Assessment of Segmentation Dependence in Macroscopic Lung Cavity Extraction

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Training of respiratory motion models and population-based patient phantoms of the lung often requires the definition of the entire lung cavity region in the 4D-CT. To ease the workload of clinical experts, automatic selection is highly desirable. Many lung cavity extraction methods rely on a pre-segmented lung volume. We propose a simple yet fully automatic pipeline that preserves the 3D shape of the lung while also incorporating the chest wall and diaphragm, both of which carry significant respiratory information.

The proposed pipeline consists of three main parts: First, a convex-hull algorithm provides a mesh representation encompassing the lung region in continuous world coordinates. Second, raycasting w.r.t. the original dimensions returns a voxelized binary volume, and third, morphological operation includes the desired parts of the diaphragm and chest wall.

For seven 3D-CT patient datasets in end-inhale respiratory state, we evaluated the pipelineś robustness against the chosen segmentation method by comparing three different initial segmentations: 1) An intensity-based method using adaptive thresholding, 2) a registration-based atlas segmentation, and 3) segmentation by a 3D fully convolutional neural network.

A dice-score increase of up to 0.167 and average pair-wise sensitivity of 91.2 % and specificity of 98.7 % show that the pipeline is reasonably robust against varying initial segmentations, indicating that a simple intensity-based method provides similar results to complex deep-learning approaches. The resulting lung cavity can find use in population models of internal organ structures or serve as a cropping mask for the ground truth of motion models.