Ein Virtual-Reality-System für die interventionelle Radiologie

A Virtual Reality System for Interventional Radiology

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Today, surgical or interventional navigation systems have entered clinical practice. The main feature of these systems is to allow overlaying planning data as well as current instrument position on pre- or intra-operatively acquired images. While this is already a major advantage for many minimally invasive procedures, the user interface usually consists of a monitor outside of the surgical or interventional field. Therefore, the user, i.e. the surgeon or interventionist, still needs to mentally correlate the image on the computer screen to the intra-operative situation. This is a difficult and error prone task and requires intensive training.
We report on a demonstrator system for virtual and augmented reality in interventional radiology. The system provides an easy to use and intuitive user interface for interventional use.
A 3D computer display is positioned in the line-of-sight of the interventionist showing a stereoscopic view of the virtual scene containing a CT image of the patient, planning data, and the instruments used. This view is constructed from the measured position of the interventionist and is registered to the intra-operative scene.

The navigation system consists of a standard PC based workstation, which is connected to an autostereoscopic 3D display (Dimension Techonologies Inc., Rochester, NY, USA). An optical position measurement device (Optotrak 3020, Northern Digital Inc., Waterloo, Ontario, Canada) is used to track the position of instruments, the patient, the display, and the head of the user.
For the accuracy tests described here, an interventional abdominal training phantom (CIRS Inc., Norfolk, VA, USA) was used. This phantom includes several organs, e.g. liver, spinal column, ribs, and vessels. A CT data set of the phantom was produced and registered to the coordinate system of the position measurement device using fiducial markers.
In order to calibrate the display, the 3D positions of the display corners relative to a display tracker were determined with the help of a measurement microscope.

The user wears glasses, which are equipped with LEDs allowing the position measurement device to determine the position and orientation of the user's head. In an initial calibration step both eye positions are determined and adjusted to the individual user, thus allowing an accurate stereoscopic visualization.
A Java3D based visualization software package is used to display the virtual scene including instruments, planning data, and a surface model of the phantom's organs.

In accuracy tests with geometrical phantoms the accuracy of the virtual reality system described here was found to be comparable to a conventional navigational setup without virtual reality display using the same system components. First tests of the system on phantoms simulating a biopsy showed an increased efficiency of the users in comparison to a conventional navigation setup without a virtual reality display. The users reported on a reduction of stress during the procedure and a faster learning curve.

In conclusion, the system described allows all functions of a conventional navigation system and is additionally much less demanding on hand-eye coordination. It is very easy to use and requires less training than conventional systems.