Cavity Surface Feature Recognition

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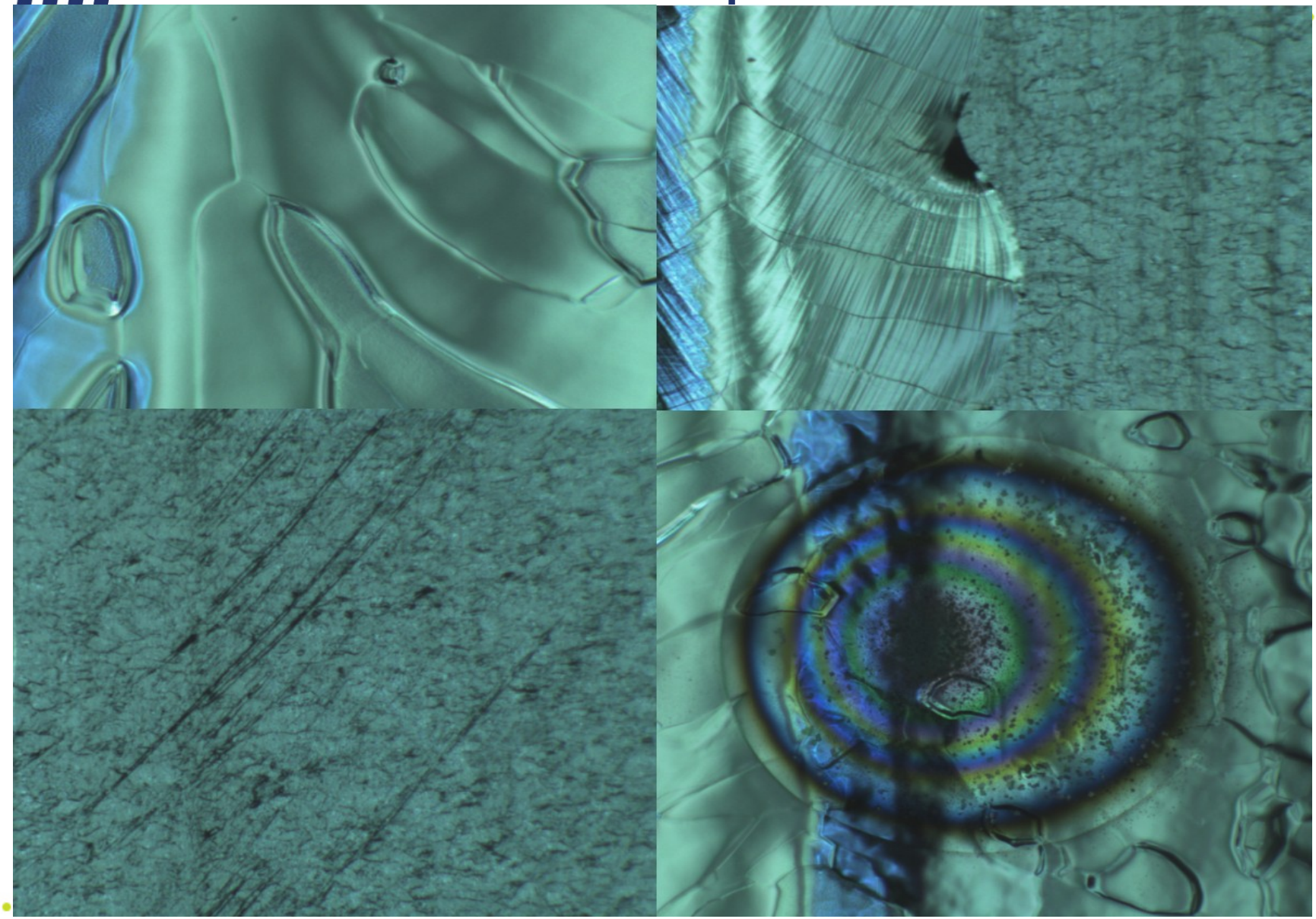
DESY

Examples



Optical Inspection (reminder)

- Picture covers an angle of 4 degrees
  - **90 Images per equator, 810 per cavity** **(without iris)**
  - **2616x3488 Pixel, 3.5µm/pixel, ~26MB per file**

How do I find 'irregularities' in this huge amount of data?

