Focus set based reconstruction of micro-objects

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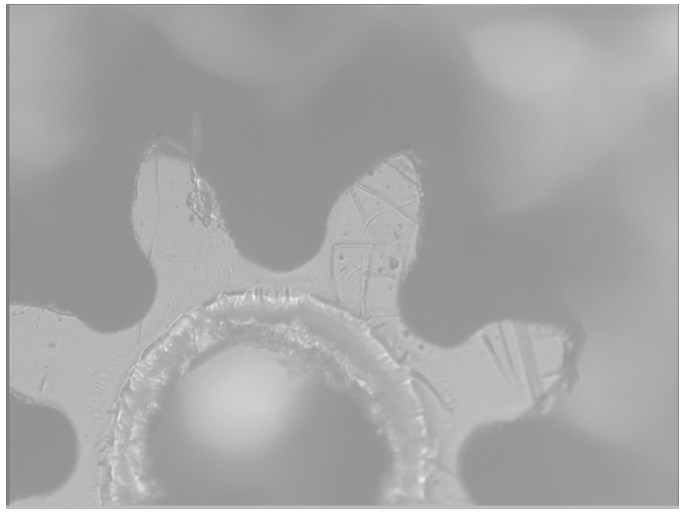
13.9.2004

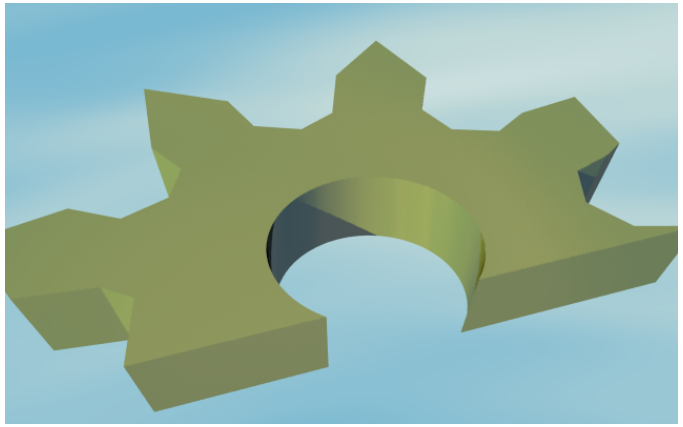
MiCRoN http://wwwipr.ira.uka.de/~micron/

MMVL http://www.shu.ac.uk/mmvl/

People: Balasundram Amavasai, Manuel Boissenin, Axel Bürkle, Fabio Caparrelli, Arul Selvan, Jon Travis

micro-vision and micro-robotics





Closed-loop control

- Estimate pose of manipulator in real time

Task planning

- Estimate pose of known micro-objects
- Recognize obstacles for avoiding collisions
- Provide data for determining gripping points

