Diplomarbeitspräsentation

FAKULTÄT FÜR !NFORMATIK

Faculty of Informatics

GE Healthcare

Application of Smart Visibility on Medical 3D Ultrasound Datasets

Masterstudium:
Visual Computing

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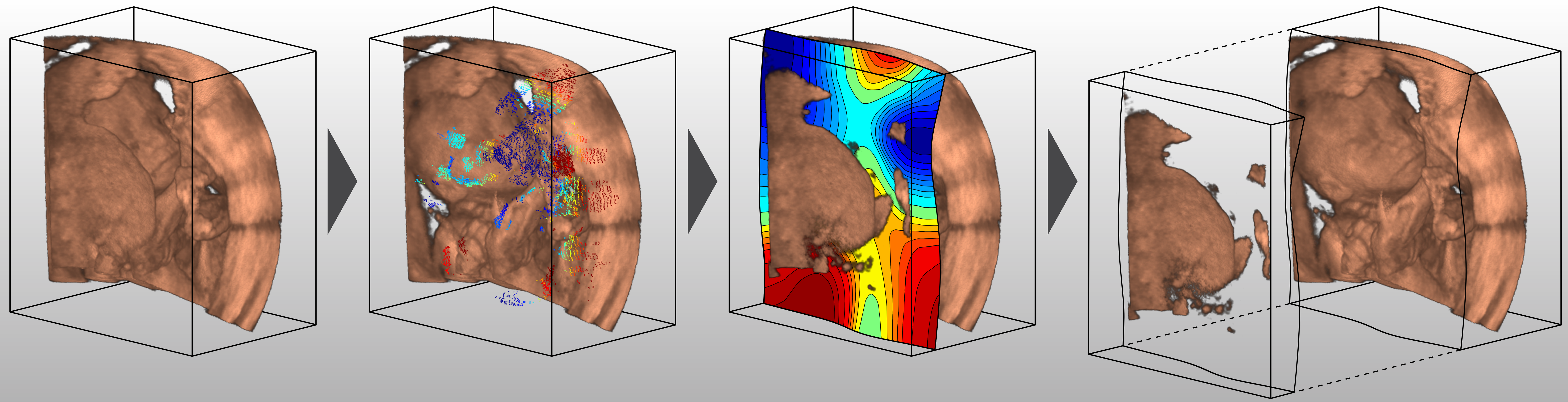
Motivation / Problem Statement

In visualizations of three-dimensional ultrasound datasets, the occlusion of the region of interest by surrounding tissue is one of the main problems. Currently used techniques to remove occluders from visualizations are often difficult to control and interrupt the work flow of an US examination session.
This work evaluates the smart visibility method for prenatal ultrasound. This recently developed technique reduces the user interaction required to achieve unoccluded visualizations of the fetus in obstetric datasets.

Contributions

- Development of a modular evaluation framework to analyze smart visibility method implementations
- Evaluation of the quality and performance of the smart visibility method with three different implementations of the surface reconstruction step
- Integration of the smart visibility method into state-of-the-art ultrasound machine firmware

Smart Visibility Method



Input Dataset
The smart visibility method operates on the unedited results of a 3D ultrasound scan. The three processing steps are shown on one of our test datasets.

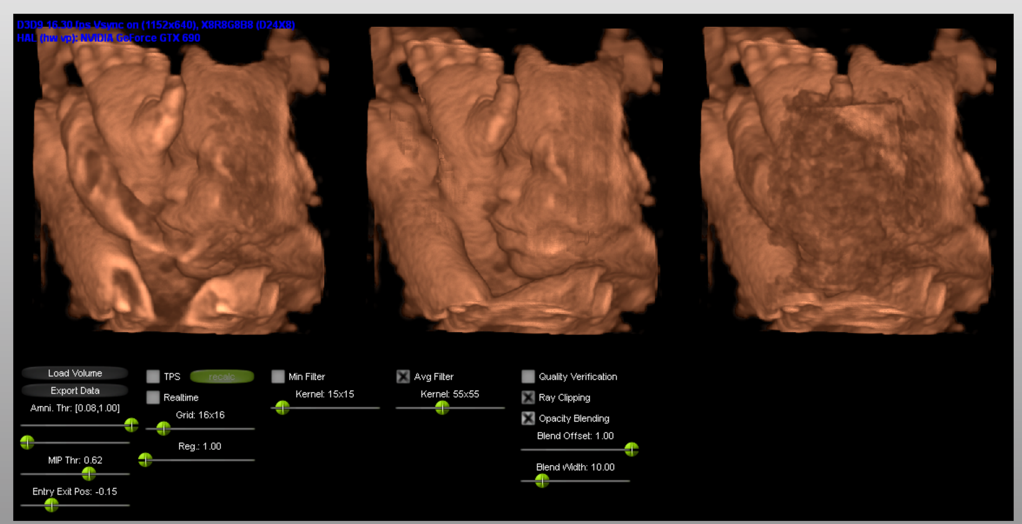
Initial Point Selection
A set of points located between the occluding tissue and the fetus is heuristically selected based on anatomic features found within the dataset.

Surface Reconstruction
The initial points are used to reconstruct a clipping surface. This surface separates the fetus from occluding tissue.