And are all the 'irregularities' defects?

Image understanding

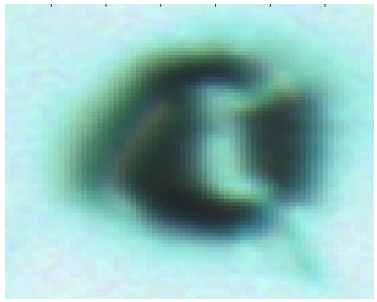
- There is no perfect way...
  - Depending on the task and the image: different techniques
  - Not even objective criteria for benchmarking of algorithms
- Step by Step:
  - Image creating / formating
  - Image processing (high & low level, bottom up or top down)
  - Image segmentation
  - Segment description
  - Pattern recognition / Image understanding

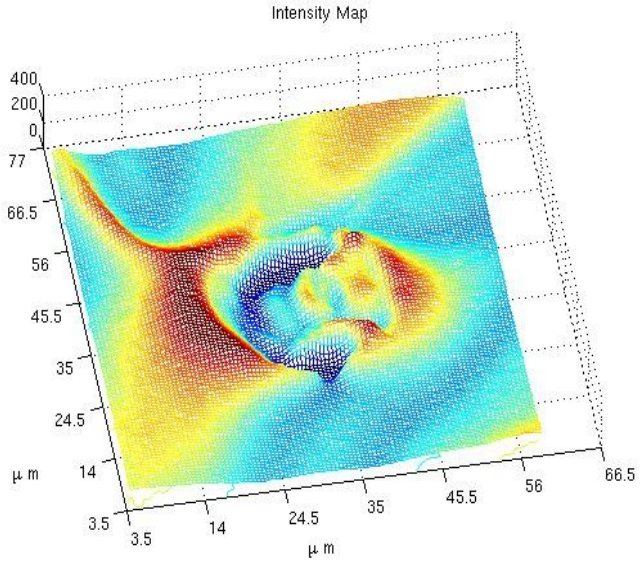
Image Segmentation

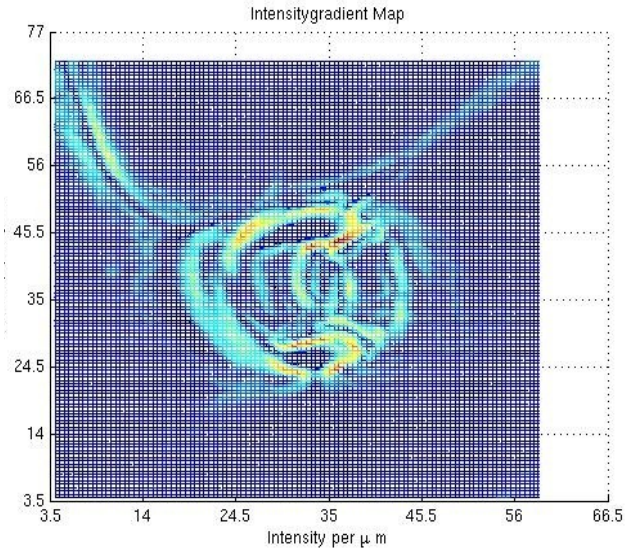
- Even processing is a vital point and can also used after segmentation, segmentation is the key
- What is segmentation?
  - **Split image in**
    - Background
    - Regions
  - **Merge regions if necessary**
  - **Analyze these regions**

Segment description

- What kind of parameter do we get?
  - **e.g. area, eccentricity, compactness, bending energy or curvature, euler number**
  - **Intensity gradient ~ slope**







Pattern Recognition

- Or: What can I learn from the parameter?
- What classes do exist?
  - **Mechanical defect**
  - **Grain Boundary**
  - **Chemical compound**
  - **Artifact**
- How to classify?
  - **Statistical Descriptor**
  - **Template Matching**
  - **Neuronal Network**
  - **Decision Tree**