present state of micro-vision

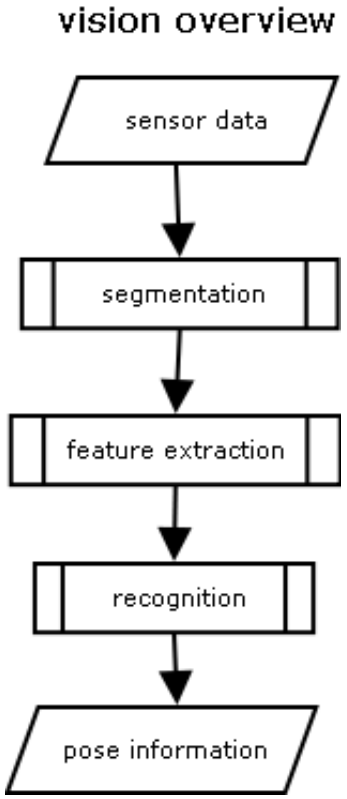
characteristics

- Limited depth of focus
- Teleoptical settings

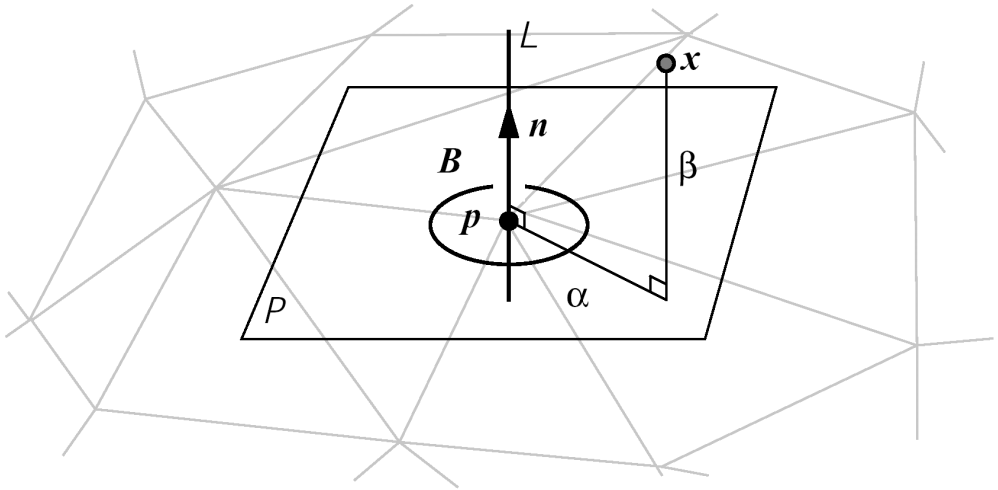
vision problems

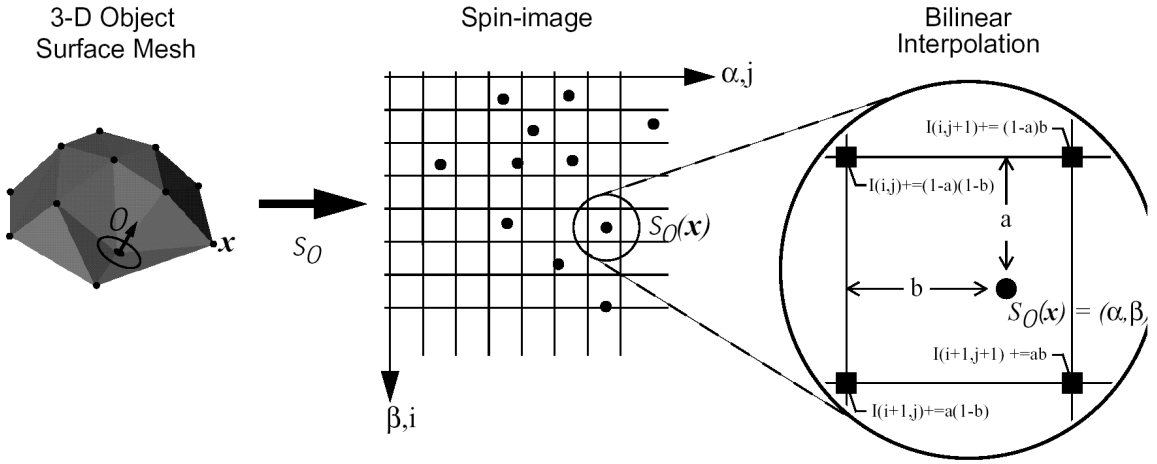
- unstable feature extraction
- limited depth of view

⇒ most standard approaches are failing



spin images (Andrew Johnson 1997)





