Layered Surface Detection in Micro-CT Tetra Pak Data

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Layered Surface Detection in Micro-CT Tetra Pak Data

Vedrana Andersen Dahl, DTU Compute

Industrial CT scanning Erfa-group meeting, 7. October 2014

Focus on...

- Image analysis. Principles, challenges, opportunities. . .
- One surface detection algorithm

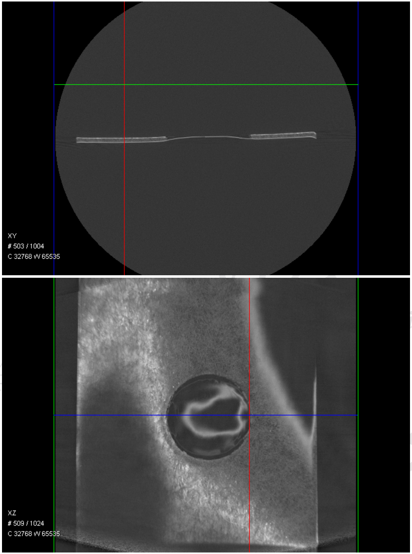
Data collection

Carsten Gundlach, DTU Physics

Three settings

- Objective: LFOW, Pixel size: 21.2 μm
- Objective: 4X Pixel size: 4.7 μm
- Objective: 10X Pixel size: 1.9 μm

Voltage 40 kV
Power 10 W
Filter AIR
Exposure: 5 s, 5s, 25 s.



Data collection

Carsten Gundlach, DTU Physics

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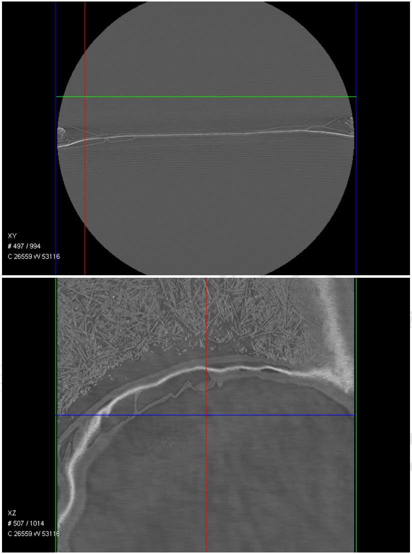

Data collection

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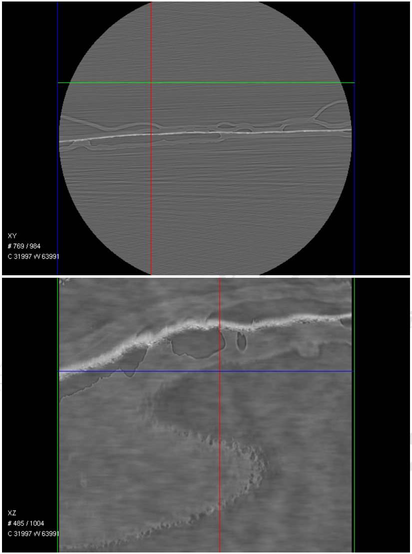
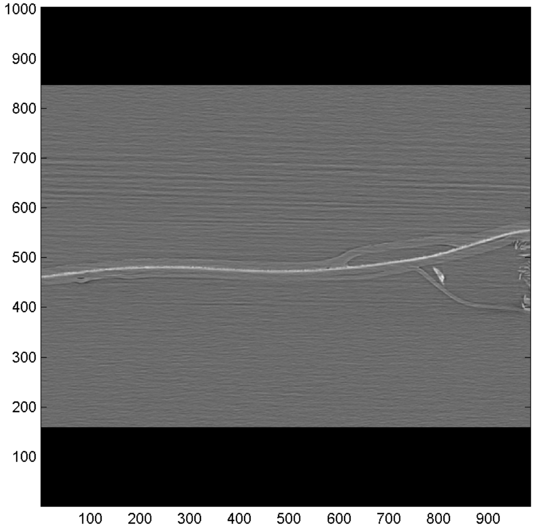


The nature of data

- Data is noisy, including projection data. Reconstruction data cannot be less noisy without assumptions.
- All image/volume segmentation is based on assumptions.
- Our interpretation of data depends on assumptions made under analysis – also in cases where those assumptions are implicit.