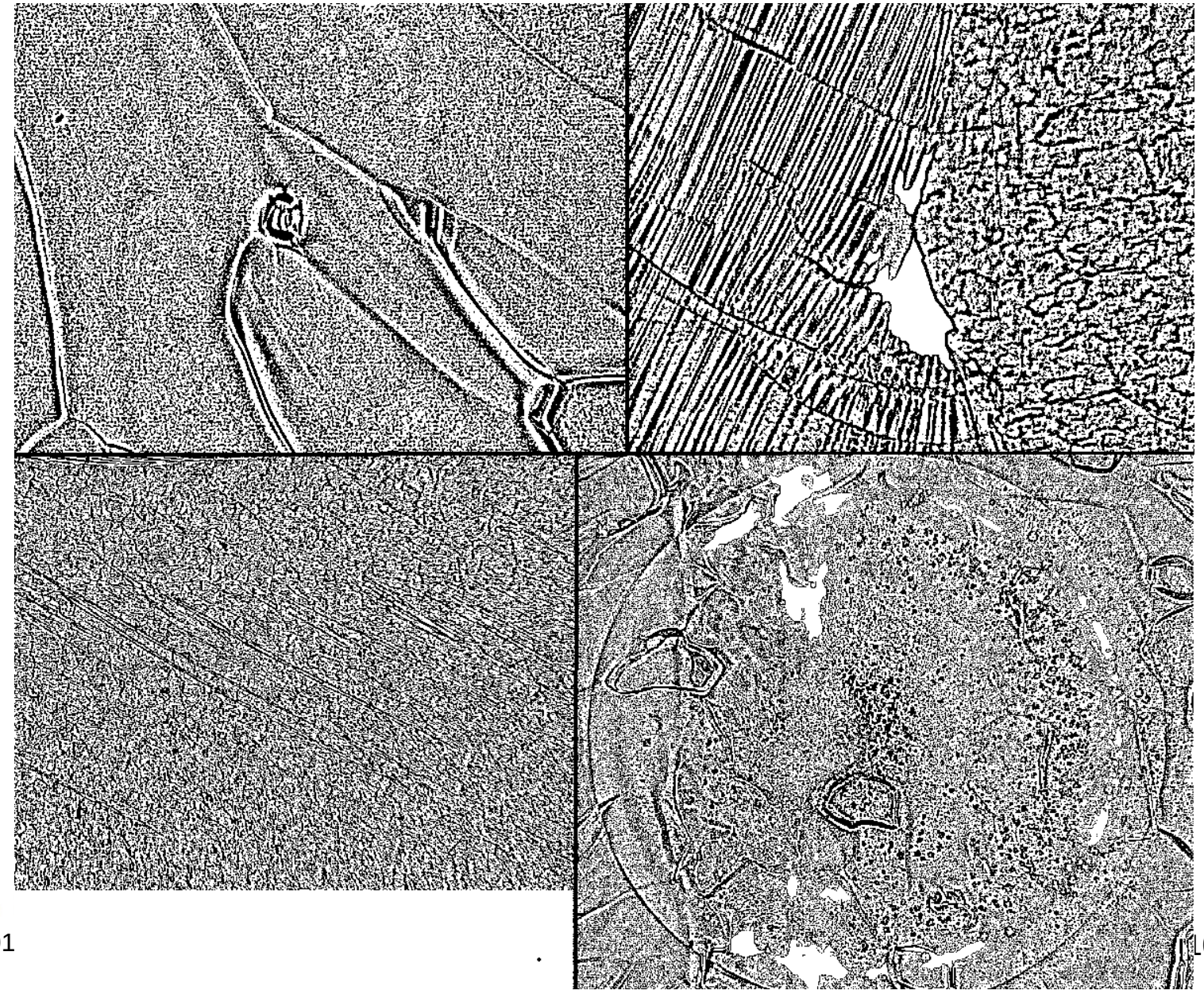
Future Work & Summary

- Quantitative characterization of the surface
- Search for Defects with higher Quench or FE probability
- Feedback to vendors concerning process quality

- Therefore, we need to find the right steps
  - **Different algorithms for different defects?**
  - **What parameters are relevant?**
  - **What classifiers are needed?**

