Ein effizientes Verfahren für die Segmentierung der Nasennebenhöhle

An Efficient Approach for Segmenting the Paranasal Sinus

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Purpose:

Functional endoscopic sinus surgery (FESS) is the state of the art in the surgical treatment of endonasal pathology. For a more accurate access planning including 3D measures of the cavity, especially in complex cases of tumor diseases, a segmentation of the paranasal sinus might be a useful tool. Moreover, a system that allows for determination of the volume of the nasofrontal duct and if it is open or not may supply future rhinologists with valuable diagnostic information. In addition, segmentation of the endonasal cavities can be regarded as an extreme useful technology in future approaches using robot assisted, navigation-controlled procedures in endonasal sinus surgery.

Unfortunately, this structure is quite complicated and difficult to segment, so that previous methods require little less than an hour (Apelt 2003). In our contribution, we propose the a semi-automatic segmentation pipeline that reduces the total processing time significantly, and the required interaction to a few minutes.

Methods:

Our segmentation process is based on a multi-slice CT scan of the head focusing on the paranasal sinus region. This region contains several membrane-like structures that make the segmentation a non-trivial process. We begin with a preprocessing step in which we first correct the contrast of the input dataset.

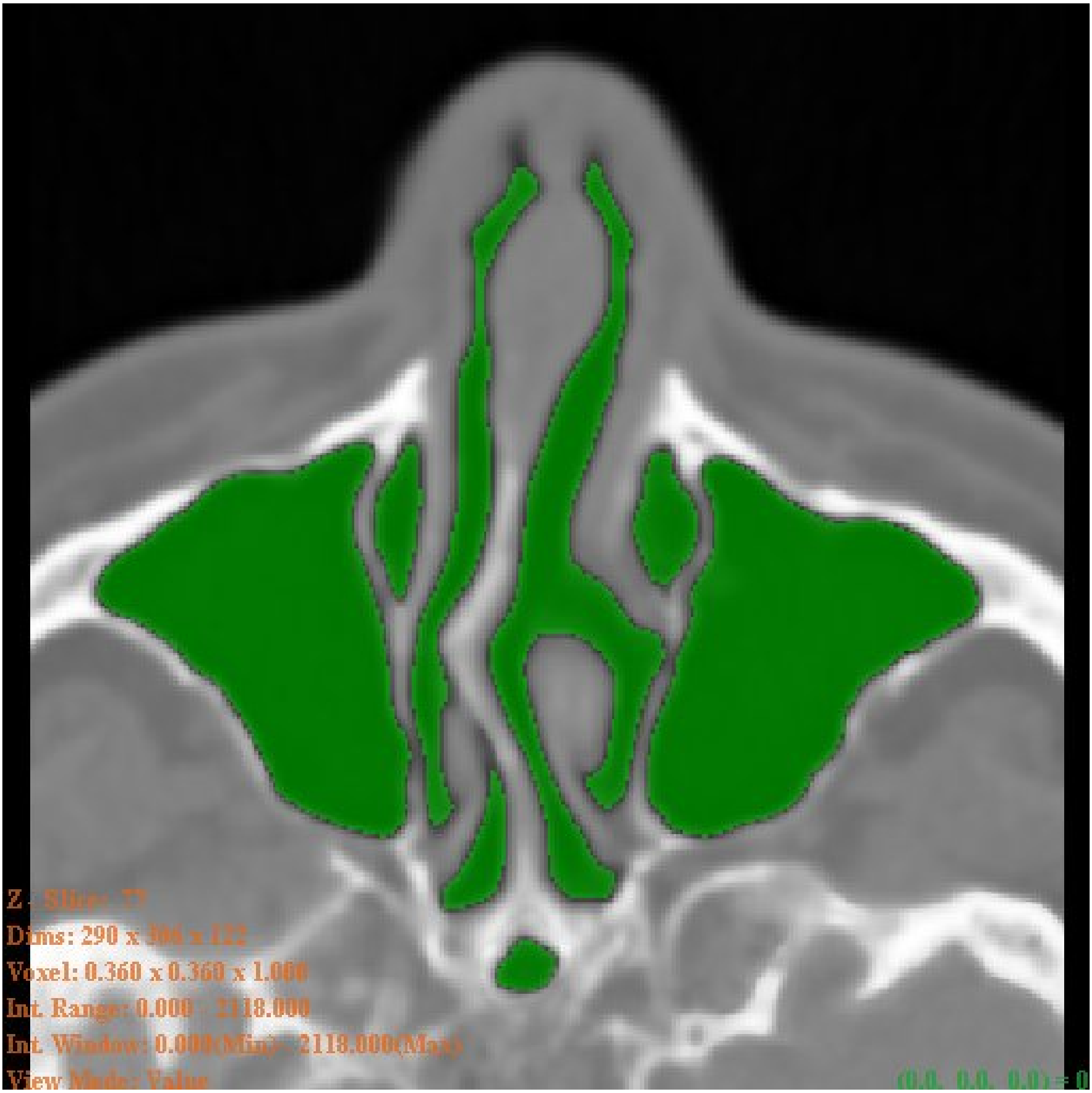
Bad contrasts are usually caused by existing metal parts (gold teeth, implantats, etc.) that appear in extremely high intensities relative to the actual anatomical structures.
Datasets are then denoised by Gradient Anisotropic Diffusion, which is an edge-preserving smoothing method. The use of such smoothing is important since traditional blurring approaches tend to resolve thin, sharp structures, that are important in our case.