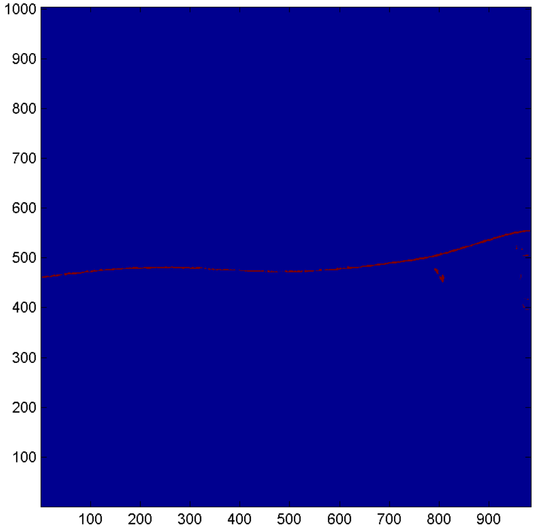
Surface detection, initial analysis

Example slice, volume dimensions 980 × 984 × 1004 voxels



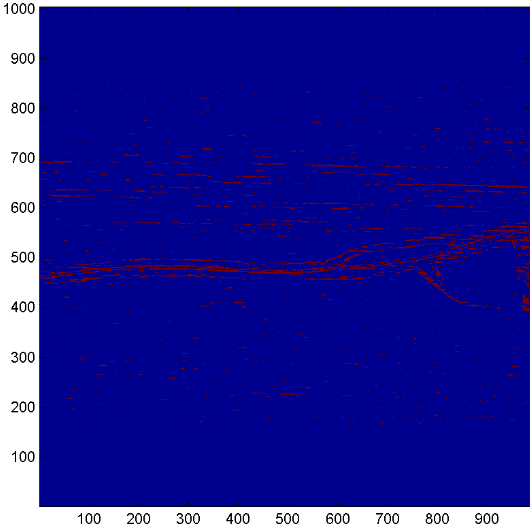
Surface detection, initial analysis

Thresholding aluminium foil – ok



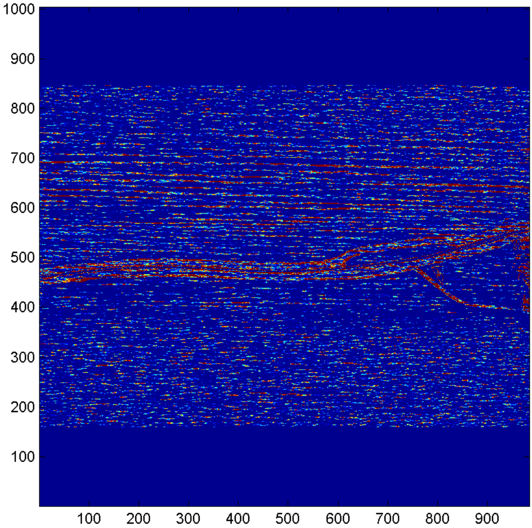
Surface detection, initial analysis

Thresholding plastic membrane – noisy



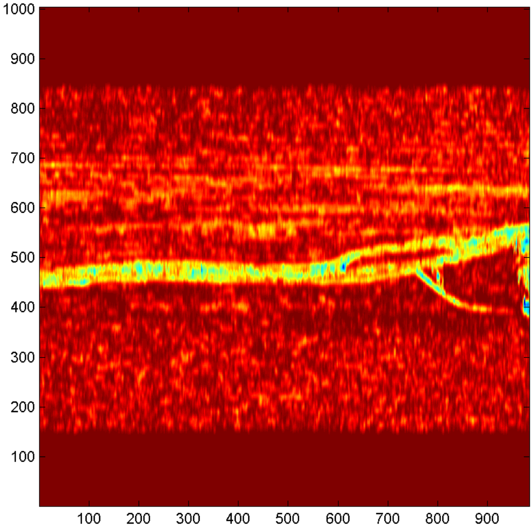
Surface detection, initial analysis

Relaxed plastic membrane response



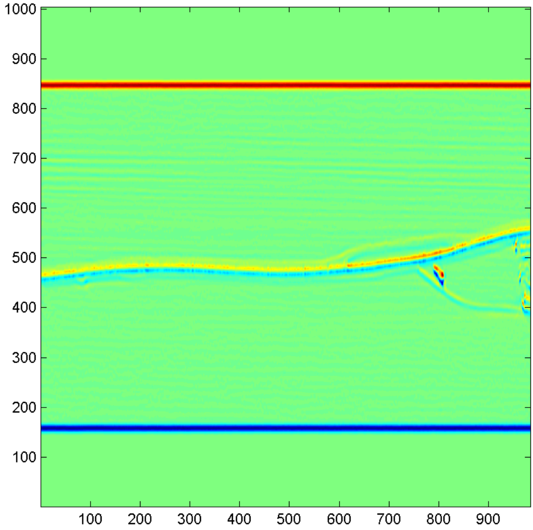
Surface detection, initial analysis

Averaged relaxed plastic membrane response – a useful contribution



Surface detection, initial analysis

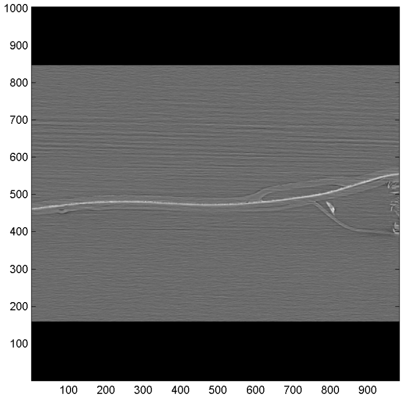
Edge response – a useful contribution



Surface detection, initial analysis

- Challenges: data size, presence of noise.
- Conclusion: We need to choose a model, including an appearance model and a geometric model.

