

Bewegungsdetektion und -prävention für ein Roboterunterstütztes Nadel-Positionierungssystem

Motion Detection and Prevention for a Robot-Assisted Needle Positioning System

Markus Nagel¹, Gerd Schmidt², Ralf Petzold³, Willi A. Kalender¹

¹Institute of Medical Physics, University of Erlangen-Nuremberg, Germany

²Siemens Medical Solutions, Forchheim, Germany

³CAS innovations AG, Erlangen, Germany

Purpose

The purpose of our project was to find a safe method for both patient motion detection with an optical tracking system and patient motion prevention using a fixation device. When using a robot-assisted needle positioning system together with local anesthesia and a fixed needle positioning system, patient motion may lead to severe injuries of the patient. Such movements are considered an unacceptable risk and therefore have to be detected and/or prevented.

We developed a software module to measure movements caused by respiration and body movements and integrated an alert system which informs us about any unintended movements of the patient. The software was also used to analyze the capability of a fixation device for the prevention of body movements.

Methods

For evaluation of the developed software module we tested the performance with volunteers. They were positioned on the CT table and 6 reflecting skin markers were fixed on their skin (3 abdomen, 3 chest). An optical tracking system (Polaris, NDI) was applied to monitor the position of the markers.

A rigid reference frame (RF) was used to define a coordinate system. We positioned the RF in close vicinity to the skin markers with the z-axis of the RF coordination system perpendicular to a plane which approximates the surface of the anterior skin. Movements of the skin markers in z-direction were utilized to monitor respiration and movements parallel to the RF (x-, y-axis) were interpreted as body movements.

We used the vacuum device BodyFix (Medical Intelligence) to fixate the volunteers in order to test its ability to prevent patient movement.

Results

For every volunteer we performed two series of measurements. The first measurement was done without the fixation device. We recorded the movement in z-direction for every volunteer and obtained a highly sufficient respiration curve. In addition, each volunteer was asked to move in order to test the integrated alert system for body movements. Relevant movements were detected by the system and it was also possible to distinguish between body movement and motion caused by respiration.

We performed the same measurement in combination with the fixation device. A sufficiently well pronounced respiration curve was still measurable for all volunteers but with a lower average amplitude. As a result of the fixation, it was difficult for the volunteers to move, which was intended. Small motions were detected by the alert system as a result of the volunteer's effort to move.

Conclusion

Using our motion detection system it was possible to detect both respiration and body movements. Its integration into a robot-assisted needle positioning system shall allow a visualization of respiration curves during the intervention and give an important feedback on the current respiration behavior of the patient.

In contrast to a respiratory belt which can also be used for monitoring respiration, we were able to simultaneously detect body movements with our system. By using a fixation device it was possible to prevent involuntary body movements.