ECE 893-3 Machine Vision
Spring 2006

Instructor: Stan Birchfield, 207A Riggs Hall, 656-5912, stb at clemson
Office Hours: 10:00-11:00 MWF, or by appointment

Grading assistant: TBD

Class meets: 1:25-2:15 MWF, 301 Riggs Hall

Website: **http://www.ces.clemson.edu/~stb/ece847b**

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: ECE847 Image Processing; also probability and statistics, linear algebra, signals and systems, programming skills, creativity and enthusiasm

Overview: This course builds upon ECE847 by exposing students to fundamental concepts, issues, and algorithms in digital image processing and computer vision. Topics include texture, classification, 3D reconstruction, calibration, shape, model fitting, and function optimization. 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 shape representation, texture, classification, 3D reconstruction, camera calibration, model fitting, and function optimization. Explain the various algorithms and concepts proposed to solve these problems and discuss the relationships and tradeoffs between them.
- *Computation.* Write code to implement standard algorithms (such as region analysis, edge detection, template matching, segmentation, stereo correspondence, perspective projection, epipolar geometry calculation, color discrimination, compression, 3D reconstruction).
- *Course project.* Research a topic by finding and reading relevant research papers, writing a survey of past research, and identifying holes in the current approaches. 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 oral presentations and written reports.

Grading: biweekly assignments and project milestones (70%), quizzes (30%); up to 10 points extra credit for contributions to the C++ vision library

Topical outline:

- shape (active contours, B-splines, shape context, generalized cylinder, deformable template, Mumford-Shah, dual contour, level sets)
- classification (Bayesian decision theory, statistical pattern recognition, linear methods, architectures, boosting, ROC curve)
- texture (stuff vs. things, co-occurrence matrix, Fourier transform, filter banks, wavelets, Gabor filters, steerable pyramids, texture synthesis)
- 3D reconstruction (rank constraint, essential and fundamental matrices)
- camera calibration (Hildreth's radial calibration, Tsai's calibration model)
- model fitting (least squares, line fitting, robust estimators, Hough transform RANSAC)
- scale space (SIFT features)
- function optimization (expectation maximization (EM), Newton-Raphson, Gauss-Newton, gradient descent, conjugate gradient, Levenberg-Marquardt, multiway cut)

Academic integrity: "As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning.' Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form." – from the university's web page on academic integrity: http://www.cs.clemson.edu/html/academics/academic_integrity_2002.html