

Purdue University
School of Electrical Engineering
EE637: Digital Image Processing I
Class Information
Spring 2001

Credits: 3

Area: Communications and Signal Processing

Prerequisites: EE 302 and EE 538 (or equivalent preparation)

Lecturer: Prof. Charles A. Bouman

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Office Hours: Wednesday 2:00PM - 4:00PM; Thursday 9:00AM - 10:00AM

Course Text:

Al Bovik editor, *Handbook of Image & Video Processing*, ISBN 0-12-119790-5, Academic Press, San Diego, 2000.

Supplementary References

A. Rosenfeld and A. Kak, "Digital Picture Processing," volumes 1 and 2, Academic Press, 1982.

A. K. Jain, "Fundamentals of Digital Image Processing", Prentice-Hall, 1989.

B. W. Kernighan and D. M. Ritchie, "The C Programming Language: Second Edition," ISBN 0-13-110370-9, Prentice-Hall, Englewood Cliffs, NJ, 1988.

Course Description:

Introduction to digital image processing techniques for enhancement, compression, restoration, reconstruction, and analysis. Lecture and laboratory experiments covering a wide range of topics including 2-D signals and systems, image analysis, image segmentation; achromatic vision, color image processing, color imaging systems, image sharpening, interpolation, decimation, linear and nonlinear filtering, printing and display of images; image compression, image restoration, and tomography.

Course Objectives:

The objectives of this course are to:

- Cover the basic analytical methods which are widely used in image processing. These include topics such as deterministic and stochastic modeling of images; linear and nonlinear filtering; and image transformations for coding and restoration.

- Cover issues and technologies which are specific to images and image processing systems. We will introduce a wide range of current technologies that are having impact in the image processing field. We will also study the related areas such as human visual modeling, and display/printing device characteristics.
- Develop experience with using computers to process images. We will use the VISE laboratory currently located in MSEE 184 to perform homework assignments and projects which use both the Matlab and C programming environment.

Course Policies:

There will be assigned and graded homework assignments. In addition to the homeworks, there will be regularly assigned course projects of limited scope that must be performed **independently** by each student.

There will be two midterm exams and a single final exam. Final grades will use the following weighting.

Homework and computer projects	20%
Midterms	25%
Final exam	30%

Policies for Off-Campus Students:

During some semesters, this course is offered to off-campus students via the Continuing Engineering Education (CEE) department. During those semesters, the following policies apply.

Exam policies: Exam times, dates and locations are specified at the beginning of the course for each off-campus site. Since some off-campus sites take exams on a delayed basis, all student are expected to maintain the highest ethical standards, and to avoid any situation which may lead to unauthorized access to exam material. Any accidental compromise of exam security should be immediately reported to the instructor.

The following important policies also apply.

- All off-campus exams should be administered by the on-site proctor at the scheduled time and date.
- Any changes in the scheduled time and date of exams must be authorized in writing (or email) by the course instructor in advance of the scheduled exam time and date.
- Any exam which is not administered at the authorized time and date will not be counted.

Course Outline:

1. Continuous Parameter Signals and Systems
 - (a) Continuous time Fourier transform (CSFT)
 - (b) Continuous space Fourier transform (CSFT)
 - (c) The Radon transform and tomography
 - (d) Image systems

2. Discrete Parameter Signals and Systems
 - (a) Discrete time Fourier transform (DSFT)
 - (b) Discrete space Fourier transform (DSFT)
 - (c) 2-D sampling and apperture effects
 - (d) 2-D FIR, IIR and sharpening filters (**Lab**)
 - (e) 2-D random processes (**Lab**)
3. Image topology, and segmentation
 - (a) 2-D neighborhoods and topology
 - (b) Neighbors; causal orderings; connectedness;
 - (c) Edge detection
 - (d) Connected components (**Lab**)
 - (e) Region merging and segmentation
4. Imaging Perception and Representation
 - (a) Achromatic vision
 - i. Light, luminance
 - ii. Contrast and contrast sensitivity functions
 - iii. Gamma correction (**Lab**)
 - iv. Visual MTF
 - v. A simple model of achromatic vision
 - (b) Chromatic vision (**Lab**)
 - i. Tristimulus model of color
 - ii. Opponent model of color
 - iii. Color coordinate systems
 - iv. Uniform color spaces
 - v. Image fidelity metrics
5. Resolution conversion
 - (a) Image decimation
 - (b) Image interpolation
6. Image Enhancement and Filtering (**Lab**)
 - (a) Histograms and pointwise operations
 - (b) Weiner and least squares filtering
 - (c) Minimum weighted mean squared error filters

- (d) Median, weighted median and Rank order filters
7. Image Quantization and Halftoning
- (a) Uniform quantization
 - (b) Lloyd-Max quantizer
 - (c) Vector quantizer
 - (d) Color quantization
 - (e) Halftoning (**Lab**)
 - i. Ordered Dither
 - ii. Error diffusion
8. Image Coding (**Lab**)
- (a) Overview of lossless and lossy coding
 - (b) Entropy and rate-distortion
 - (c) Block truncation coding
 - (d) Predictive coding
 - (e) Transform coding
 - i. KL transforms
 - ii. 2-D DFT
 - iii. Cosine transforms
 - iv. QMF and Wavelet transforms
 - (f) Motion compensated video coding
9. Image Reconstruction
- (a) Tomographic imaging models
 - (b) Fourier slice theorem
 - (c) Convolution and filtered backprojection
 - (d) Iterative reconstruction methods