PRECISION AND ACCURACY OF MOTION TRACKING SYSTEM FOR PEDICLE SCREW PLACEMENT IN ADOLESCENT IDIOPATHIC SCOLIOSIS

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Introduction

Background
- Prevalence of adolescent idiopathic scoliosis (AIS) is 2-3% [1]
- Severe curves require surgery involving inserting pedicle screws into the spine to secure instrumentation to the spine.
- Accuracy and precision are critical to prevent spinal cord or vascular damage from screw malpositioning

Naviagation in Spinal Surgery
- Navigation systems use motion capture to track surgical tools in conjunction with intraoperative CT scans to provide image guidance
- Required accuracy cited as approximately <1mm of translation and <5° of rotation for the thoracic spine [2]
- Current navigation systems have technical accuracy of 0.2-0.6mm [3,4]
- Goal of study is to evaluate motion capture for an ultrasound navigation system for spinal surgery

Objective
1. Determine the static precision of Optitrack Prime 13W motion capture cameras.
2. Evaluate the translational and rotational accuracy and precision of motion capture cameras at varying magnitudes

Methods

Camera and Capture Volume Setup
- 3 Optitrack Prime 13W motion capture cameras placed 0.7-1.2m from the capture volume. (Figure 1)
- Motive: Tracking software used to calibrate and obtain data.
- Mounted three 7.9mm markers onto custom 3D-printed rigid body
- For translational testing, rigid body mounted on digital calipers
- For rotational testing, rigid body mounted on 3-directional protractor

Experimental Setups for Accuracy Testing
- Static Testing: 6 hour trial to evaluate positional/rotational precision with sampling every five minutes
- Translational Accuracy: Evaluated accuracy at 1cm, 2cm, 4cm, 8cm and 15cm increments in X, Y and Z directions (Figure 2) 
- Rotational Accuracy: Evaluated single angles, angles <10° and >60° (Figure 3)

Discussion

Limitations to Study
- Rotation sometimes erred by more than 6° for rotations in two directions greater than 70°
- Directions of movement were in approximate directions, not perfectly aligned to camera position.

Conclusions
- Static precision is 0.15mm and 0.12° when including pre-heating
- Translational accuracy is 0.25mm while rotational accuracy is 3.5° for angles up to 70°.

References

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