UNIVERSITÄT ZU LÜBECK

TECHNISCHE HOCHSCHULE LÜBECK

Program: Biomedical Engineering

Master's thesis

Topic:

Development and Optimization of 2D/3D Cage Planning and Visualization for Lumbar Spine Surgery: A Computational Approach

Summary:

Accurate cage planning and placement during lumbar spine surgery is crucial for restoring spinal alignment and ensuring the success of spinal fusion procedures. This thesis presents a computational system for optimizing cage placement in Posterior Lumbar Interbody Fusion (PLIF), Lateral Lumbar Interbody Fusion (LLIF), and Transforaminal Lumbar Interbody Fusion (TLIF) surgeries. The system employs 2D-to-3D transformation techniques to convert radiographic images into precise three-dimensional coordinates, enhancing the surgeon's ability to visualize and position spinal cages preoperatively. Both 2D and 3D visualization methods were integrated into the system, allowing for more intuitive planning and intraoperative guidance. Key parameters, such as the Center Point Ratio (CPR), guide the accurate placement and alignment within the vertebral endplates. A unique approach was adopted to calculate cage positioning, taking into account the patient's anatomical variability and surgical goals, including lordotic angle restoration and minimization of disc height reduction. The integration of surgical navigation systems further improves precision, with real-time tracking of the instruments and cage positions during surgery. In addition to technical innovations, this study introduced methods for automatic cage parameter computation to ensure more consistent and accurate placement outcomes across different patients. By combining advanced computational models with clinical feedback, this study lays the foundation for future navigation systems that can streamline and enhance the accuracy of spinal fusion surgeries through enhanced 2D and 3D visualizations.

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