Purdue University
School of Electrical Engineering
EE637: Digital Image Processing I
Class Information
Spring 2011

Credits: 3
Area: Communications and Signal Processing
Prerequisites: EE 301 and EE 302 (or equivalent preparation)
Lecturer: Prof. Charles A. Bouman
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Course Text (optional):

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

Supplimentary References

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

Signals and Systems, A. V. Oppenheim, A. S. Willsky with S. H. Nawab, Prentice-Hall, Inc., New Jersey, ISBN 0-13-814757-4, 1997.

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

The C Programming Language: Second Edition, B. W. Kernighan and D. M. Ritchie, ISBN 0-13-110370-9, Prentice-Hall, Englewood Cliffs, NJ, 1988.
Statical Inference, S. D. Silvey, ISBN 0-412-13820-4, Chapman & Hall, New York, NY, 1075.

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.

Grading Policies:

There will be regularly assigned course laboratory which will require the preparation of laboratory reports. Homeworks and laboratories must be performed **independently** by each student. Violation of this rule will be considered a form of cheating.

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

Computer laboratories	15%
Midterm	25%
Midterm	25%
Final exam	35%

Academic Honesty Policies:

The ECE faculty expect every member of the Purdue community to practice honorable and ethical behavior both inside and outside the classroom. Any actions that might unfairly improve a student's score on homework, quizzes, labs, or examinations will be considered cheating and will not be tolerated. Examples of cheating include (but are not limited to):

- Sharing results or other information during an examination.

- Bringing forbidden material or devices to an examination.

- Working on an exam before or after the official time allowed.

- Requesting a re-grade of answers or work that has been altered.

- Submitting a homework or laboratory report that is not your own work, or engaging in forbidden homework or laboratory report collaboration.

- Possession of another person's laboratory solutions or report from the current or previous years.

- Reference to, or use of another person's laboratory solutions or report from the current or previous years.

- Allowing another person to copy your laboratory solutions or work.
- Representing as your own work anything that is the result of the work of someone else.

All homeworks and laboratories must be performed **independently** by each student. Violation of this rule will be considered a form of cheating.

At the professor's discretion, cheating on an assignment, or examination will result in a failing grade for the entire course, or a reduced grade, or a zero score for the particular assignment, or exam. All occurrences of academic dishonesty will be reported to the Assistant Dean of Students and copied to the ECE Assistant Head for Education. If there is any question as to whether a given action might be construed as cheating, please see the professor or the TA before you engage in any such action.

Emergency Preparedness: In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. In the event of an emergency, students can get information from the following sources:

1. The course web page
2. By emailing the course instructor or teaching assistant

In an emergency, students are also welcome to contact Prof. Bouman by phone at his office or home.

Additional Academic Honesty/Exam 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 students 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 apperature 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 theorm
    (c) Convolution and filtered backprojection
    (d) Iterative reconstruction methods