Image Analysis

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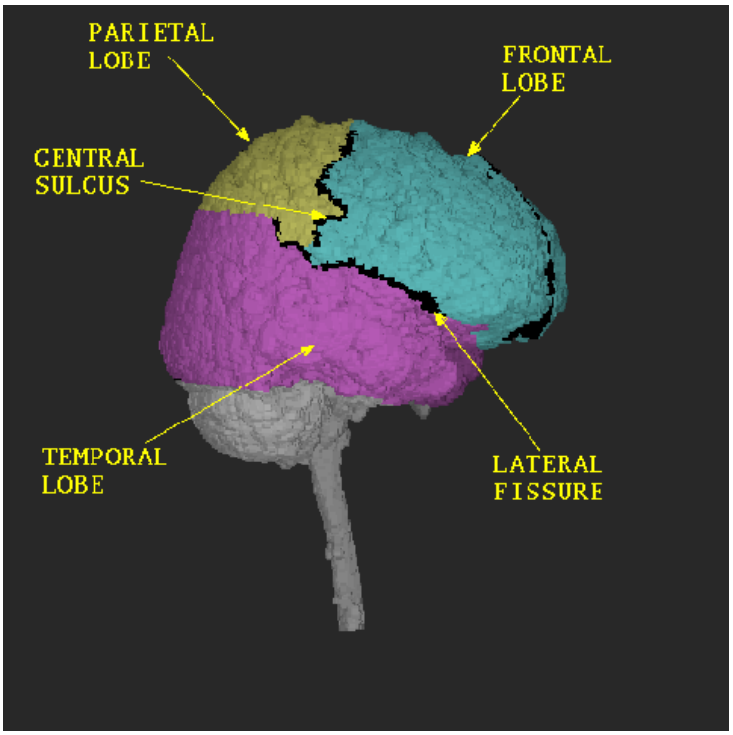
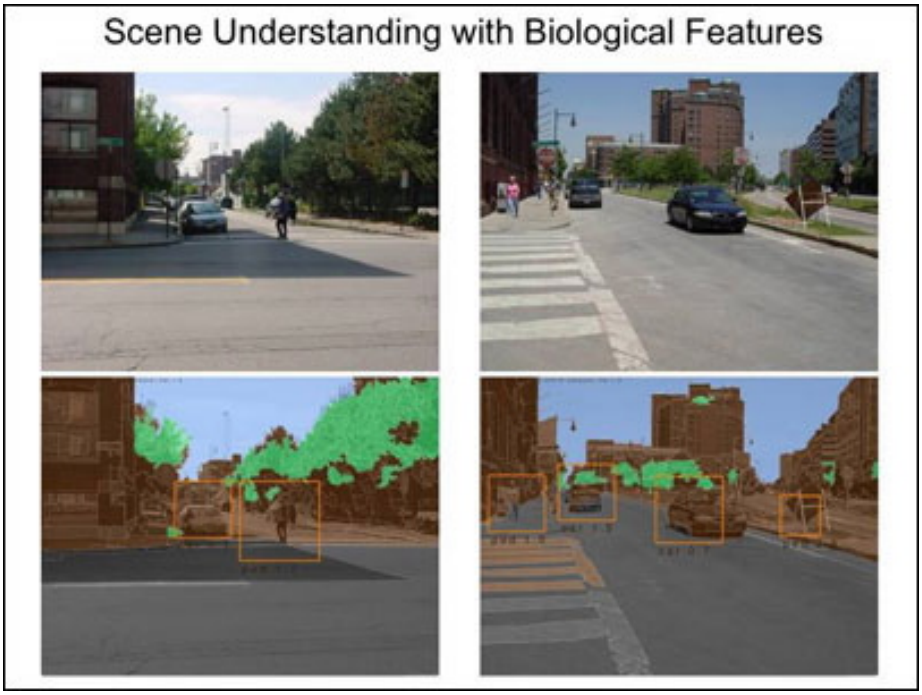
Medical Image Analysis