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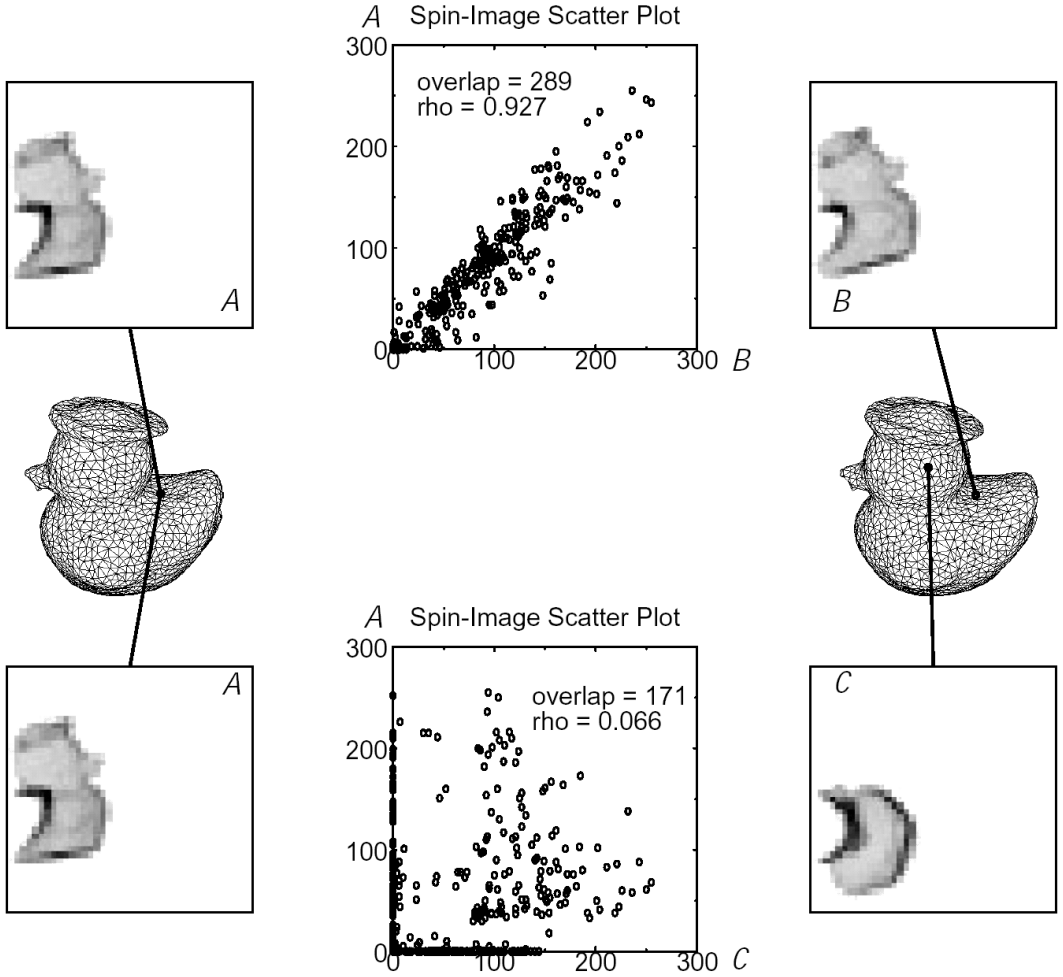
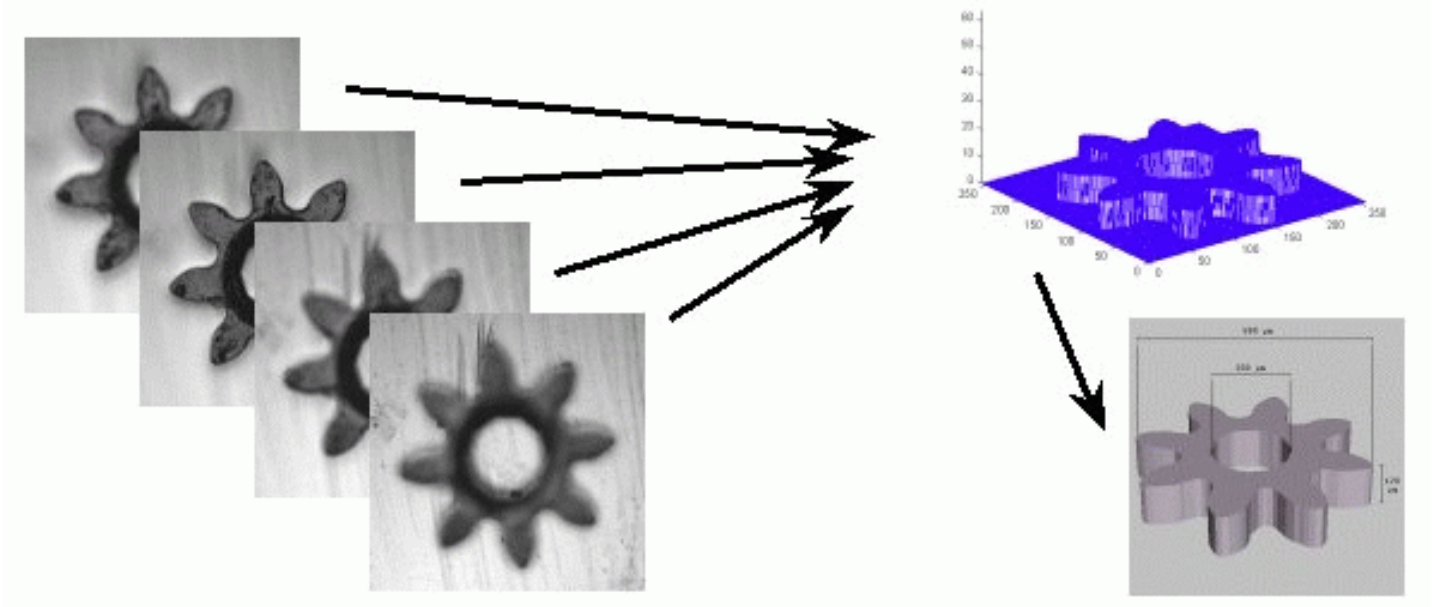
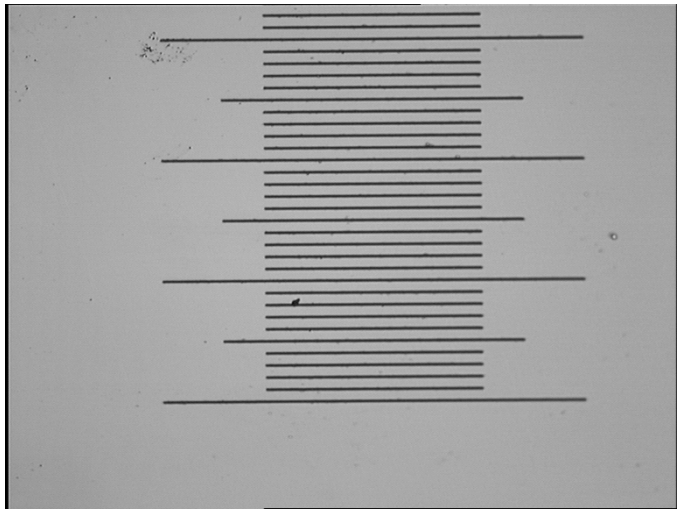


