Introduction Image Processing

Guido Gerig

CS/BIOEN 6640 FALL 2014

Courses and Seminars related to Research in Image Processing and Analysis

SoC Image Analysis Track (2014/15 Director Guido Gerig) (click)

Fall 2014:

- Image Processing CS 6640/ BIOEN 6640

Spring 2015:

- 3D Computer Vision CS 6320 (Guido Gerig)
- Advanced Image Processing CS 7960 (Ross Whitaker)
- Mathematics of Imaging BIOEN 6500 (Sarang Joshi)

On demand:

- Special Topics Courses: Non-Euclidean Geometry, Non-Param. Stats, ..

Seminar:

- Image Analysis Seminar CS 7938 / BIOEN 6810: weekly Mondays 12.15 to 1.15, WEB 3670 (1 credit if participant presenting one lecture)

Main Goals

- to tell you what you can do with digital images
- to show you that developments in image analysis and computer vision can be fun and exciting
- to demonstrate that image processing is based on strong mathematical basic principles, applied to digital images via numerical schemes
- to demonstrate that you that you can solve typical image processing tasks on your own

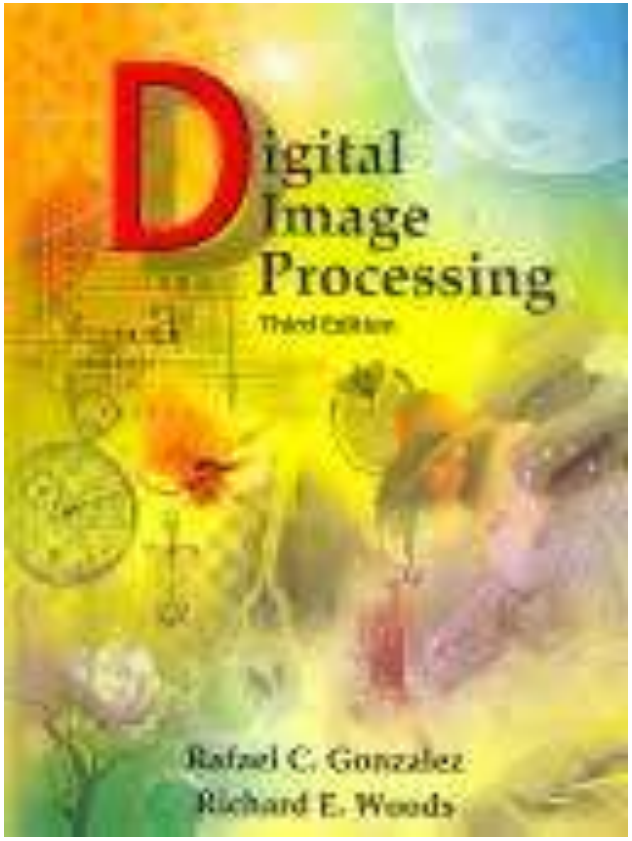
CS/BIOEN 6640 F2014

- Go to the web-site: http://www.sci.utah.edu/~gerig/CS6640-F2014/CS6640-F2014.html and get familiar with the contents.
- Look over the instructions w.r.t. honor code and CADE computer lab.
- Look at the midterm exam and final project due dates and mark those on your calendar.
- Purchase the book using your preferred method (bookstore, online, used books, etc.), first two chapters will be provided by teacher via pdf documents.
- We will use canvas for course organization (assignments, grading etc.)
- Do the first reading assignments.
- Participate in the discussion on familiarity with Matlab (novice, medium, proficient).

CS/BIOEN 6640 F2014

- The UofU ***canvas*** web system will be used to organize this course (announcements, assignments, grading, communication). (CS 6640)
- The ***main course page*** including goals, general information, materials, and week-by-week schedule with downloads, honor code, grading, and resources is linked to canvas: http://www.sci.utah.edu/~gerig/CS6640-F2014/CS6640-F2014.html .
- We will ***not use email for communication***, all information, materials, deadlines etc. are available through canvas and the course website.
- The ***scheduling of topics is not completely rigid*** and fixed, and some topics and timings will change as the class develops.

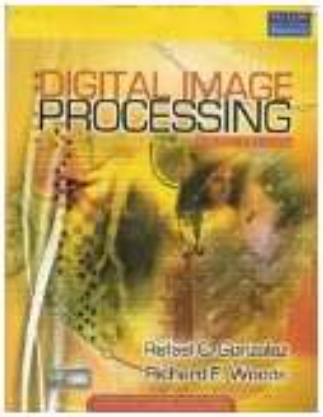
Textbook



Digital Image Processing
[Book]by Rafael C. Gonzalez, Richard Eugene Woods · Pearson/Prentice Hall · Hardback · 954 pages · ISBN 013168728X

	Rent from	Amazon Price	New from	Used from
Kindle	—	$153.88	—	—
Hardcover	$36.99	$165.21	$152.93	$112.99
Paperback	—	—	$38.86	$38.00

Textbook Paperback



Digital Image Processing (International Edition) by Gonzalez Woods (2009)

Formats	Price	New	Used
Paperback		$29.94	$20.99

Trade-in eligible for an Amazon gift card

- Textbook is not ordered through the UofU bookstore, everyone can purchase individually.
- Introduction, Chapter 1 and Chapter 2 will be made available electronically on course web-site.

