LUS probe are of great importance when using ultrasonography. To support interpretation of the LUS images, we integrated an in-house developed surgical navigation system. The navigation system consists of a computer with dedicated software and a tracking system. When performing LUS, the tip of the flexible LUS probe is tracked with an integrated miniature electromagnetic tracking sensor, allowing the visualization of corresponding oblique images from CT/MR according to position and orientation of the LUS image. A calibration procedure was performed, matching the LUS probe and the MR/CT images to the phantom through a registration procedure using external markers. **A new, multi-modal liver phantom** suitable for LUS, CT and MR imaging has been developed. The phantom is used to simulate a LUS task in the box trainer. The tracking system is used to assess user's performance of the task by means of motion analysis parameters including path length, depth perception, motion smoothness, and time. **To our knowledge**, no such LUS training systems have been proposed previously. We believe that including realistic force application and haptic feedback together with multi-modality images and navigation will be beneficial to those who learn LUS skills. Furthermore, the combination of navigation with LUS could make LUS a more valuable tool for experienced surgeons.