

Image Analysis

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Course on Image Analysis, winter term 2011/12

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Image Analysis

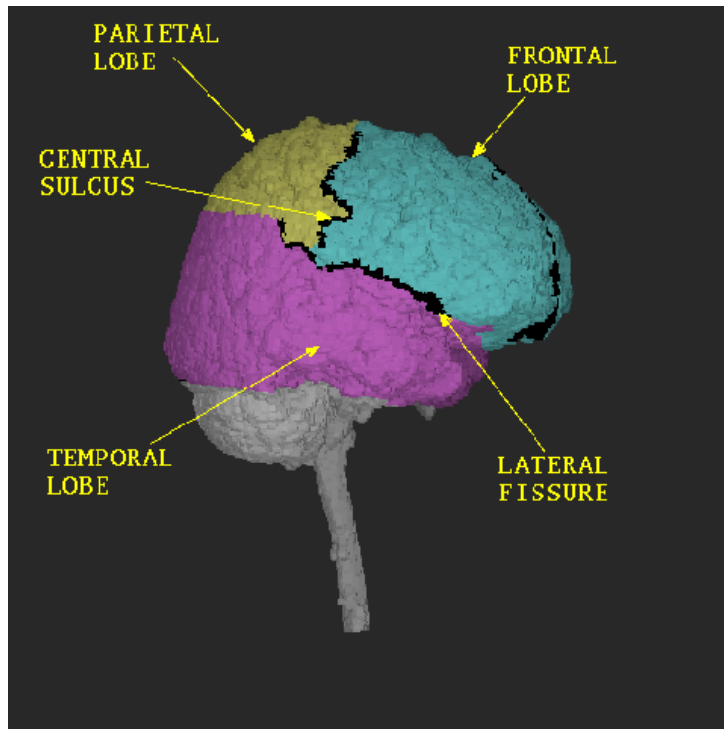


1. What is Image Analysis?

2. Course Outline

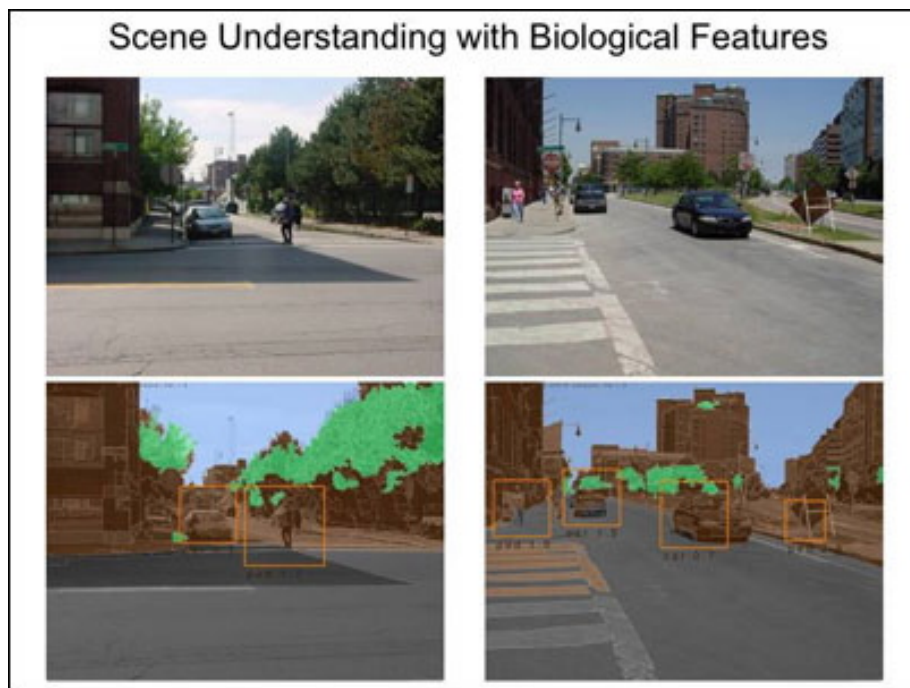
3. Organizational stuff

Medical Image Analysis



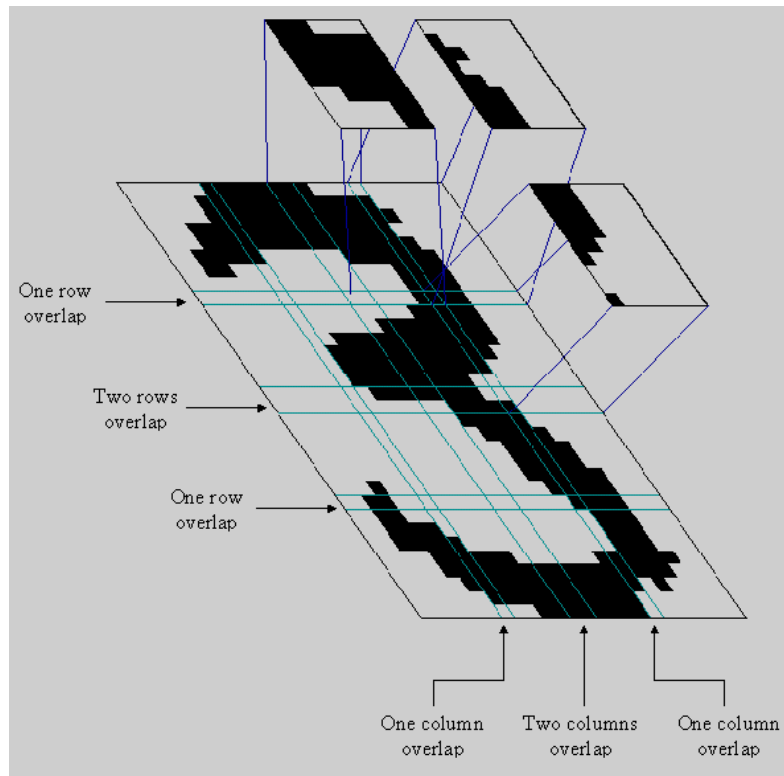
from: T. McInerney, D. Terzopoulos (1996): *Deformable Models in Medical Image Analysis: A Survey*, Medical Image Analysis, 1(2), 1996, 91-108.