The actual segmentation is based on 3D intensity-based region growing. We firstly apply this region growing process to highlight the grey soft tissue. We then mark bone structures similarly. This will make sure that these structure are not harmed when we segment the sinus. Finally the paranasal hull is extracted (Fig. 1). Threshold values needed for the region growing filters (of the grey tissue and the sinus) are calculated by examining the histogram of the smoothed image (that we got from the previous step) to find intensity ranges where the frequency distribution abruptly changes.

Due to the nature of the region-growing filters, the segmentation that we acquire may leak into parts that actually do not belong to the sinus (eg. into the mouth and out of the nose holes). To overcome this problem, we use a post-processing editor that detect the leakage regions by generating a path (centerline) from a source point in the sinus and a destination point in the leaked region. A cutting plan is then placed at the location where the cross section across the centerline reveals the narrowest connection.

Results and Conclusion:

We propose an efficient procedure for segmenting the paranasal sinus, that includes very limited user-interaction. A complete segmentation session, including leakage correction, ranges between 2 and 6 minutes. This segmentation is intended for several clinical applications such as computer aided or navigated and robotic assisted surgery of the paranasal sinus. Moreover, we present a prototype of a paranasal walk-through system (Fig. 2), which allows for unconstraint walk-through in the sinus and hence reaching regions that are difficult to navigate by traditional endoscopes (eg. the maxiliary sinus).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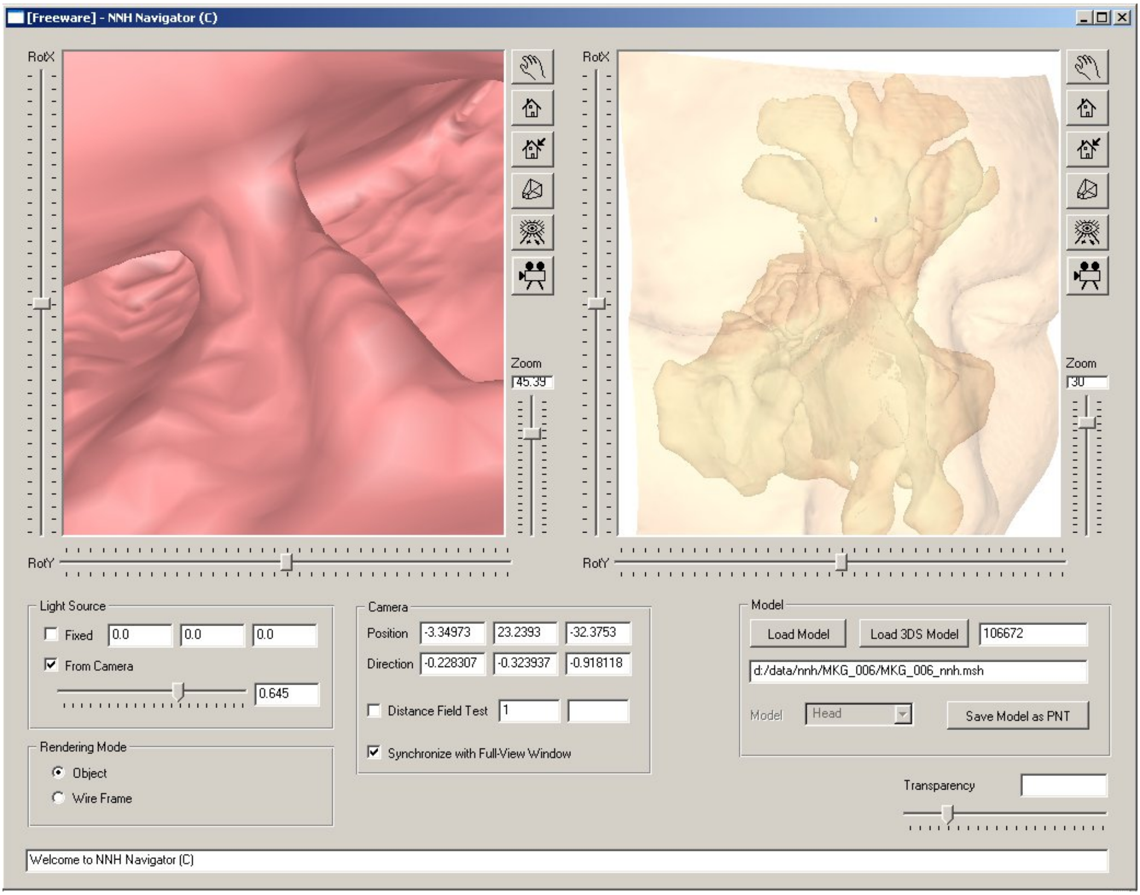
[Freeware] - NNH Navigator (C)
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Distance Field Test
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Synchronize with Full-View Window
Model
Load Model
Load 3DS Model
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Head
Save Model as PNT
Transparency
Welcome to NNH Navigator (C)