Automatic Positioning of a Surgical Microscope

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Despite its central function in neurosurgical operations, surgical microscopes still have two main deficites: 1) Preoperative images are not used to navigate the microscope. 2) Manual repositioning complicates precise movements. They are very important because tissue is observed multiply enlarged. In this view, even very small motions can move tissue out of focus. Moving microscopes with constant working distance around a target point situated inside the body (pivotation) is hardly practicable and very time-consuming.

In addition to this, positioning microscopes manually interferes with the surgeon's workflow and increases the procedure's duration. This makes the replacement of the surgical instruments necessary every time. Manual contact is also a substantial infection risk because of increased danger of sterility loss.

A surgeon has to react to different situations during surgery. At the beginning, usually a broad field of view is necessary to get an overview of the operation area. Afterwards, the procedures requires several variations of working distance and focus position. In any case, it is important that the field of view remains focused. The combination of automatic positioning based on preoperative images and an autofocus function to identify the optimal working distance enables the surgeon to change the field of view fast and precisely without beeing interrupted by manual interactions.

Therefore, a surgical microscope with six degrees of freedom has been fully motorized and the system can be positioned automatically. An external firewire camera is mounted to the video interface of the microscope and captures the current field of view. The recorded images are then used to calculate the focus score on an external computer because a separate autofocus function is not provided by the microscope. A combination of two methods to calculate a focus score of the current field of view is used for autofocusing. It ensures unimodality, accuracy and repeatability so that online computation is enabled.

A procedure for interactive navigation of a fully motorized surgical microscope is presented in this work. This procedure uses preoperative MRT- or CT-images to generate a 3D-model of the patient which then represents the basis for navigation during surgery. Target points can now be defined in these images prior to surgery and later the microscope can be positioned automatically at a point chosen by the surgeon. The positioning accuracy of the autofocused field of view has been examined to be less than 1 mm.