MATLAB

- This course will support MATLAB for practical parts of assignments. C++ or other languages can be used but there will be no support and we need proof that code is fully developed by the student.
- Access via COE CADE computer lab, Matlab licences available. Remote access possible, but very slow.
- Matlab is also installed on the computers in the Knowledge Commons at the Mariott Library on Campus:
  - http://www.lib.utah.edu/services/knowledge-commons/index.php
  - According to this webpage, it is also available to use remotely: http://www.lib.utah.edu/services/labs/software.php
- If students want to purchase their own copy, Matlab for students is $50, or $99 (including 10 toolboxes.), link
- We will ***NOT USE Toolboxes*** but implement our own code.

MATLAB ctd.

We will organize a MATLAB Imaging interactive introduction by TA's and experienced MATLAB users:

- **Date**: Friday, 8/29, 3-5pm
- **Location**: Evans Conference Room, WEB 3780, Warnock Engineering Building, 3rd floor.
- **Materials**: Documents, test code & test images available as downloads (see course web-page at bottom, will be updated)

Learning Approach

- Students should read the relevant chapters of the books and/or reading assignments before the class.
- In the course, ***relevant parts of the material*** will then be ***discussed*** in detail on the board and via slides and motivated with real world examples and applications.
- There will be assignments with theoretical & programming questions to provide students also with practical experience of the techniques. We will also do a number of short quizzes in class to evaluate the level of understanding (feedback to students and teacher).

Learning Approach ctd.

Theoretical Background:

- Theoretical questions will help to deepen lecture materials.

Learning by Doing:

- Image Processing is particularly attractive to experience algorithms and methods since one immediately sees what is done by displaying results via images and graphing image-derived quantitative information.

Creativity:

- Projects will be designed to motivate and encourage students to become creative by going further than the minimal requirements and exploring algorithms on own pictures and/or images taken from their research projects.

Learning Approach ctd.

Project Report:

- While programming a working solution based on the course materials is a first important task, reporting on the solution strategy and demonstrating results and experiments will be seen at least as important as the coding.
- The practical part should be written with a text system and should include equations, hints to the programming solution, outline of solution strategy, graphs and results, and a critical discussion of results and eventual obstacles.

Methodology vs. Programming

- This is NOT A PROGRAMMING class, but we will use programming to deepen understanding, practice with algorithms and images, and test parameter settings.
- Assignments and Projects will require successful implementation of programs in order to run experiments, but the experiments, tests, results and critical discussions are as important as the code.

Assignments/Projets

- Homework assignments are due at 11:59pm on the given due date.
- Late policy on assignments: 10% grade deduction per late day, assignments will no more be accepted after 3 days.

Laptops/Tablets/Smart phones in Classes

- We DO NOT NEED laptops or tablets during the class.
- Use of electronics (computers, tablets, smart phones, email, texting) during the class is disturbing, may express lack of interest and should thus be avoided.

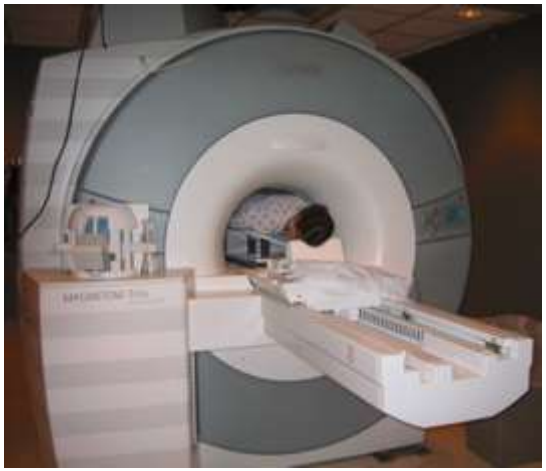
Attendance

- Attendance to lectures is required to be eligible for office hours by the instructor and the TA. Regular active participation is required to get the participation grade.
- Absences count as unexcused absences unless students present documents signed by officials (e.g. medical certificate), with advanced notice to course instructor and TA.
- Regular in-class quizzes on materials taught in class will be used to test level of understanding and give students regular feedback.

UofU Honor Code

- Please read honor code documents and rules (see section on course web-page) of the COE departments.
- Copying of materials (code, solutions to assignments, results) violates honor code.
- Violation has consequences, e.g. the COE can dismiss students from the University.