depth of focus



- Acquire focus set of images $g(x_1, x_2, z)$
- Compute local sharpness measure $s(x_1, x_2, z)$
- Compute depth map $d(x_1, x_2) := \underset{z \in \mathbf{Z}}{\operatorname{argmax}} \big(s(x_1, x_2, z)\big)$

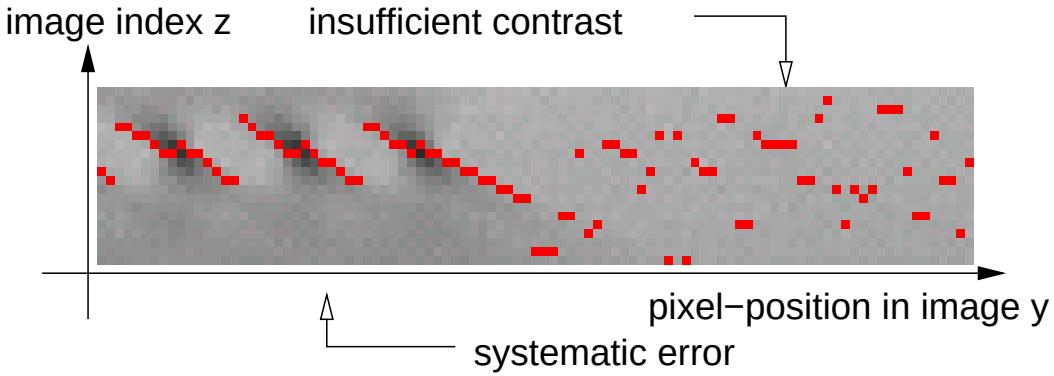
systematic error

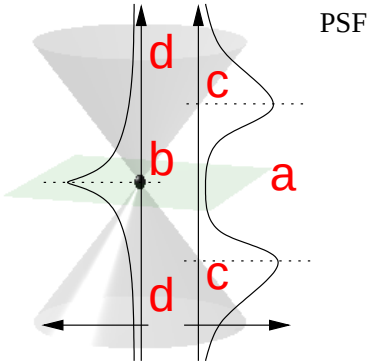


test with micro-ridge

- Algorithm fails when contrast low
- Systematic errors
- Trade-off between resolution and stability

