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Praxistaugliche erweiterte Realität für die Medizin basierend auf medizinischer Standardtechnik

Practical Reality Augmentation for Medicine using Off-the-shelf Medical Equipment

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Purpose

Image-guided surgery (IGS) is the standard method for providing additional visual information and orientation to the surgeon. Such additional graphical representations are especially helpful for minimally-invasive interventions, during which only a limited endoscopic or microscopic view is available.
In the past years, the idea of transferring augmented reality (AR) techniques into medical applications has been tested in many experimental settings. One drawback of most of these experimental setups is their reliance on specialized hardware like special magnetic or optical trackers and display systems like translucent LCDs or head mounted displays (HMDs).Such specialized system components often prevent the transition of medical AR systems from a research state into the clinical practice. The reason for this is the fact, that these devices can require tedious setup procedures, take up a lot of space in the operating room, and can suffer from magnetic interference. Moreover, they are usually not certified for use in an actual medical application.
We propose a novel system for medical augmented reality. Our approach is based on using existing, commercially available image guided surgery equipment for the tasks of medical AR.

Material and Methods

We have built a prototype augmented reality application, which receives virtually all data necessary for useful reality augmentation from a VectorVision IGS device. In our system, a standard webcam is used for acquiring a digital video stream. The webcam is tracked by the built-in infrared cameras of the image guided surgery device. In order to achieve the correct overlay of virtual graphical objects over the real scene, a transformation from the coordinate space of the IGS cameras to the webcam coordinate system is required. We have devised a one-time calibration step for computing this transformation.

A specialized network-based interface is used for the download of tracking information from the image guided surgery system. This experimental interface, VectorVision Link, also provides facilities for the exchange of many other types of data. These include patient datasets and operation plan elements like planned points or segmentation results.

Results

We have implemented an example application providing an overlay of anatomical data, including the actual current patient dataset, over the camera image. Moreover, graphical representations of tracked surgical tools can be displayed in the augmented view. We have found our application to be able to generate an augmented video stream at a steady frame rate of 15 fps.
In addition to the standard display of graphical objects, we have devised a method for correctly handling occlusion by the patient anatomy. Our algorithm extracts a visual hull volume from the currently displayed patient dataset and uses it as a phantom model for occlusion handling. This way, a much more easily understandable and intuitive augmented reality view is generated.

Conclusion

Our design paradigm for medical augmented reality is to minimize the necessity of additional hardware components. We have achieved this by relying on commercial image guided surgery. Thus the transition of AR into the clinical practice could be facilitated. Most of the components used in our augmented reality system are certified for use in medical settings, reliable, and widespread. In fact, additionally only a standard webcam and a standard PC are required for building a basic AR application.