Image Sensors



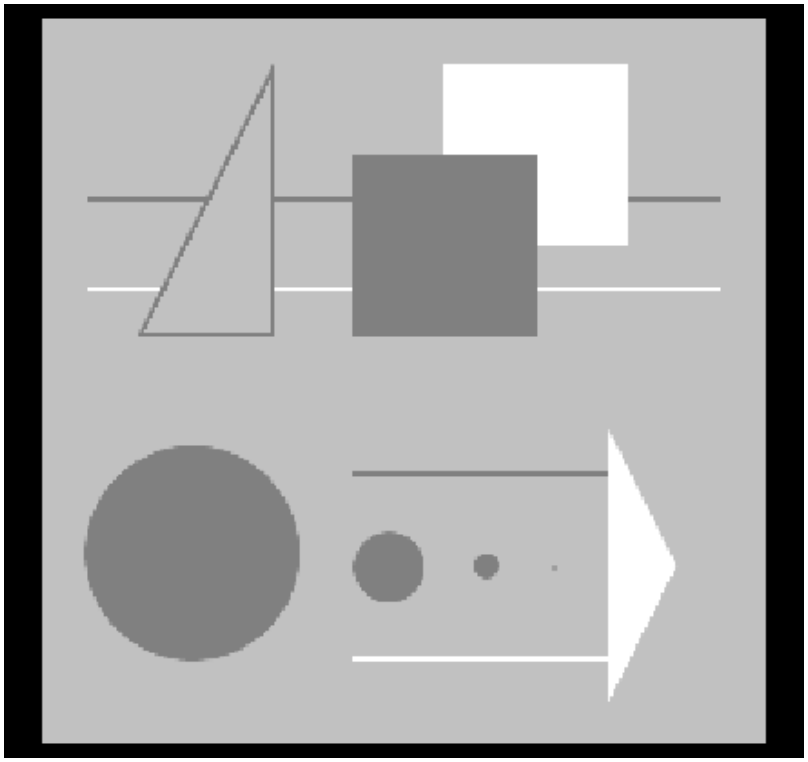
Digital Image

Digital Image

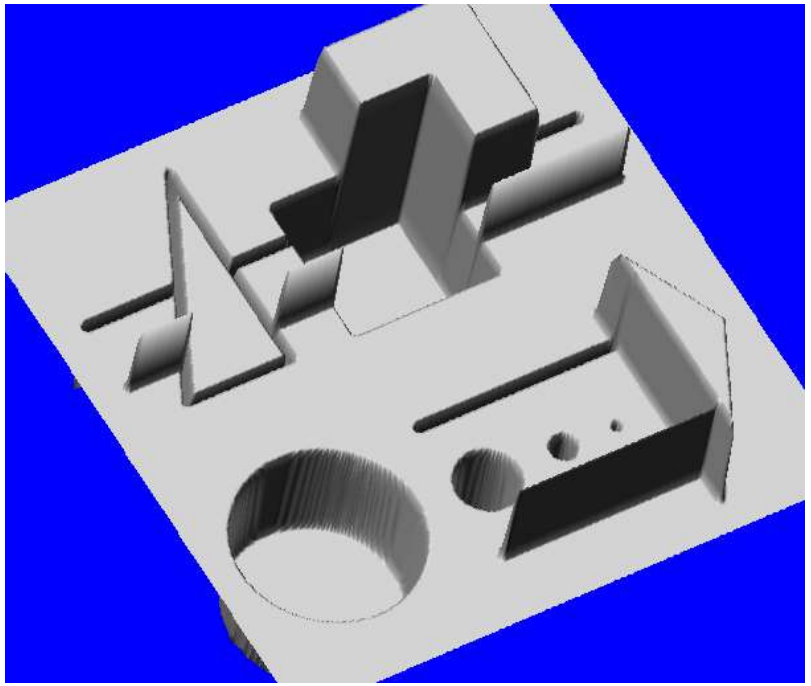
Each cell has number, either a scalar (black and white) or a vector (color).

Discrete representation of continuous world (sampling with aperture).