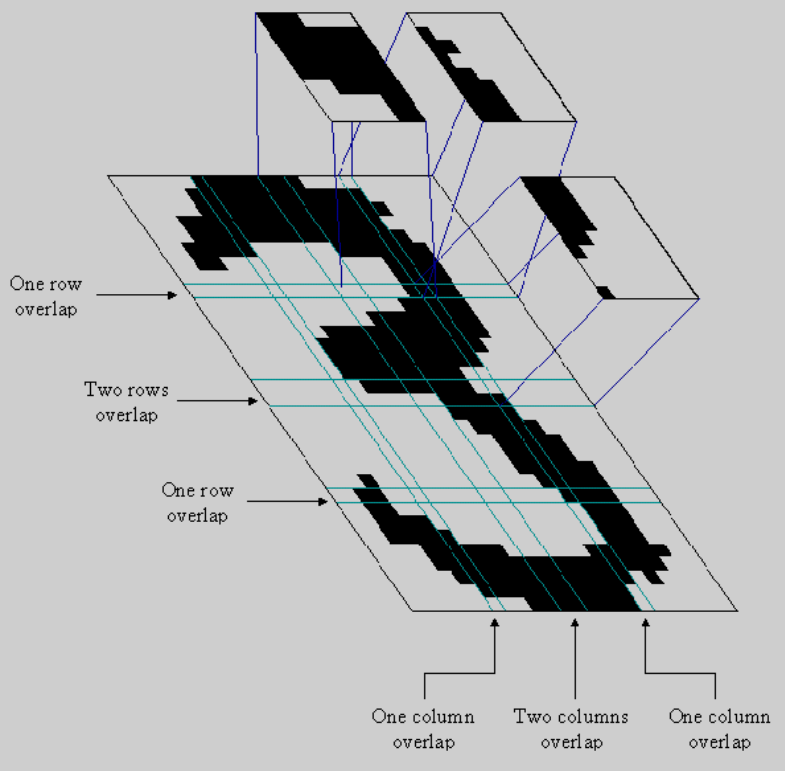
from: T. McInerney, D. Terzopoulos (1996): *Deformable Models in Medical Image Analysis: A Survey*, Medical Image Analysis, 1(2), 1996, 91-108.

Robot Vision



from: Jhuang H., T. Serre, L. Wolf and T. Poggio (2007): *A Biologically Inspired System for Action Recognition*, Proceedings of the Eleventh IEEE International Conference on Computer Vision (ICCV), 2007.

Optical Character Recognition (OCR)



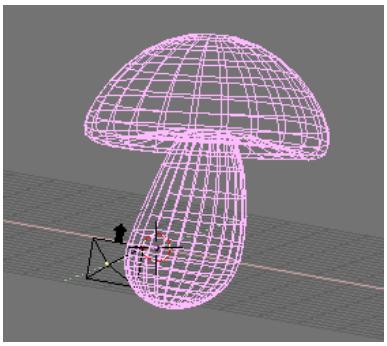
from: http://www.micro.dibe.unige.it/Research/OCR.htm

Example Applications

- **Medical Image Analysis**:
  – detect anomalies in MRT images.
- **Robotics**:
  – detect the road, other vehicles, passer-bys and traffic signs.
- **Document Processing**:
  – recognize text from scanned images (optical character recognition; OCR), e.g., to allow searching, editing, etc.
- **Manufacturing**:
  – optical quality control for parts, e.g., jet engine blades.
- **Defense** and **Security**:
  – recognize faces, vehicles etc.

Rendering in Computer Graphics

image model

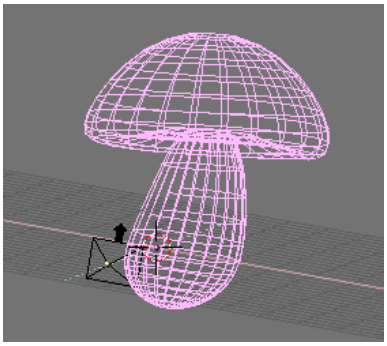


raster / digital image

- geometry
- viewpoint
- texture
- lighting
- shading
- etc.

Image Analysis: Inverse Rendering

image model



raster / digital image

- geometry
- viewpoint
- texture
- lighting
- shading
- etc.

Different Names – Common Research Problems

- **Image Processing**:
  – origin in signal processing; sometimes used to focus on low-level tasks and image-to-image transformations.
- **Image Analysis**:
  – stresses inverse rendering problem.
- **Pattern Recognition**:
  – stresses usage of machine learning methods.
- **Imaging**:
  – stresses specific application context as in **Medical Imaging** (and includes image production, storage etc.).
- **Computer Vision** (also **Artificial, Robot or Machine Vision**):
  – stresses overall application problem and 3d.

A First Look at Image Classification

Given

- **images** and
- some (global) **annotation**, e.g., if the image shows a person or not,

try to learn the annotated concept, so that the annotation can be done automatically in future.

Useful for

- image retrieval (search by keyword/tag).
- many applications (e.g., sort tomato plants).

image	person?
	no
	yes
	no
	yes
	?

Image Restoration / Contrast Enhancement

If the image has low contrast,

enhance the contrast of the image.

Image Restoration / Deblurring

If the image is blurred,

deblurr the image.

Image Restoration / Denoising

If the image is corrupted by noise,

denoise the image.

Edge Detection

From the original image

detect edges.

Line Detection / Hough Transform

From the original image

detect lines.

