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

Roboterunterstützung eines OP-Mikroskopes

Control-System for roboted OR-Microscopes

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Introduction

Operation microscopes are essential devices for all kinds of surgery on small structures e.g. neurosurgery. The microscope is not only positioned at the beginning and removed at the end of the surgery, but is rather frequently repositioned throughout the surgical procedure. The microscope has to be moved to different positions to achieve different angles and perspectives of the same field, but also has to continuously move with the surgical activity to areas newly exposed during the procedure. In this cases, the instruments have to be given to the nurse, the microscope is repositioned, the surgeon gets new instruments and finds his way to the situs again to continue his work. This results in a break of the work-flow and increases the risk of infection.

We want to introduce a microscope control, which can be operated by the surgeon without taking his hands from the scene. A first study based on a KUKA industrial robot and a Moeller-Wedel Mikroscope was constructed for evaluation of the microscope movements and the control concepts.

Implementation

A small microscope head was attached to a KUKA KR3 industrial robot, which can be controlled from an external pc. The image of one of the oculars was transmitted by a camera to the computer. The first movement implemented was the pivot-movement, during which the camera moves on a sphere with fixed distance to the region of interest (ROI). An application for this would be the inspection of the situs during or after surgery from different angles. The surgeon can move the microscope on a virtual sphere, change its rotation around the axis of view, and he can also change the distance to the ROI.

The control device consists of three buttons which are integrated into surgical instruments such as the suction.

Discussion

The pivot-movement was tested by neurosurgeons. The concept of an instrument-based microscope control proved to be workable in hypothetical neurosurgical settings. However, the number of switch operations required to achieve desired alternative working angle so fare seemed to be high and sometimes complicated. As a conceptional limitation of strict pivot-movements it was noted that moves on a sphere with fixed distance to the region of interest resulted in a large amplitude of movements of the microscope head, which means that the surgeon has to extensively move his head to follow the eyepieces of the microscope. This effect needs to be compensated by a variable focal distance during pivot-movements to limit the extent of eyepiece movements. To adequately function in neurosurgical procedures in addition to pivot-movements the required control needs to include translational movements too, which in real-live settings would be equally often needed.

Conclusion

First successful tests proved the idea of an robot-assisted microscope control. Nevertheless, further evaluations of additional movements and other control concepts are necessary. As a next step, a standard OR microscope will be fully motorized, the results of the study will be implemented and surgical studies will be performed on cadaver specimens.