curac2004
3. Jahrestagung der Deutschen Gesellschaft für Computer- und Roboterassistierte Chirurgie e.V.

Kalibration eines Operationsmikroskops für die Erweiterte Realität – erste Resultate

Calibration of an operating microscope for Augmented Reality – first results

Michael Aschke[1], U. Eisenmann[2], C.R. Wirtz[2], J. Raczkowsky[1], H. Wörn[1], A. Unterberg[2]

[1]Institute for Process Control and Robotics, Universität Karlsruhe (TH)
[2]Department of Neurosurgery, Universitätsklinik Heidelberg

Purpose

Current operating microscope based augmented reality systems in neurosurgery use mono ocular two dimensional overlay techniques. The aim of the ARNO-System (Augmented Reality for Navigated Operating Microscopes) is to provide the surgeon with a stereoscopic full colour three dimensional overlay of models like tumors, resection lines etc. of the operating field into the operating microscope. This leads to a more intuitive intraoperative orientation for the surgeon. This paper describes results of first tests regarding the accuracy of the navigation system, the calibration of the operating microscope and the registration of the models onto the patient's anatomy.

Method

The models which will be overlaid intraoperatively are segmented from preoperative data sets of the patient. In order to achieve a correct correlation between the position and orientation of the model according to the anatomy, the operation microscope optics have to be calibrated as well as the image overlay source. Furthermore the segmented models are registrated to the patient via a pointer based registration. The presentation of the model has to be prepared stereoscopically.

Results

By defining a rigid frame of virtual cameras, the stereoscopic processing of the model is achieved.. Because the virtual cameras are ideal according to lens-distortions, no

calibration of the cameras is necessary. As overlay image sources we use reflective LCOS-displays which are illuminated by a special LED-RGB-panel. The displays are integrated in a prototype-bench which is connected directly to the microscopes optics.

The calibration process of the display is done by picking the centres of circles of a calibration pattern in display coordinates and correlating them with the known coordinates in the calibration pattern coordinate system. This is done in two positions of the calibration pattern varying the height by 10mm. We calibrated the microscopes optics with minimal and maximal zoom configurations. When using manual specification of each center of the overall 49 circles which are visible in maximal zoom, we achieve a display average deviation of 0,04 mm and a maximum deviation of 0,15 mm. As a result from the calibration we get the position of each virtual camera. These parameters as well as current zoom and focus have to be applied to the virtual camera objects. An automated approach of the calibration process is currently investigated. The pointer based registration also delivers good results. In order to estimate the influence of the navigation system itself onto our system accuracy, we took 5000 frames of a not moving active rigid body fixed at the microscopes optics. We got a position variance of 0,03mm and a standard deviation of 0,17mm. The maximum angle deviation was 0,07degrees. The standard deviation of the location of an object in the image plane by using this active rigid body was 0,75mm.

Conclusions

Stereoscopic full color augmented reality is possible by using the ARNO-System. With the navigated and scaled overlay of virtual 3D-objects onto the surgical field a more intuitive orientation for the surgeon will be possible without interruption of the surgical workflow.