3D Surface-Based Detection of Pleural Thickenings

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Medical Background

- Long-term consequences of asbestos exposure
- Commonly used till the 1990s (in Germany)
- Accumulated in the lung
- Permanent penetration of pleura
  ⇒ Thickening expansion in transverse direction only partially regarded
- Expected maximum of diagnosed cases 2018 [1]

Motivation

- Difficulties in diagnosis
  - High workload (each dataset with 700 slices)
  - Strong inter- and intra-reader variance [2]
- Manual volumetric measurements not practicable
- To date, thickening expansion in transverse direction only partially regarded

Framework

- Fully automatic processing
- Detected thickenings and matching modifiable
- Follow-up assessment with objective volumetric measurements
- Processing steps realized in 3D volume image

Methods

- Healthy lung modeled individually
- Potential thickenings described by difference of healthy and actual lung
- Required input data: lung mask, obtained by two-step supervised thresholding [3]
- Provided output data: pre-segmented thickenings

Notes on the Implementation

- Number of points reduced by edge detection
- Convex hull created by Quickhull algorithm [4]
- Fast voxelisation of triangles by extracting slice crossing triangles

Sliding Convex Hull

- Definition:
  \[ \text{conv}(R_z) = \left\{ \sum_{i \in R_z} a_i \right\} \]
- For each slice \( z \):
  \[ R_z = \{ (x, y, z) \in R : |x - \ell| \leq n \} \]

Results & Conclusion

- Thickenings are small (<2000 mm³) compared to expected healthy anatomical structures (>10000 mm³)
- Thickening tissue has higher CT-number (20 to 60 HU) compared to fat tissue (-220 to -50 HU)
- Macroscopic anatomic structures might cover thickenings
- Structures masked by erosion
- Growing structuring element
- Combination of results from all erosion levels provides final set of thickenings
- Number and volume of thickenings are compared
- Stable results for parameter \( n \geq 4 \)
  ⇒ Successful consideration of connectivity in z-direction by adapted expansion of hull

References