

# CS7960 Advanced Image Processing

Spring 2010

T,H 10:45 AM – 12:05 PM, WEB 1450

Instructor: Guido Gerig (gerig@sci.utah.edu)

## Syllabus

### Goal and Objectives:

- To discuss advanced topics in image processing and analysis that build on the introduction course.
- To teach participants about scientific methodology which includes reading of scientific publications and book chapters, summarizing the contents, developing strategies to implement the algorithms, and finally presenting the theory, tests, and applications to the audience.
- To enable participants to implement solutions for complex image processing problems.
- To enable participants to better understand novel, advanced methodology that is discussed in the image processing and image analysis literature.
- To enable participants to teach image processing materials to the group by preparing and presenting a class lecture.

**Short description:** In-depth study of advanced methods and research topics of current interest in image processing and analysis. Covers PDEs, shape representations, deformable models (snakes, level sets), statistical shape analysis, scale-space and registration. Focus and list of topics might change from semester to semester.

**Who should attend this course?** Graduate students who are interested in getting advanced knowledge in image processing and analysis, following the course *6640 Introduction to Digital Image Processing* or equivalent. The course is particularly important for students involved in image processing research and will be a core course of the newly established imaging track.

**Prerequisites:** Course 6640 Introduction to Digital Image Processing or equivalent. Advanced programming skills related to imaging (C++, imaging libraries, Matlab or equivalent). Students with different background and curriculum need to discuss suitability and options with the teacher.

## Overview of the Course

- Introduction
- Feature Detection and Characterization
  - Notion of Scale Space
  - Gaussian Derivatives
  - Differential Invariant Structure
  - Nonlinear Scale Space
    - \* Anisotropic Diffusion

- \* Diffusion of Higher Order Derivatives
- Shape Analysis
  - Fundamentals in Shape Analysis
  - Moment Invariants
  - Contour-based Invariants
    - \* Active Shape Models (ASM)
    - \* Active Appearance Models (AAM)
    - \* Elliptical Harmonics
  - Medial Axis Representation
- Object Segmentation
  - Generalized Hough Transform
  - 3D Deformable Models
  - Snakes
  - Level set evolution
  - Others (Normalized Graph Cuts, etc.)
- Image Registration

## Materials

We will not use a textbook but a set of scientific publications and relevant sections of textbooks. Basic materials will be provided by the instructor, and students will be advised to find secondary literature related to the specific topics. All material used in this course (scientific papers, chapters from other textbooks etc.) will be distributed during the course and made available via the UofU webct/blackboard system (<https://webct.utah.edu/>).

## Learning approach

- Students will read the relevant publications or chapters of books books and/or reading assignments BEFORE the class lectures.
- In the course, the material will then be discussed in detail and motivated with real world examples and applications.
- Students will actively participate in teaching by preparing a class lecture.
- There will be 5-6 projects where material discussed in class will be implemented, tested and applied to image data.

## Projects

Projects will be done by individuals on topics assigned approximately every 2-3 weeks by the instructor (i.e. there will be approximately 5-6 projects). Projects will require submission of the project code and findings in an html format (in a directory readable by a web browser). Project programming will be done in either MATLAB (the basic package — no extra toolkits) or C++ using the Vispack library for image I/O and basic image operations.

Project reports need to be sufficiently detailed and structured to give a reader full information about theory, approach, implementation, results, and eventual difficulties and limitations.

## Organization

Teaching:	Guido Gerig email: gerig@sci.utah.edu Tel: (801) 585-0327
Lecture time and place:	T,H 10:45 AM – 12:05 PM, WEB 1450
Material:	Handouts on WebCT, Scientific publications from library
Projects:	Theoretical preparation for implementation strategies, programming work with Matlab/C++ or C++, tests on real images, detailed report. Class lectures: Students will pick a topic and will prepare a class lecture. Project reports: Students will report in detail about one of the projects.

## Honor Policy

Students are expected to work *on their own*, as instructed by the Professor. Students may discuss projects with other individuals either in the class or outside the class, but they may not receive code or results electronically from any source that is not documented in their report. *Students must write their own code, conduct their own experiments, write their own reports, and take their own tests.* Any use of sources (for projects or tests) that are not specifically given to the student by the Professor or TA, must be discussed with the Professor or TA or documented in the report. Any student who is found to be violating this policy will be given a failing grade for the course and will be reported to the authorities as described in the University's Student Code (<http://www.admin.utah.edu/ppmanual/8/8-10.html>).

## Late Policy

There will be 10 point deduction per week (out of 100) for late project submission.

## Grading

Projects (5-6)	80%
Class Lecture	10%
Participation	important
Presentation of one project	10%