Back Up

Processing



Watershed-Transformation

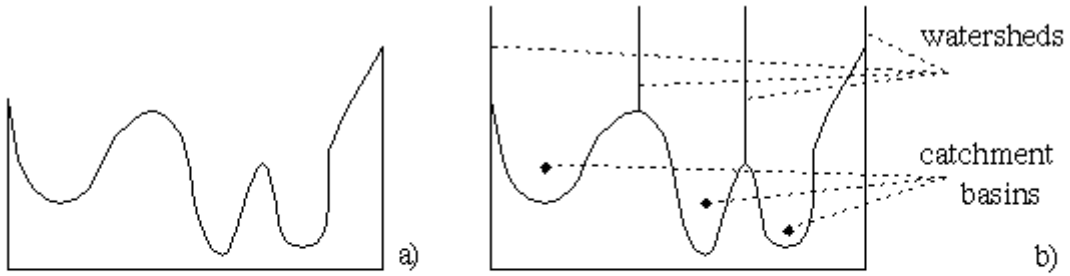
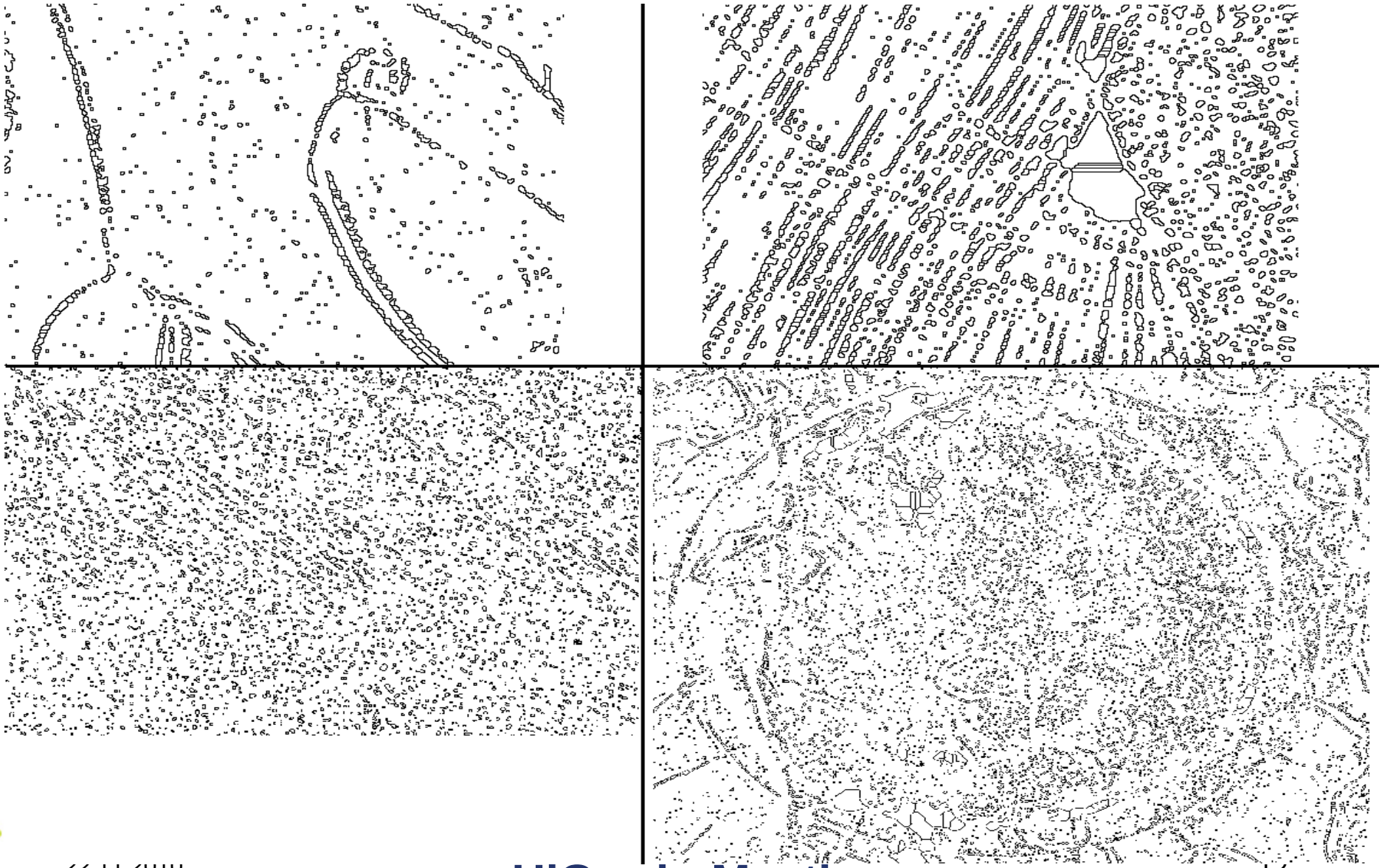


