

Methoden für die Registrierung und Navigation bei Roboterassistierten Operationen

Methods for Registration and Tracking in Robot Assisted Surgery

Heinz Wörn¹, Peters, Helge¹

¹Institut für Prozessrechentchnik, Automation und Robotik der Universität Karlsruhe (TH)

Introduction

Sensors for navigated and robot assisted surgery are essential for the intraoperative performance of a surgical intervention based on a virtual plan. This talk describes principles of the computer aided, navigated and robot assisted surgery, presenting the essential sensors. It focusses especially on sensors for localisation and navigation.

Materials & Methods

The process chain of a navigated or even robot assisted surgery starts with image acquisition. Intraoperatively, the physician or the robot system can access various tracking systems. Examples hereof are: mechanical tracking systems, electromagnetic tracking systems, optical tracking systems, tracking using fiber optics and as well tracking using radio frequency identification systems (RFID). Patient registration, which is essential for surgery of these kinds, does also base on these sensors.

Results

State of the art of navigation systems in medicine is currently the optical tracking. Its main drawback is the need for a steady free line of sight between two cameras and one or more reference frames attached to the patient and/or tool. But all other tracking methods discussed here have as well their specific advantages and serious drawbacks. Yet there are approaches to new technologies promising great progress for the navigated and robot assisted surgery.

Discussion

The intensive use of sensors for robot assisted surgeries demonstrates the surgical robot system „RobaCKa“, developed at the institute for process control and robotics, University of Karlsruhe, Germany. A force / torque sensor attached to the robots end effector enables the surgeon to lead the robot softly through a compliance control. This feature is for example used during patient registration, when the surgeon picks up land marks on the patient. But registration is also possible through image recognition. Pictures taken by two cameras can be used to compute the three dimensional shape of a patient's surface. This surface data can then be matched with the preoperatively acquired ct data. While the robot mills the bone a force / torque sensor continually measures all occurring forces and detects their adherence to certain limits. Since bone tissue is not homogenous the milling feed can not be kept constant. Thus the milling feed is adopted according to the process forces measured by the force torque sensor. During the whole surgery an infrared navigation system supervises the robot tool's as well as the patient's position. In case the system detects any deviations of the robot from the planned path and any movements of the patient it will react properly by retracting the tool and stopping the robot.

For the future a further increase of navigation in surgery can certainly be expected. Image acquisition and sensors for tracking and navigation are essential requirements for navigated and robot assisted surgery.

There is a trend towards markerless registration methods without the additional invasive intervention.

Late technologies like fiber optics and RFID offer new potentialities for navigation.