Surface detection, suggested geometric model



- Terrain-like surfaces

$$z = f(x, y)$$

- Smoothness

$$|f(x+n, y) - f(x, y)| < \Delta$$

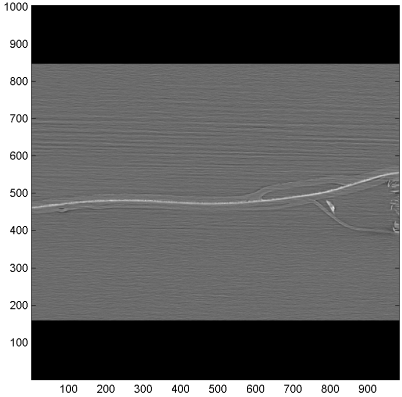
$$|f(x, y+n) - f(x, y)| < \Delta$$

- Optimality

$$\min \sum_{x,y} c(x, y, f(x, y))$$

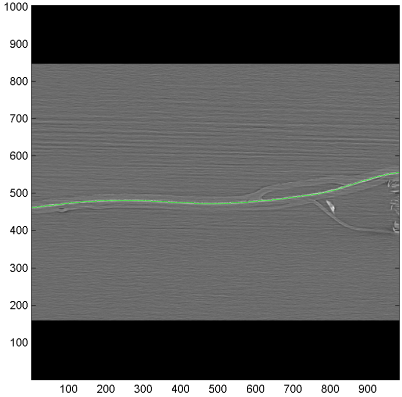
- Initial focus on three surfaces: aluminium foil, lowest edge, highest edge.

Surface detection, suggested appearance model



- Aluminium foil:
  - binary aluminium foil response
- Lowest and highest edge, a weighted sum of four contributions:
  - relaxed plastic membrane response
  - edge response
  - repulsion from aluminium foil (limited range)
  - cumulative term (first strong occurrence)

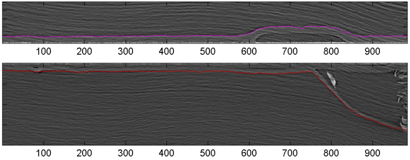
Surface detection, pipeline



Ordering

1. aluminium foil
2. lowest plastic edge and highest plastic edge in sampled images
3. plastic edge transformed back