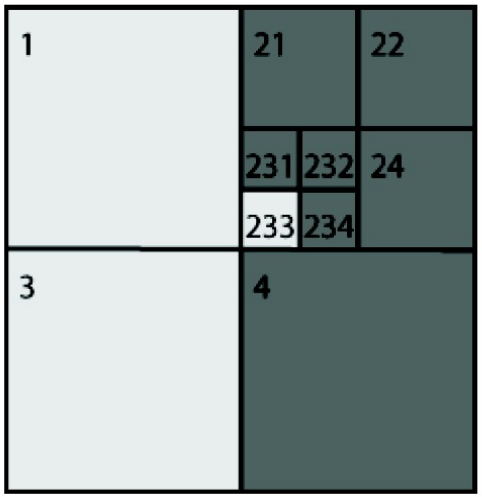
Figure 5.47 *One-dimensional example of watershed segmentation. (a) Gray level profile of image data. (b) Watershed segmentation – local minima of gray level (altitude) yield catchment basins, local maxima define the watershed lines.*

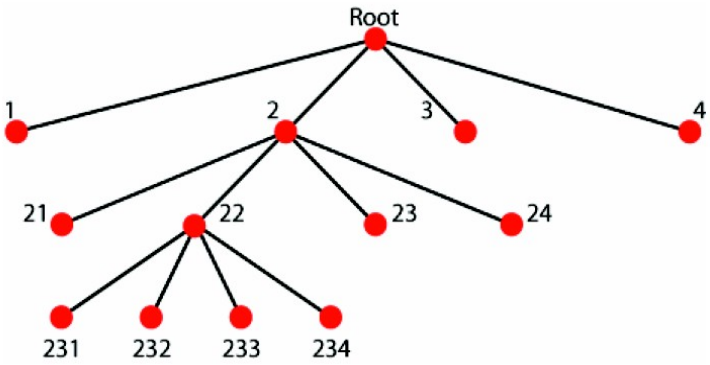
From: M. Sonka, V. Hlavac, R. Boyle, "Image Processing, Analysis and Machine Vision, Chapman & Hall Computing, 1993

Watershed-Transformation



Quadtree-Segmentation





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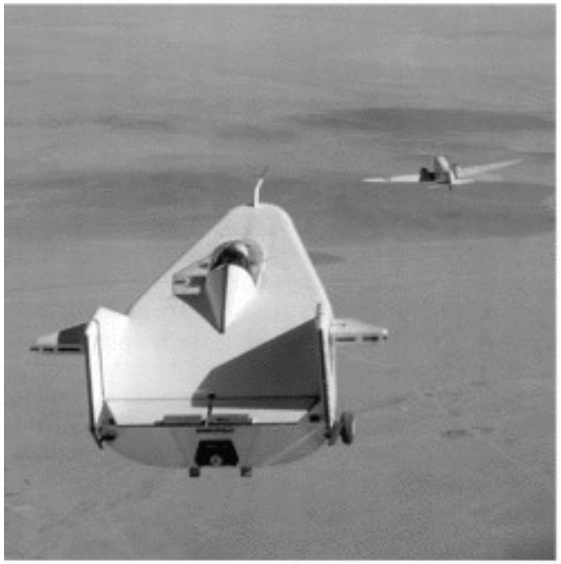


