CS 543 / ECE 549 – Computer Vision – Spring 2017

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Room: **1310 DCL**
Class Time: **Tuesday and Thursday 11:00pm – 12:15pm**
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Computer vision algorithms attempt to make sense of photographs, video, and other imagery. Applications include analysis of medical images, automated quality inspection, entertainment, vehicle safety, security, and media search, among many others.

In this course, we will cover many of the basic concepts and algorithms of computer vision: single-view and multi-view geometry, lighting, linear filters, texture, interest points, tracking, RANSAC, K-means clustering, segmentation, EM algorithm, recognition, and so on. In homeworks, you will put many of these concepts into practice. As this is a survey course, we will not go into great depth on any topic, but at the end of the course, you should be prepared for any further vision-related investigation and application.

General Information

This course does not follow any textbook closely. Many recommended readings are for Computer Vision: A Modern Approach (2nd edition) by David Forsyth and Jean Ponce (2011). Other useful books include Multiple View Geometry in Computer Vision by Hartley and Zisserman, Concise Computer Vision: An Introduction into Theory and Algorithms by Reinhard Klette, and Computer Vision: Algorithms and Applications by Rick Szeliski.

More useful books:
Computer Vision, Shapiro and Stockman *(a nice introduction to computer vision)*
Linear Algebra and its Applications, Gilbert Strang *(excellent book on linear algebra)*
Vision Science: Photons to Phenomenology, Stephen Palmer *(great book on human perception)*
Digital Image Processing, 2nd edition, Gonzalez and Woods *(a good general image processing text)*

Prerequisites include good knowledge of linear algebra, calculus, and probability. All homeworks involve programming in Matlab.

Attendance is expected. Lecture slides will be posted and videos recorded, but participation in class is necessary to understand the slides and will lead to better retention.

To obtain **disability-related academic adjustments** and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES you may visit 1207 S. Oak St., Champaign, call 333-4603 (V/TDD), or e-mail a message to disability@uiuc.edu.

Assignments and Grading

Grades are based on five homeworks and a final project. The homeworks are worth 75%, and the final project is worth 25%. To have a guaranteed "A", you need an average grade of 90%. I reserve the right to lower but not raise this threshold. Each person should submit his or her own complete solutions and code, but homeworks can be discussed in groups. Indicate any collaborators on the hand-in.

Academic Honesty: You are expected to do your own work. When you turn in an assignment, be sure to list any collaborators. Collaboration means that you discuss assignments, but don't share code or copy solutions. Do not use outside code without prior permission from the instructor. Also, make sure to list any sources of ideas or code, no matter how minor. Violations of the student code of academic honesty will be reported, with a **minimum penalty of 0 for the entire assignment**.

Late Policy: You are expected to do assignments on time. Late assignments will be assigned a penalty of 10 points per day. You may have a total five late days on the homeworks without penalty – use them wisely. Generally, homeworks can be turned in only once (not revised), though special circumstances may be considered.

Tentative **due dates** for homeworks are Feb 13, Feb 27, March 13, April 3, and April 17. The final project will be due during the final period. These are subject to change.

Final Project

The project is a chance to further explore a topic of interest. Groups of up to four are highly encouraged. More is expected of larger groups. Projects will include a short written component and a poster presentation. Various types of projects are possible, including those below. The work does not have to be of publishable originality, though revised versions of projects in the past have sometimes been accepted into top conferences.

Research Project: Perform a project in a topic of your choice. Formulate a goal, devise an approach, and evaluate. When proposing, indicate what dataset you will use for evaluation. For example, you could base your project on an existing paper and try to improve the accuracy or speed with some modification. You could also apply existing algorithms to your own field (e.g., robotics).

Review and Implement a Paper: Choose a paper or set of papers and write a scholarly review. Then, implement and evaluate the algorithm. If done in a group, more than one paper should be implemented and compared. Reviews should be written independently for each person, but the group can collaborate on implementation and evaluation.

Class Organization

The class is organized into six sections, with one homework for each of the first five sections. Homeworks will include some derivation and some implementation. Assignments may, for example, include building an edge detector; detecting and tracking interest points; using tracked interest points to do 3D reconstruction; parameter learning with EM; object instance recognition; graph cut segmentation; and image categorization.

Weeks 1-3: Interpreting Intensity
- Light, shading, and color
- Image filters, template matching, and image pyramids
- Edge detection

Weeks 4-5: Correspondence and Alignment
- Interest point detection and feature tracking
- Fitting and registration of objects and images

Weeks 6-7: 3D Geometry
- Camera models
- Single-view and multi-view geometry
- Stereo and structure-from-motion

Weeks 9-10: Grouping and Segmentation
- Clustering, EM
- Segmentation

Weeks 11-13: Recognition
- Face recognition
- Categorization, classifiers, and CNNs (deep networks)
- Object recognition and semantic segmentation with CNNs
- Object tracking

Weeks 14-15: Special Topics
- Action recognition
- 3D scene interpretation
- VQA