

Video based instrument pose tracking in navigated laparoscopic surgery

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Introduction

To overcome the challenges of depth loss and limited field of view, image-guided surgery has been introduced for intraoperative guidance in laparoscopic surgery. Currently used navigation systems are based on external instrument tracking systems (e.g. optical, electromagnetic). However, these systems face challenges like instrument bending, line-of-sight (optical systems) and magnetic distortions (electromagnetic systems). Video based tracking represents a low-cost tracking method which would eliminate the need for external trackers and the induced errors.

Methods

The proposed system uses the video from the stereo laparoscope currently used in the liver surgeries. Visual markers, attached or engraved on the instruments, are then detected in the left and right image of the video. Using the geometrical parameters of the camera, the pose of the instrument is calculated, which is then fed back to the navigation system.

Results

The first prototype of a video based tracking system was implemented and integrated into a commercially available navigation system (CAS-One AR, CAScination AG, Switzerland). The instruments were successfully detected in the 3D video and their location displayed on the navigation screen. In a phantom setting, a tracking frequency of 10 frames per second was achieved.

Conclusions

Initial integration of video based tracking of instruments in a surgical navigation system was demonstrated. By tracking the instruments in the laparoscopic video, the system eliminates the need for an external tracking system and might reduce setup time and inaccuracies caused by bending. However, the tracking frequency and the accuracy have to be improved and validated under clinical conditions.