Cavity Surface Feature Recognition

How to teach a PC to see?

- ✓ Motivation
- ✓ Optical Inspection
- ✓ Image Processing
- ✓ Image Segmentation & Understanding
- ✓ Summary



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Motivation

- > High gradient superconducting cavities for linear colliders
 - XFEL requires 800 Cavities with an accelerating gradient of 23.5 MV/m
 - ILC requires 16000 Cavities with an accelerating gradient of 31.5 MV/m
- To achieve gradient: quality assurance during production, assembly & surface treatment
- Understand correlations between 'irregularities' and 'defects'
- Therefor do data analysis of surface images and corresponding T-maps & Second Sound measurements



Optical Inspection I

> Details and current status: see previous talk by S. Aderhold



Optical Inspection II

- > Picture covers 4 deg.
 - 90 images per equator
 - 810 images per cavity (without iris)
- > 2616x3488 pixel , effective resolution of 3.5 µm/pixel
- Now bitmap, soon png
- > ~ 26 MB per image
- > What are irregularities?
- > How to find them automatically?



Machine Vision – Image Understanding

- Image creation
 - Illumination
 - Image format
- Image Processing
- Image Segmentation & Region Merging
 - Split image in background and region of interest (Segments)
- Segment Description
- Pattern Recognition / Image Understanding





Machine Vision – Image Understanding

- > But: There is no golden rule!
 - Depending on image format, its content and use: different approaches
 - Which step when?

Image Segmentation (find regions of interests) is hardest task

- Otsu's Method 🙁
- Watershed Transformation 🙁 ?
- Quadtree-Segmentation (3) ?
- Neuronal Network ?



Examples





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Processing





Watershed Transformation



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





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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.

Quadtree-Segmentation





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



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



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Summary

- There are several algorithms that have to be implemented, adapted and tuned to this specific problem
 - Shadow removement
 - Edge enhancement
 - Segmentation & Region merging
 - Classification
- > Additional Options
 - Depth of Focus (focus stacking)
 - Illumination algorithm