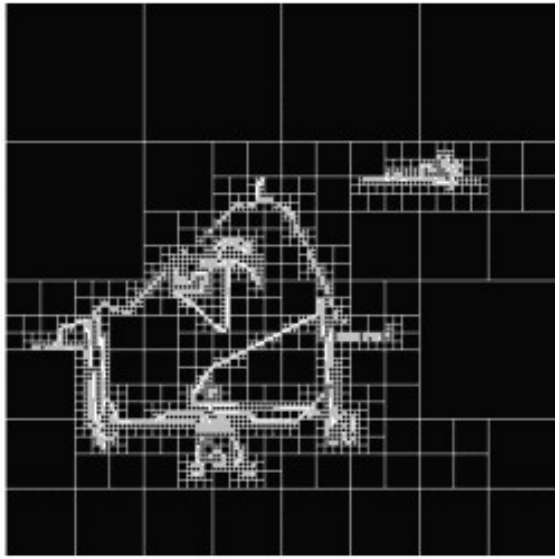
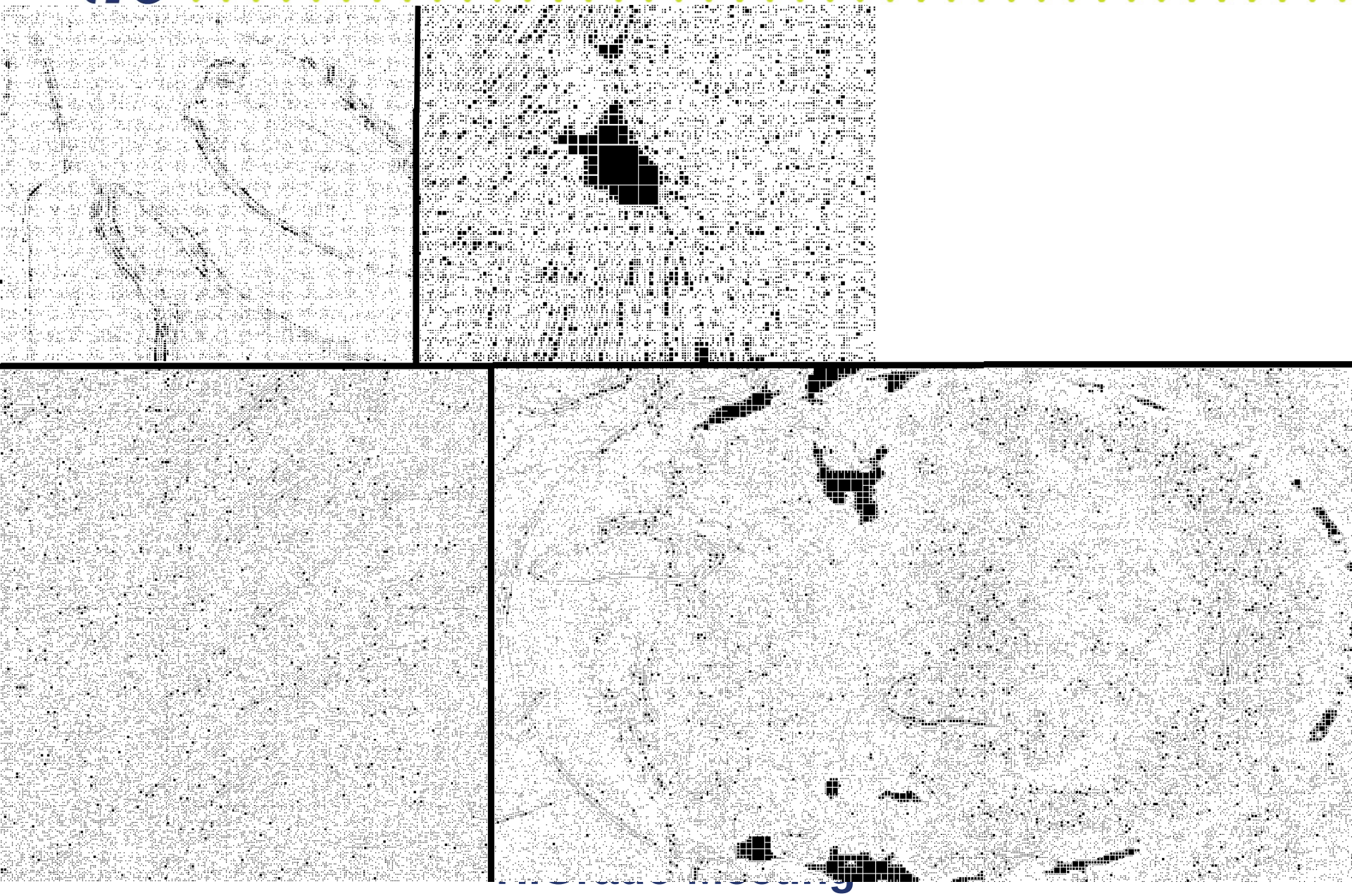