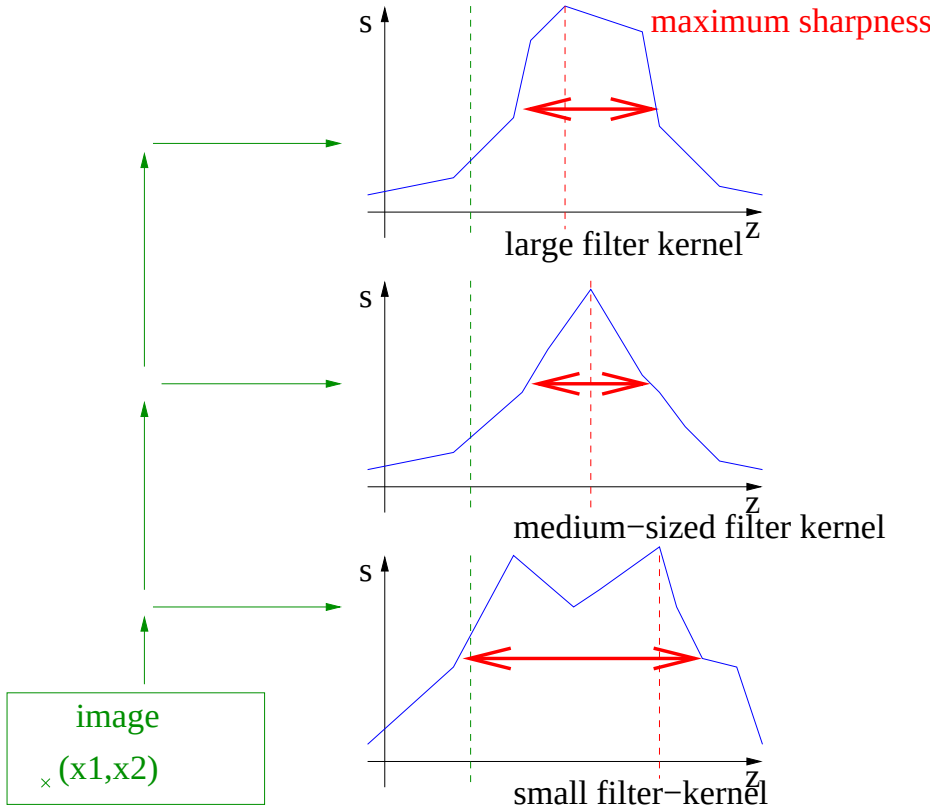
⇒ Filter-bench



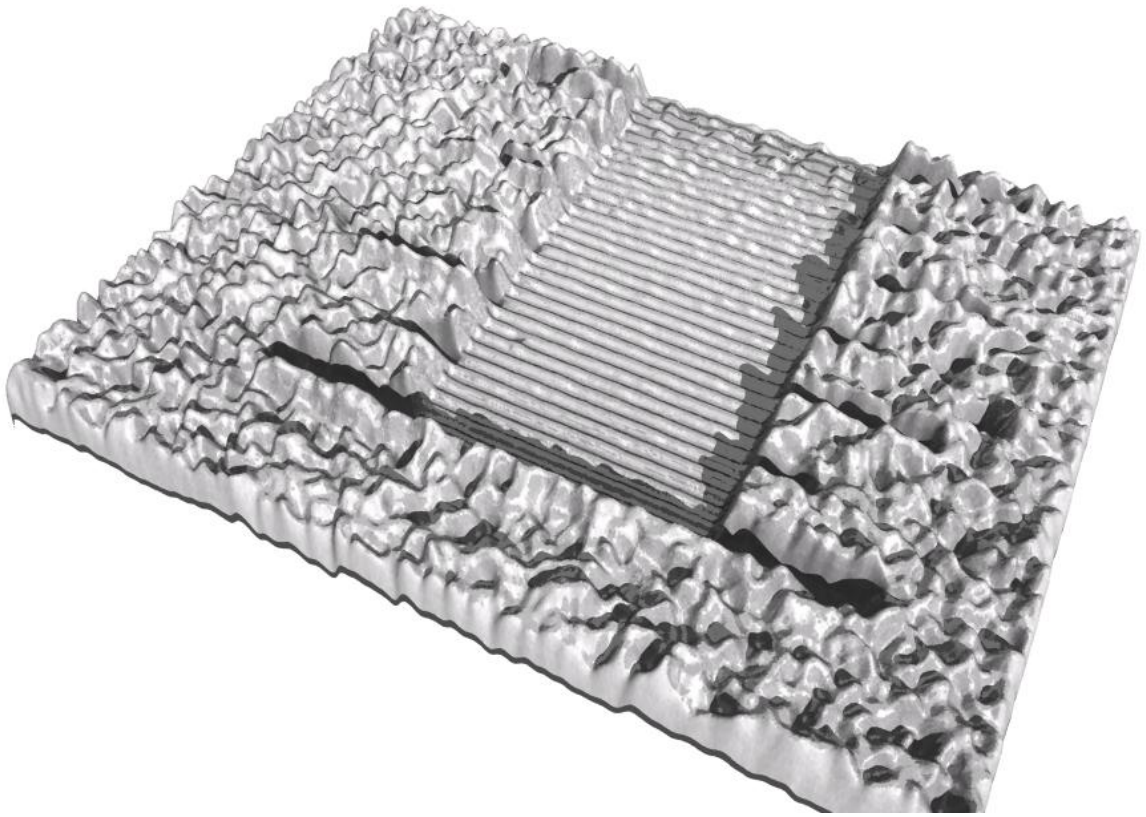


multiscale approach

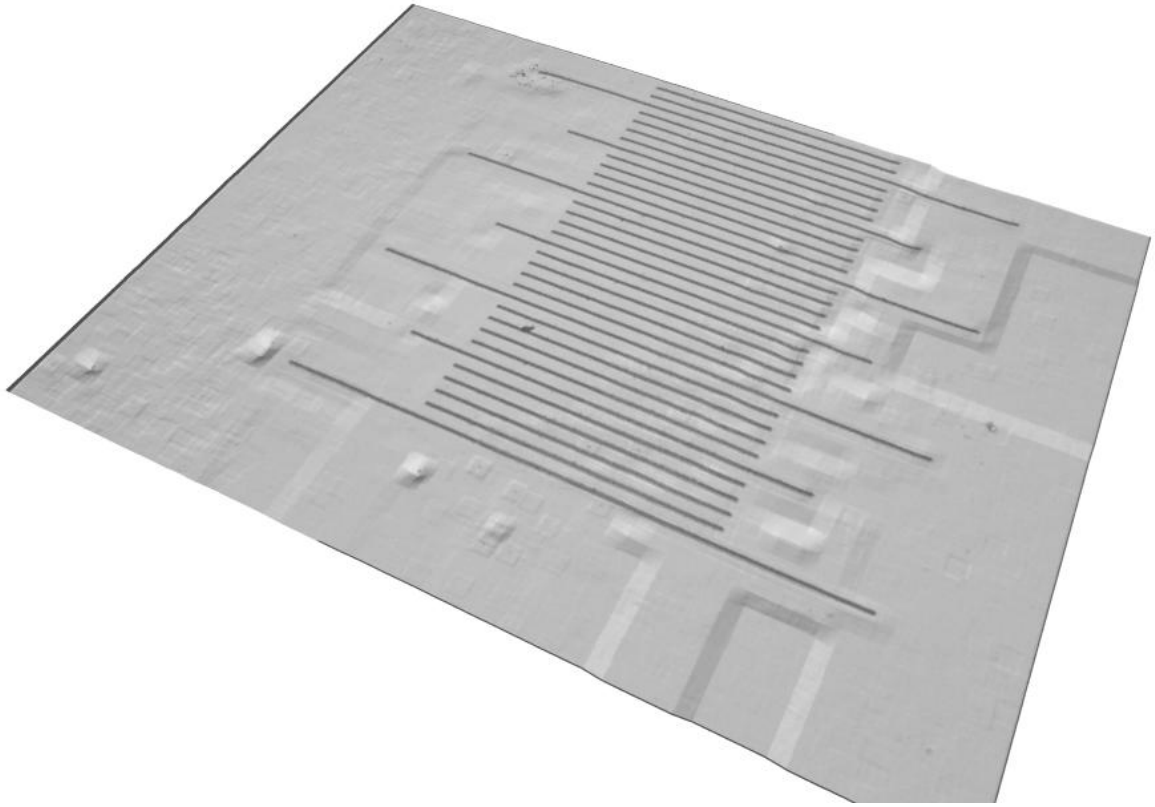
- Recursive filtering
- Not real-time efficient
- Complexity
  (N = number of pixel)
  - $O(N)$ time
  - $O(N)$ memory
  - $\sqrt[3]{N}\,O(N^{\frac{2}{3}})$
    parallelisation
- No systematic error