Digital Images

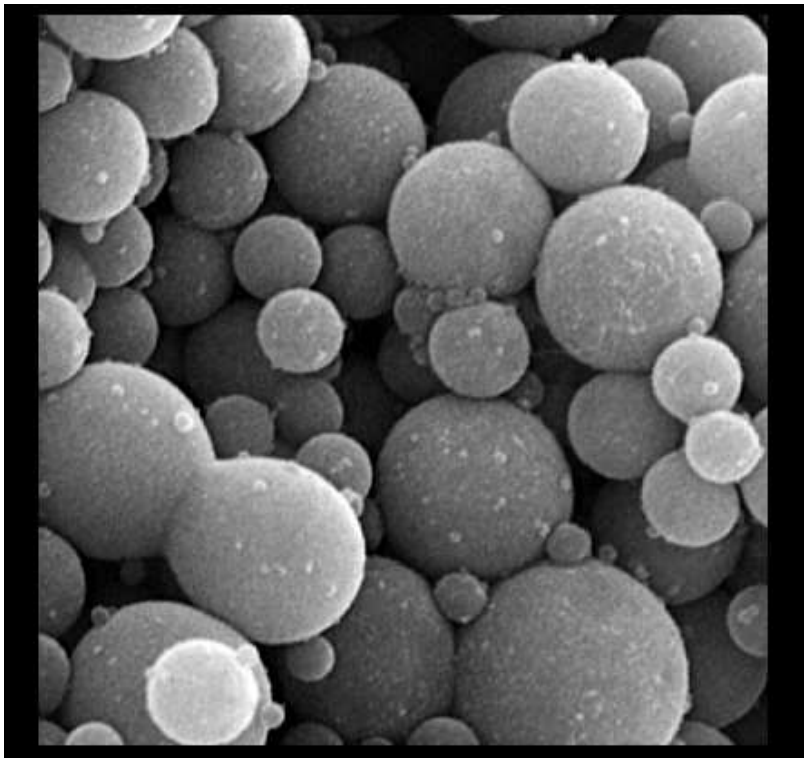


2D gray-level image

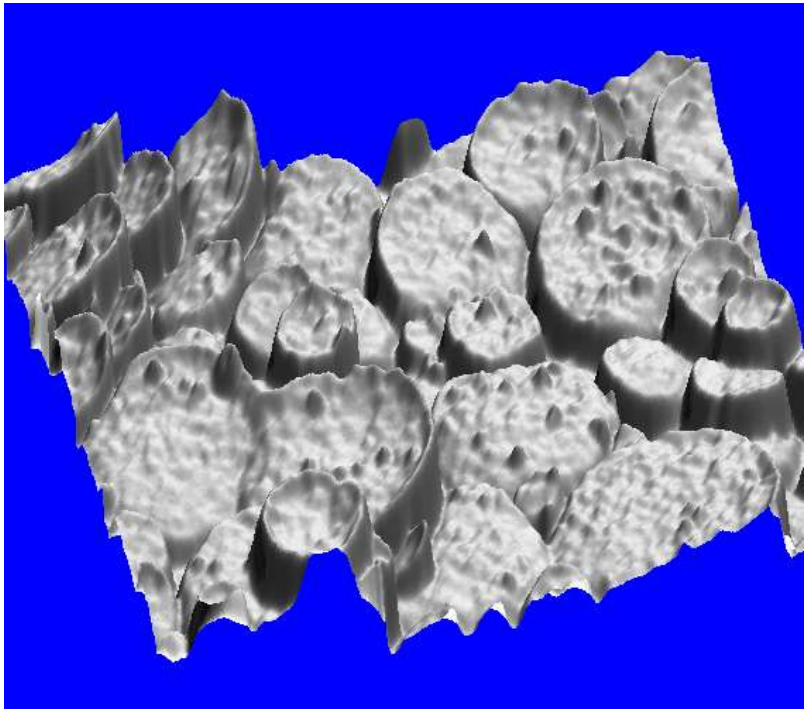


3D mesh representation (intensity= height)

Digital Images



2D gray-level image



3D mesh representation (intensity= height)

Image Processing

- Input: Digital images
- Output: set of measurements, models, morphometric measurements, objects in abstract representation
- Key procedures:
  - Preprocessing, filtering, correction for artefacts
  - Geometric transformations (image registration)
  - Feature detection (edges, lines, homogeneous patches, texture)
  - Grouping of features to objects
  - Model-based versus data-driven segmentation
- Needs:
  - Math, Algorithms
  - Numerical implementations
- Excellent material: http://homepages.inf.ed.ac.uk/rbf/CVonline/

Why Image Analysis?

- Image Processing, Analysis and Computer Vision offer exciting development and research projects.
- Ideal area for CS (algorithms, math, coding, visualization, data structures …), ECE (robotics, pattern recognition, signal processing), BioEng ((bio)medical image analysis, and ME (robotics)
- Faculty at SCI from SoC, ECE, BioEng:
  - Ross Whitaker, Sarang Joshi, Guido Gerig, Tolga Tasdizen, Tom Fletcher, Rob MacCleod

Next Lecture Wed Aug 27

- Get familiar with canvas page, course web-page, and syllabus.
- Carefully read honor code documents (links on course home page).
- Read Preface and Chap 1 of the G&W book (pdf's on course web-page).
- Initiate purchasing class book and eventually MATLAB software.
- Plan to attend MATLAB introduction on Friday 08/29, 3-5pm, WEB 3780 3rd floor Evans conference room.