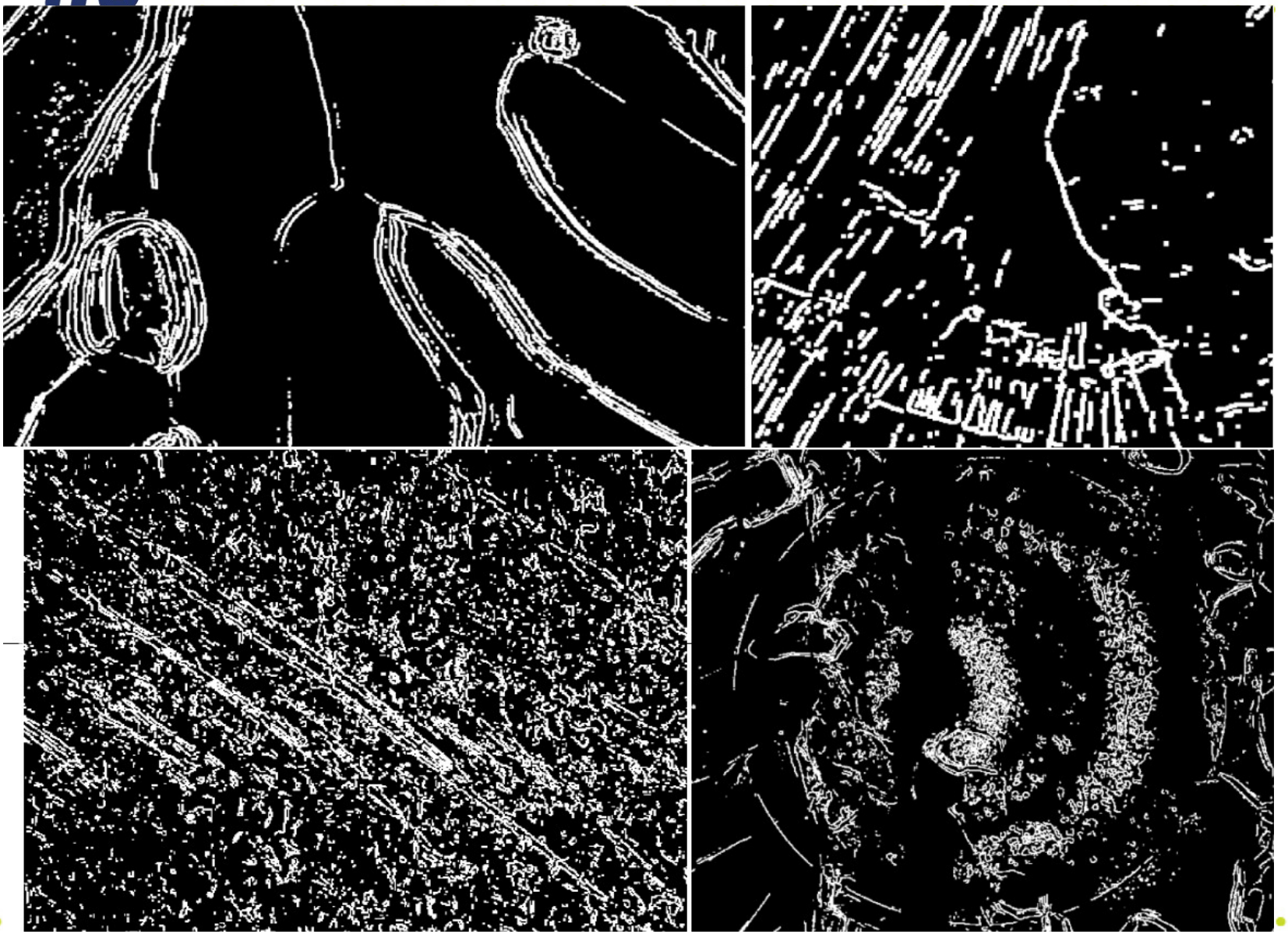
Image courtesy of NASA

Example taken from Mathworks Homepage: http://www.mathworks.com/help/toolbox/images/ref/qtdecomp.html