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>

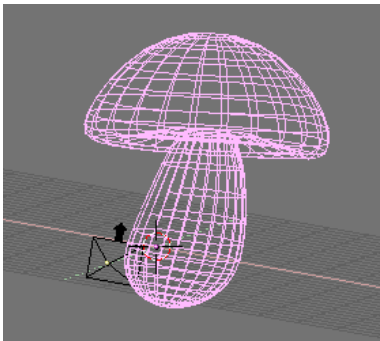
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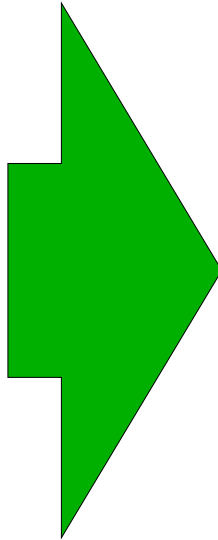
Example Applications

- **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.

image model



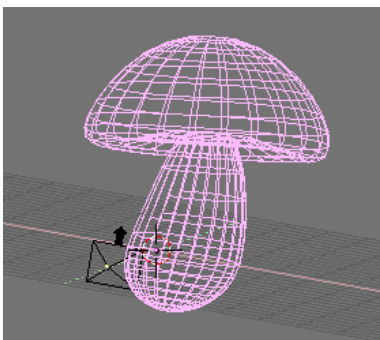
- geometry
- viewpoint
- texture
- lighting
- shading
- etc.



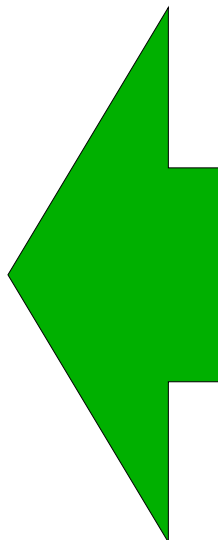
raster / digital image



image model



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



raster / digital image



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.

1. What is Image Analysis?

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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 |
|  | ? |

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Image Analysis / 2. Course Outline

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.

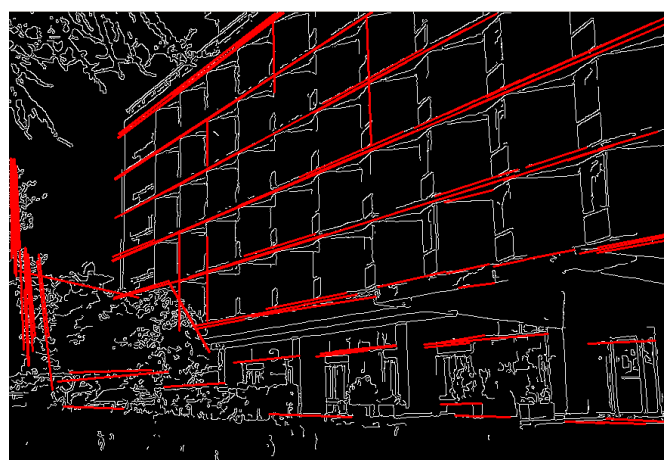


Image Segmentation

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

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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. 8.11.**
- Solutions to the exercises can be submitted until **next Tuesday before the lecture**,
1st sheet is **due Tue. 15.11.**
- Exercises will be corrected.
- Tutorials **each Thursday 8–10**,
1st tutorial at **Thur. 3.11.**
- Successful 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).
- The course gives 8 ECTS (3+2 SWS).
- The course belongs to Informatik-Gebiet KI & ML, and thus can be used in
 - Wirtschaftsinformatik MSc / Informatik / Gebiet KI & ML
 - IMIT MSc. (neu) / Informatik / Gebiet KI & ML
 - IMIT MSc. (alt) / IT Machine Learning,
 - as well as in any BSc program.

Text books

- Milan Sonka, Vaclav Hlavac, Roger Boyle (2008):
Image Processing, Analysis, and Machine Vision, Thomson.
- David A. Forsyth, Jean Ponce (2007): *Computer Vision, A Modern Approach*, Prentice Hall.
- John C. Russ, J. Christian Russ (2008):
Introduction to Image Processing and Analysis, CRC Press.
- 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-11w/>

First Software

Open source:

- **Open Computer Vision Library (OpenCV; C++ library, originally developed by Intel; has wrappers for Python & Octave; v2.3.1, 9/2011)**
<http://sourceforge.net/projects/opencvlibrary/>
- **CImg (C++; 1.3.6; 6/2010)**
<http://cimg.sourceforge.net/download.shtml>
- **Octave (MatLab like; 3.4.3; 10/2011)**
<http://www.gnu.org/software/octave/>
- **ImageJ (Java library; 1.45o; 9/2011)**
<http://rsbweb.nih.gov/ij/>

Commercial software:

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

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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>