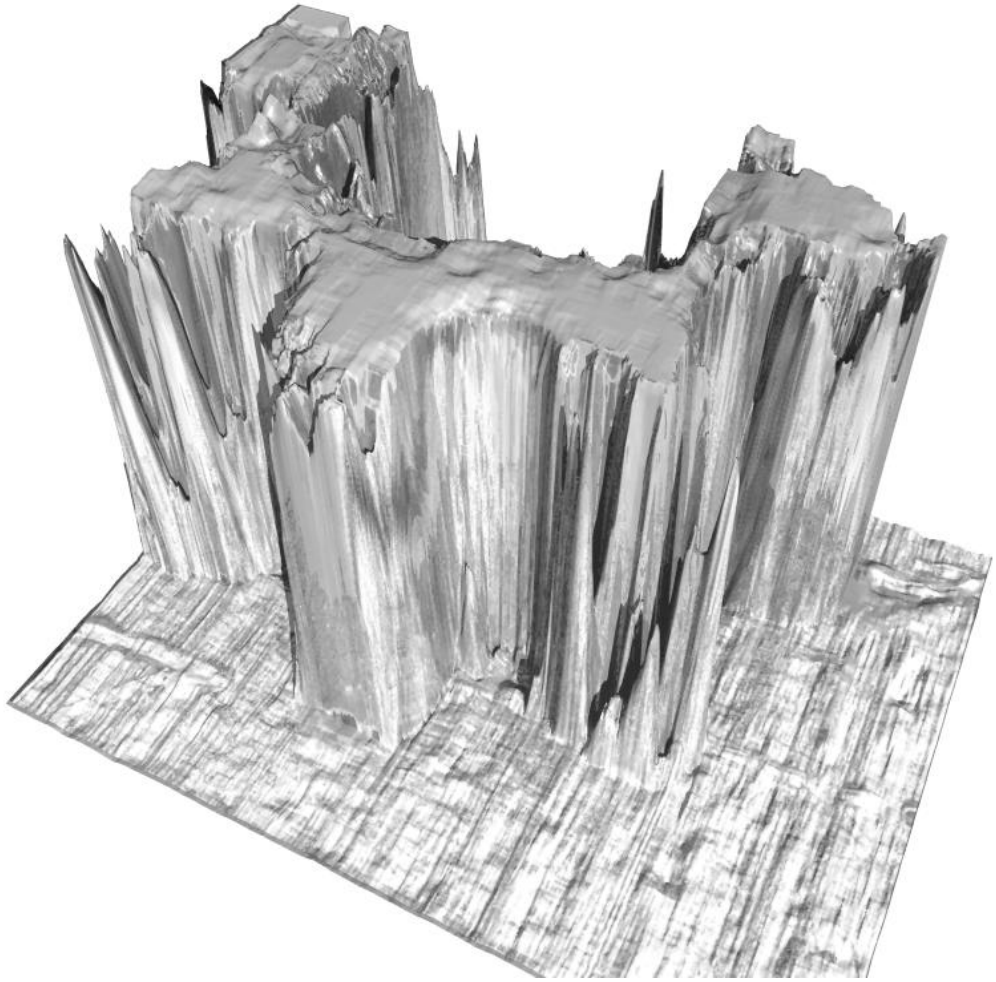
results



results



results



results