

# Comp 254, Image Processing and Analysis

## Spring 2002, Prof. Guido Gerig

### Syllabus

**Goal:** To present fundamentals for methods of processing and analysis of images using a computer. Statistical pattern recognition, multiscale shape and geometry, local to global grouping, model-based segmentation, shape representation and analysis.

### Approximate Outline and Nr. of Weeks

- Statistical pattern recognition for pixel processing: 3.0 w
  - Classification, clustering, pixel-based image segmentation
  - Karhunen Loeve transform, PCA, Fisher linear discriminant
  - Mixture model approach
- Extraction of local primitives: 7.0 w
  - Elementary geometry of surfaces: contours and ridges (Haralick)
  - Image Segmentation as geometric analysis
  - Concept of edge detection and operator design (Canny)
  - Properties of Gaussian filtering, linear scale space
  - Gaussian derivatives, invariants, multi-scale representation (scale space primal sketch, local jets)
  - Multi-scale detection of ridges and valleys by scale linking
  - Linear scale space as a PDE
  - Nonlinear diffusion (variable conductance diffusion, nonlinear PDE)
- Grouping of local primitives to global shapes: 6.0w
  - Object recognition by Hough Transform
  - Object recognition by invariant moments
  - Object segmentation by deformable contours (snakes)
    - \* Explicit snake parametrization
    - \* Implicit snake parametrization, geodesic snakes
  - Object representation by Medial Axis (concept, extraction)
    - \* Object segmentation by deformable medial model (m-rep)
  - Contour description by Fourier harmonics
    - \* Object segmentation by deformable parametrized contour model
- (\*\*) Image Registration and Warping

- Linear and nonlinear transformations in 2D and 3D
- Approaches to calculate transformation
  - \* Manual landmarking and TPS interpolation
  - \* Feature space methods: Cross correlation ratio / Mutual Information criterion
  - \* Towards high dimensional warping

(\*\*) Subject to availability of time

## Organization

|                       |   |
|-----------------------|---|
| Teaching:             | Guido Gerig (gerig@cs.unc.edu, office SN219, phone 962 1919)  |
| TA:                   | Mathieu Ruffin (ruffin@cs.unc.edu)  |
| Class time and place: | 9:30am-10:45am Tuesday and Thursday, SN011  |
| Prerequisites:        | 1) Image processing, display and vision contents of COMP 235:<br>i.e., sampling and basics in digital signal processing, Fourier analysis, convolution and filtering, the Gaussian and its derivatives<br>2) Calculus, linear algebra, probability theory |

## Material

|                   |   |
|-------------------|---|
| Handouts          | Copies of relevant book chapters and publications   |
| Recommended books | a) Bernd Jähne, Digital Image Processing, Springer, 1997 (General Image Processing Book, very comprehensive, <i>RECOMMENDED</i> )<br>b) Milan Sonka et al., Image Processing, Analysis, and Machine Vision, PWS Publishing, 1998 (General Image Processing Book, comprehensive, <i>RECOMMENDED</i> )<br>c) R.O. Duda, P.E. Hart, D.G. Stork: Pattern Classification, Wiley Interscience, 2000 (Statistical Pattern Recognition) |

## Assignments

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|-------------|--|
| Assignments | Theory and Methods, solutions on paper (50%) / Programming work using Matlab, C/C++ or other tools of choice (50%) |
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## Grading (subject to modifications)

|  |   |
|--|---|
| 5 assignments<br>(with $\approx$ 2 weeks time) | 60%   |
| Final exam                                     | 35%   |
| Class participation                            | 5%  |
| FINAL EXAM DATE                                | Sat May 4, 2002, 9pm (maybe a take-home exam) |

## **Class participation**

Regular attendance is necessary to follow the subject as the teaching will complete and enhance the material found in the handouts. Please inform the TA ([ruffin@cs.unc.edu](mailto:ruffin@cs.unc.edu)) early enough if you can't attend a lecture due to adverse circumstances.

Guido Gerig, January 10, 2002