ECE 847 Digital Image Processing
Fall 2005

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Office Hours: 1:10-2:10 MWF, or by appointment

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Class meets: 12:20-1:10 MWF, 301 Riggs Hall

Website: http://www.ces.clemson.edu/~stb/ece847

Text (recommended):
- Sonka, Hlavac, Boyle, *Image Processing, Analysis, and Machine Vision*, 1999
- Forsyth and Ponce, *Computer Vision: A Modern Approach*, Prentice-Hall, 2003
- Gonzalez and Woods, *Digital Image Processing*, 2nd ed., Prentice-Hall, 2002

Prerequisites: Probability and statistics, linear algebra, signals and systems, programming skills, creativity and enthusiasm

Overview: This course introduces students to the basic concepts, issues, and algorithms in digital image processing and computer vision. Topics include image formation, projective geometry, convolution, Fourier analysis and other transforms, pixel-based processing, segmentation, texture, detection, stereo, and motion. The goal is to equip students with the skills and tools needed to manipulate images, along with an appreciation for the difficulty of the problems. Students will implement several standard algorithms, evaluate the strengths and weakness of various approaches, and explore a topic of their own choosing in a course project.

Objectives: By the end of the course, students should be able to do the following:
- *Fundamental concepts.* Define the problems of compression, restoration, segmentation, detection, recognition, segmentation, reconstruction, and tracking. Explain the relationship between image processing, machine vision, computer vision, and computer graphics. Explain the concepts of regions, edges, filters, transforms, photometry, and geometry.
- *Computation.* Write C/C++ code to implement standard algorithms (such as region analysis, edge detection, template matching, segmentation, stereo correspondence, perspective projection, epipolar geometry calculation, color discrimination, compression).
- *Course project.* Determine a topic to investigate and research it by finding and reading relevant research papers. Develop an approach to solving the problem, implement and test the solution, and critically evaluate the results. Effectively communicate the steps and conclusions of the investigation in an oral presentation and a written report.

Grading: assignments (60%), project (25%), quizzes (15%); up to 10 points extra credit for contributions to the C++ vision library

Topical outline:

- pixel-based processing (edge and region analysis, distance measures, histograms, morphological operations)
- filters and edge detection (convolution, Gaussian, Laplacian of Gaussian, noise types, simple edge detection methods, scale-space)
- pattern detection (Hough transform, matched filter, ROC curve)
- segmentation (region growing, split-and-merge algorithm, Gestalt, watershed algorithm)
- texture (co-occurrence matrices, autocorrelation, entropy, filter banks, pyramids)
- transforms (Fourier, cosine, Gabor, and wavelet transforms; basis functions; PCA)
- projective geometry (stratification of geometry, homography and collineation, homogeneous points, projection models)
- image formation (geometry, photometry, color, sensors)
- stereo (geometry, correspondence, constraints, rectification)
- motion (optical flow and motion field, aperture problem, feature detection and tracking)

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