Virtually Transparent Epidermal Imagery

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We have been developing a novel virtually transparent epidermal imagery (VTEI) system for laparo-endoscopic single-site (LESS) surgery. The system uses a network of multiple, micro wireless cameras and multiview mosaicing technique to obtain a panoramic view of the surgery area. This view provides visual feedback to surgeons with large viewing angles and areas of interest so that the surgeons can improve the safety of surgical procedures by being better aware of where the surgical instruments are relative to tissue and organs. The prototype VTEI system also projects the generated panoramic view on the abdomen area to create a transparent display effect that mimics equivalent, but higher risk, open-cavity surgeries.

In the first year of the project, we have set up a surgery simulator and a trainer box for system development and evaluation. The simulator has a correct organ layout while the trainer box has training tasks. They will be used to evaluate and compare the VTEI with the regular laparo-endoscopic approach. Multiple versions of the wireless endoscope have been developed based on need and size requirements and also the basic parameters of the sensor: resolution, illumination, and modulation. Videos from three wireless cameras looking at the region of interest from different viewing points are stitched together with partial overlapping areas to create a seamless panoramic video with high resolution. We have explored different camera setups and corresponding image processing algorithms including single-view mosaicing, multi-view mosaicing, and multi-view stitching.

Before the panoramic video is fed into the projector, it is processed to prevent color or geometrical distortion for the convex abdomen surface with the feedback from the Point Grey Flea camera. The camera provides a visual feedback for projection distortion compensation and orientation alignment. For distortion calibration, the computer sends a checkerboard image to the projector and the camera captures the projected checkerboard image as part of surgery preparation. The locations of the checker corners in both images are automatically detected, and then a mapping between the source image and the projected image is built for future use of distortion compensation.

We have also developed a prototype of immersive anatomy education tool that uses a Miscrosoft Kinect to track a user and then render a right size anatomy model directly on the user's torso with a project. The 3D anatomy model rendered on the user changes dynamically with the user's position and orientation, to provide correct alignment. An interactive learning interface has been developed to instruct the user to click on an organ by announcing its medical terminology. As an indication of the answer, the right organ will glow following user's clicking gesture.