Surface detection, pipeline



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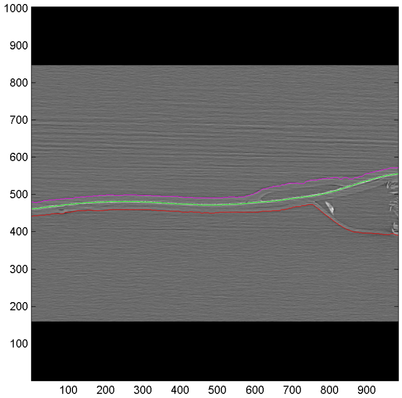

Ordering

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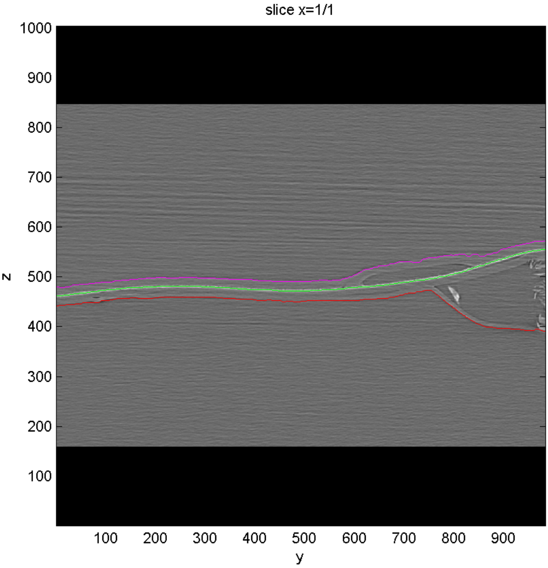
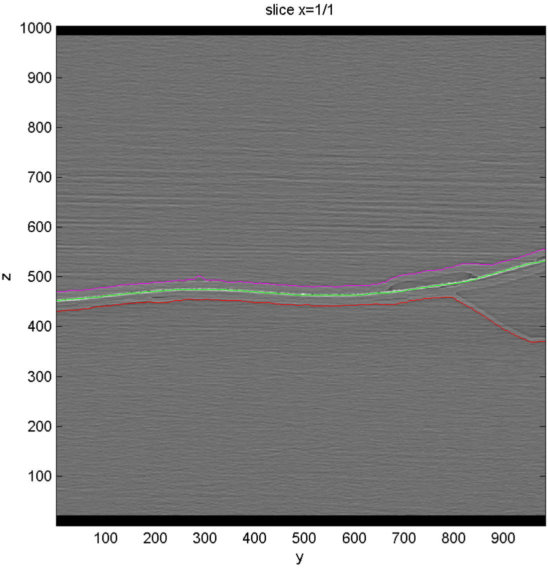
Surface detection, results



Surface detection, results



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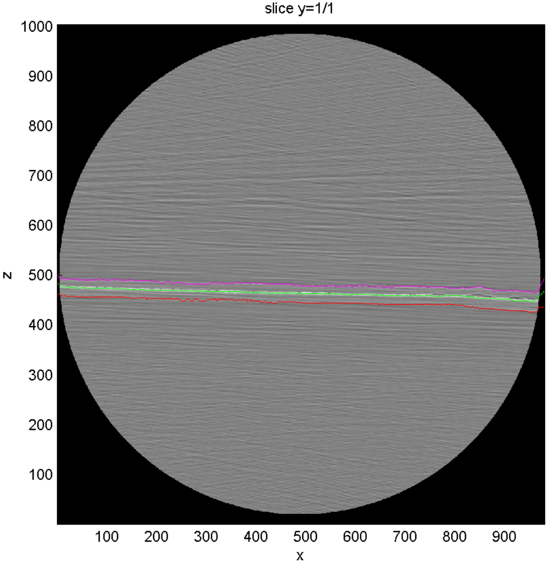
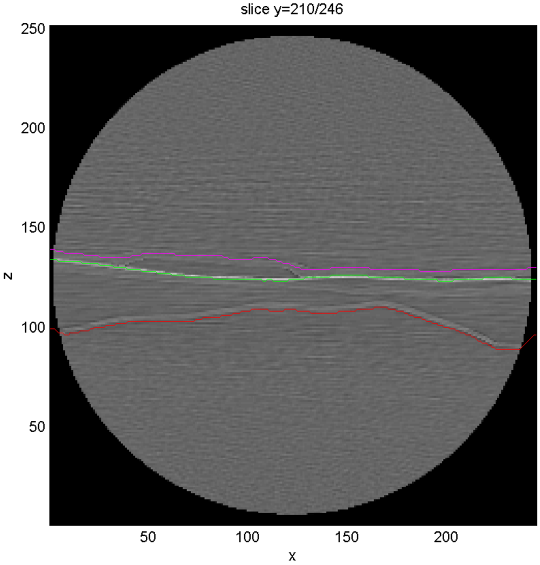
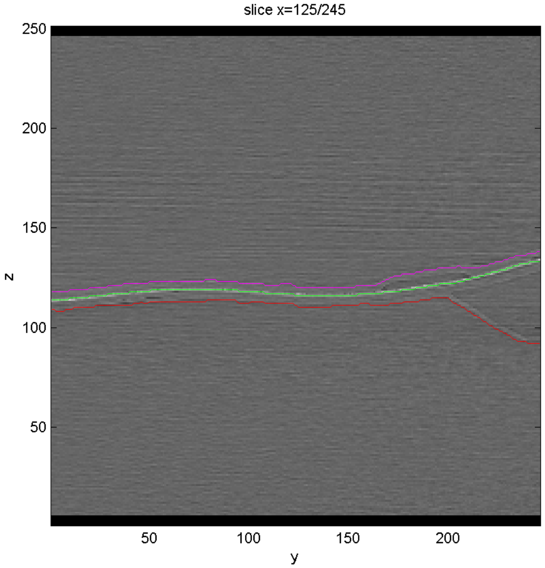