Quadtree-Segmentation



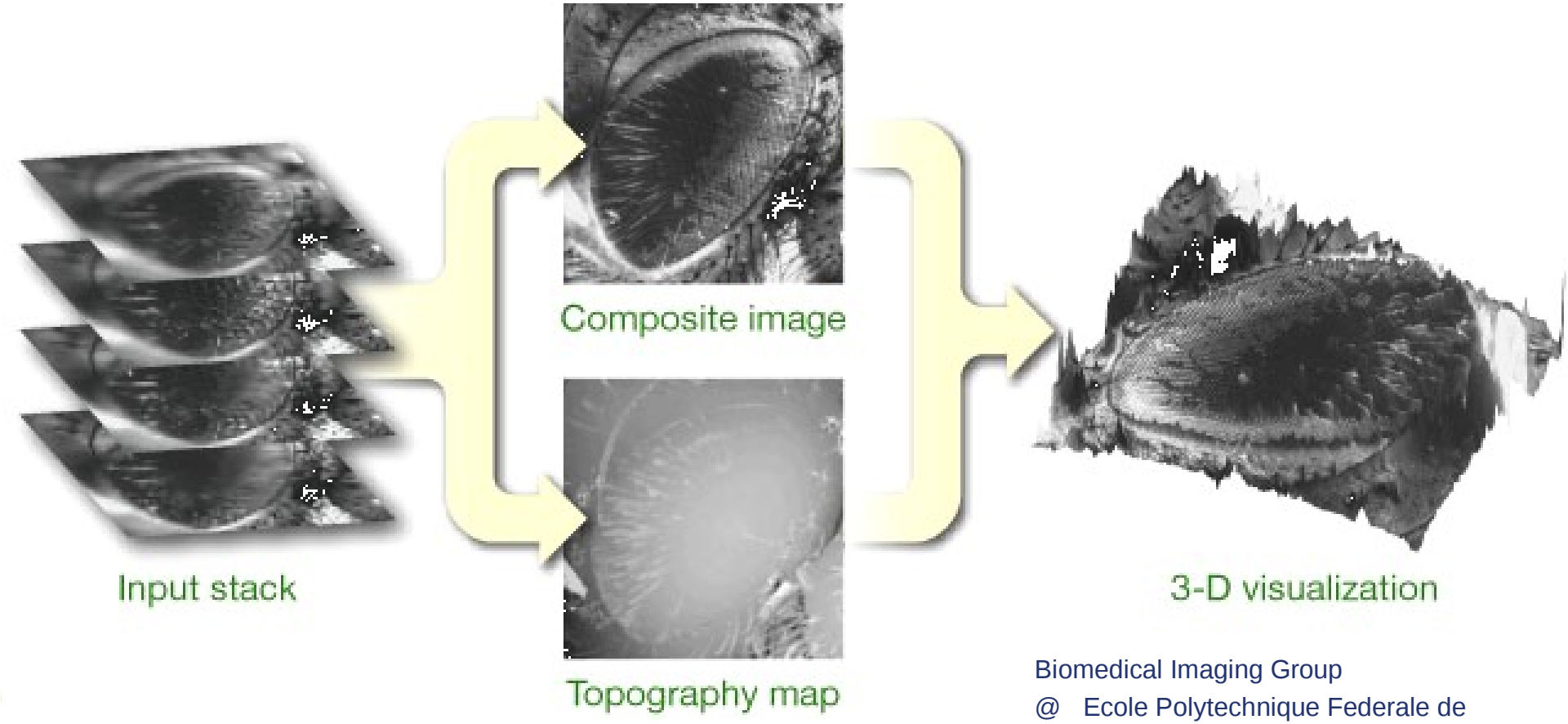
Colorbased-Segmentation



From 2D to 3D

- Extended Focus

  External program, based on ‘Complex wavelet-based method’ *B. Forster, D. Van De Ville, J. Berent, D. Sage, M. Unser, " Complex Wavelets for Extended Depth-of-Field: A New Method for the Fusion of Multichannel Microscopy Images ," Microsc. Res. Tech., 65(1-2), pp. 33-42, September 2004.*



From 2D to 3D