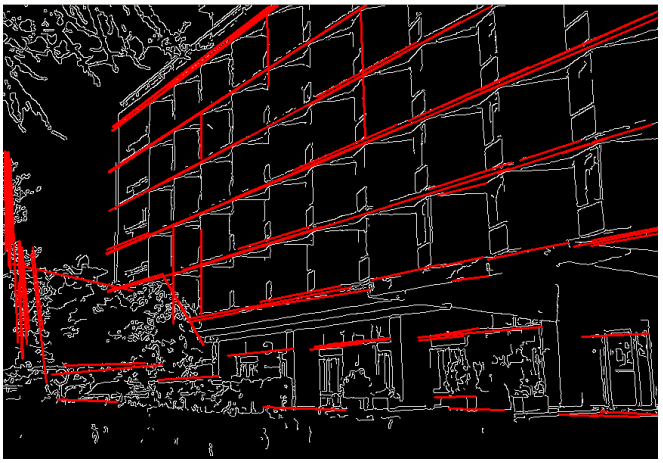


Image Segmentation

From the original image

detect regions.

Methods

Different methods introduced and/or touched in the lecture:

- Fourier transformation,
- Wavelets,
- Random Fields,
- Variational Methods,
- Partial Differential Equations

Exercises and tutorials

- There will be a weekly sheet with two exercises handed out **each Tuesday** in the lecture.
  1st sheet will be handed out **Tue. 4.11.**
- Solutions to the exercises can be submitted until **next Tuesday before the lecture**,
  1st sheet is **due Tue. 11.11.**
- Exercises will be corrected.
- Tutorials **each Thursday 14–16**,
  1st tutorial at **Thur. 6.11.**
- Successfull participation in the tutorial gives up to 10% bonus points for the exam.

Exam and credit points

- There will be a written exam at end of term (2h, 4 problems).
- This course gives 8 ECTS (3+2 SWS).
  - ECTS = European Credit Transfer System
  - 1 ECTS ≈ 30h workload (for the students)
  - 240h:

14 weeks	à 2.25 h lecture:	31.5 h
14 weeks	à 1.5 h tutorial:	21 h
	à 5 h solving exercises:	70 h
	à 6 h post preparation:	84 h
once 16h	exam preparation:	24 h
total work load:		230.5 h

Text books

- Milan Sonka, Vaclav Hlavac, Roger Boyle (2008): *Image Processing, Analysis, and Machine Vision*, Thomson.
- John C. Russ, J. Christian Russ (2008): *Introduction to Image Processing and Analysis*, CRC Press.
- R. C. Gonzalez, R. E Woods (2008): *Digital Image Processing*, Pearson.
- G. Aubert, P. Kornprobst (2006): *Mathematical Problems in Image Processing. Partial Differential Equations and the Calculus of Variations*, Springer.
- J. R. Parker (1997): *Algorithms for Image Processing and Computer Vision*, Wiley.

Slides will be available online at the course webpage:

http://www.ismll.uni-hildesheim.de/lehre/ip-08w/

First Software

Open source:

- Open Computer Vision Library (OpenCV; C++ library, originally developed by Intel; has wrappers for Python & Octave; 10/2008)
  `http://sourceforge.net/projects/opencvlibrary/`
- CImg (C++; 6/2008)
  `http://cimg.sourceforge.net/download.shtml`
- Octave (MatLab like; 10/2008)
  `http://www.gnu.org/software/octave/`
- ImageJ (Java library; 10/2008)
  `http://rsbweb.nih.gov/ij/`

Commercial software:

- MatLab (with Image Toolbox; student versions available for ca. 80 EUR)
  `http://www.mathworks.com/`

Example Images

- TRECVID
  `http://www-nlpir.nist.gov/projects/trecvid/`
- PASCAL VOC:
  `http://pascallin.ecs.soton.ac.uk/challenges/VOC/`
- LabelMe `http://labelme.csail.mit.edu/`
- N-S dataset `http://vis.uky.edu/~stewe/ukbench/`
- `http://muscle.prip.tuwien.ac.at/data_links.php`
- `http://peipa.essex.ac.uk/benchmark/databases/`
- MIT/CBCL:
  `http://cbcl.mit.edu/software-datasets/index.html`

Course Schedule

1. Tue. 21.10.
2. Wed. 22.10.
3. Tue. 28.10.
4. Tue. 4.11.
5. Wed. 5.11.
6. Tue. 11.11.
7. Tue. 18.11.
8. Wed. 19.11.
9. Tue. 25.11.
10. Tue. 2.12.
11. Wed. 3.12.
12. Tue. 9.12.
14. Tue. 16.12.
15. Wed. 17.12.
15. Tue. 6.1.
16. Tue. 13.1.
17. Wed. 14.1.
18. Tue. 20.1.
19. Tue. 27.1.
20. Wed. 28.1.
21. Tue. 3.2.

Persons

Lars Schmidt-Thieme
Alexandros Nanopoulos

Krizstian Buza
Christoph Freudenthaler
Zeno Gantner
Artus Krohn-Grimberghe
Leandro Marinho
Christine Preisach
Steffen Rendle
— research assistants

Kerstin Hinze-Melching
— secretary
Jörg Striewski
— technician

Christian Brauch, Florian Henze, Rodion Marx, Martin Ortmann, Carsten Witzke

Research Areas