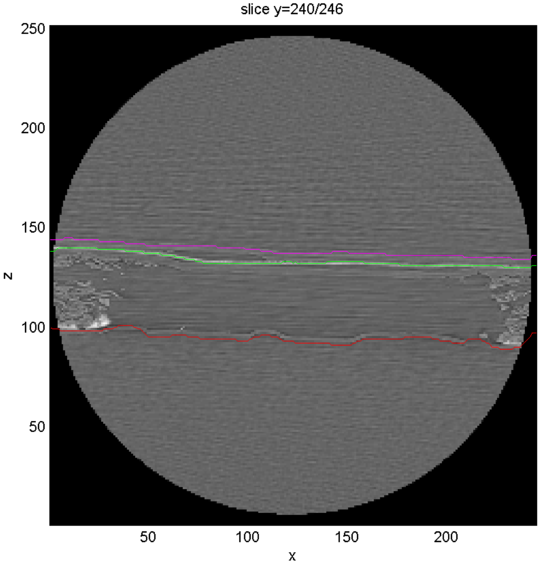
Surface detection, results



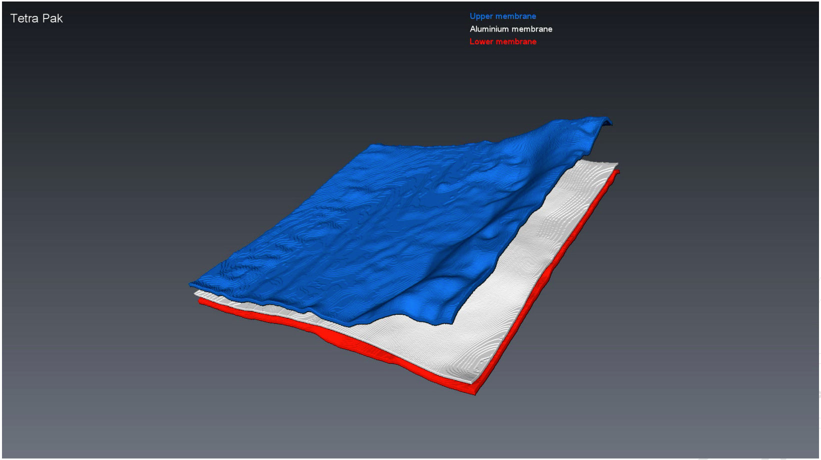
Surface detection, results



Surface detection, results



Results



Carsten Gundlach, DTU Physics

Surface detection, possible improvements

- Improvements: accuracy, boundary effect
- Extensions: multiple layers, inside regions

Thank you!