Rendering
The clipping surface is used to remove occlusions in a Direct Volume Rendering (DVR) visualization of the dataset. Areas in front of the surface are omitted during the rendering process.

Evaluation Framework

Our evaluation framework shows the smart visibility method results next to visualizations of the corresponding ground-truth and input volumes for visual verification. All parameters of the smart visibility method are accessible. The framework provides functions to measure the occlusion removal quality and performance of the tested methods. Additionally, it offers a batch processing mode for parameter space analysis.



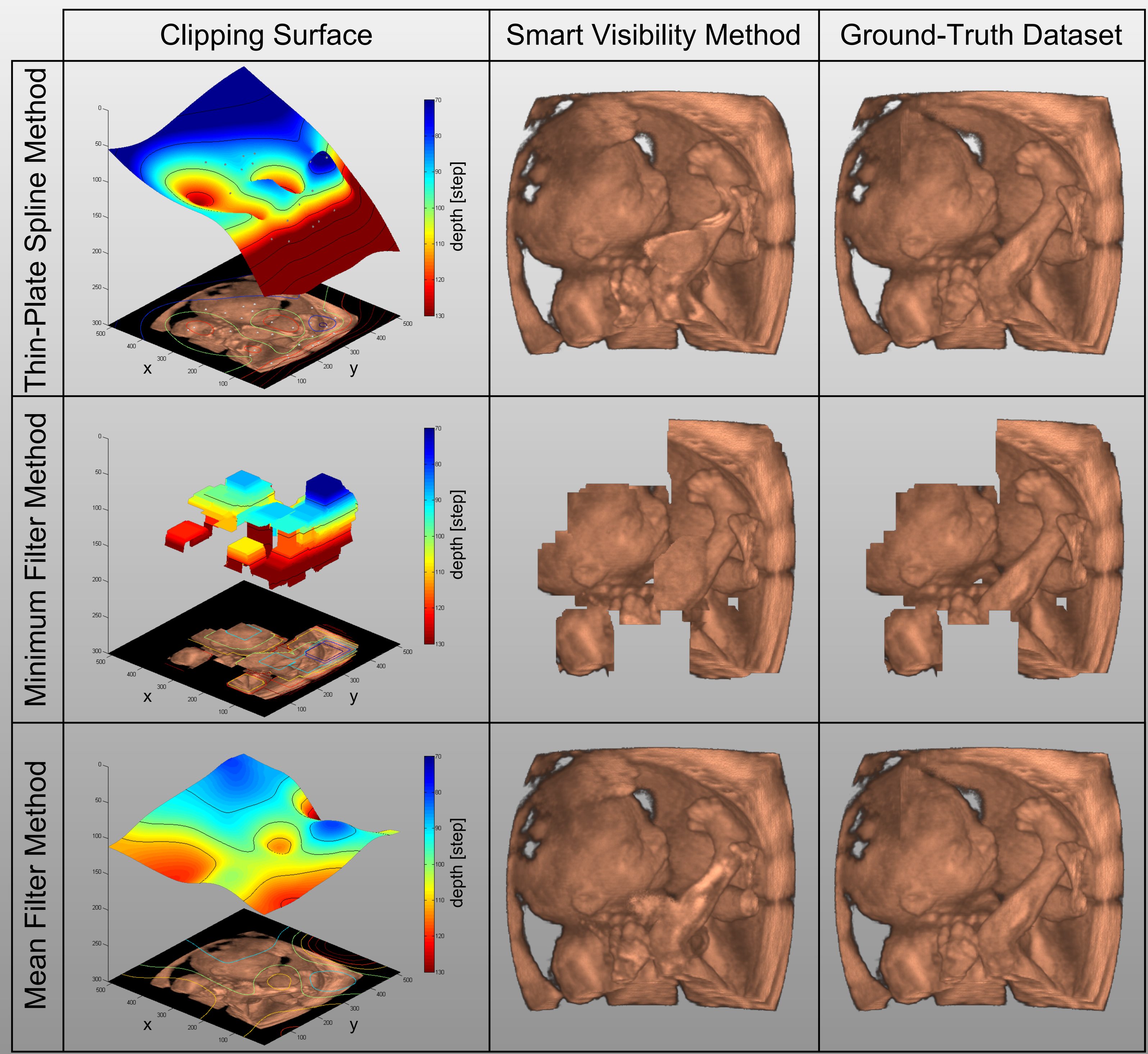
User Interface of the Evaluation Framework

Results

- The evaluation was performed using 9 test datasets provided by GE Healthcare. The Mean Filter Method has shown the best results in both occlusion removal quality and performance.
- A parameter space analysis of the Mean Filter Method revealed default settings, that reduced the required user interaction to a single parameter.
- The Mean Filter Method has been integrated into the Simu3D ultrasound firmware provided by GE Healthcare. By using hardware controls to adjust the single remaining parameter of the Mean Filter Method, it can be used as an integral part of ultrasound examinations.

Smart Visibility Method Evaluation

Three different implementations of the surface reconstruction step have been evaluated. The global Thin-Plate Spline (TPS) Method reconstructs the surface as linear combination of radial basis functions. The local Minimum and Mean Filter Methods are based on image filter techniques.



Visualization of smart visibility method results and ground-truth datasets

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