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Ein neues mechatronisches Instrument zur endoskopischen Chirurgie der Nase und Nasennebenhöhlen

A new mechatronic device for endoscopic sinus surgery: Workflow View and Proof of Concept

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Introduction

Functional Endoscopic Sinus Surgery and transnasal pituitary surgery are standard procedures in ENT and Neurosurgery in miscellaneous cases. While the endoscope is guided by the surgeon himself, single-handed operating can become extremely frustrating during delicate manoeuvres and surgically pretentious situations. In order to improve health economical interests with regard to complications, recurrence, re-operations and recovery as well as surgical confidence and precision, a mechatronic device has been designed to guide the endoscope partly automatically but always controllable by the surgeon. It thereby facilitates safer and more comfortable two-handed operating. Initial workflow-analysis and development of specific Surgical Integration Profiles (SIP) referred to an economic feasibility of a new mechatronical device.

Methods

The preoperative planning is CT-based. Uploaded scan-data is reconstructed in the workstation and aligned with the patient prior to operating after optical registration (fiducials).
During pre-operative planning the surgeon determines the access path and the initial intra-operative position of the endoscope, as well as forbidden areas that in no case may

be touched by the endoscope. Corresponding data are transferred to the control computer of a navigated mechatronic assistance system consisting of an optical 3D localizer (POLARIS, Northern Digital Inc, Canada) and a 6-link mechatronic arm (PA 10, MHI, Japan) with a range of about one meter. Technical details of the system are described in another CURAC contribution.
The arm is mounted on a mobile platform and placed on the left side of the patient. The endoscope is fixed at the wrist of the arm and can be localized by passive reflecting markers attached to the collar of the endoscope holder.
In haptic mode the wrist of the arm can be manually positioned close to the desired operating zone above the patient's head. By pushing a footswitch the arm then automatically moves the endoscope to the pre-operatively planned intranasal location, taking the meatus nasi externus as a relative pivot point and respecting the defined saftey regions. As a special function of the haptic mode the surgeon can easily move the endoscope during the operation by touching it with his fingertip. The mechatronic detects the applied small forces and moves the endoscope accordingly. At the end of the operation the mechatronic arm can be removed manually or automatically returns to its initial parking position.

Results

Proof of concept has been successfully carried out by laboratory experiments using plastic heads. We have found a workflow-agreeable hardware solution enabling an efficient control of the endoscope and giving back the surgeon his missing second hand. Registration by fiducial markers is sufficiently accurate, resulting in clinically acceptable tolerances between 0,5 and 1,5 mm. Pre-operative planning and intra-operative control is implemented by the modiCAS software-framework (ZESS, Siegen) which also facilitates intra-operative correction of pre-operative planning data.