CS 677 Advanced Computer Vision

Instructor

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Background:

This course was initiated in Fall 2017. It is an enhanced version of an earlier 3-unit computer vision course (cs574). Note that 574 is NOT a pre-requisite to 677; in fact, it is not our plan to offer cs574 in the near future.

Brief Course Description

The course will provide an overview of the challenges of vision, the commonly used techniques and the current approaches. While specific examples and applications may be used to illustrate, the focus will be on fundamental techniques and algorithms. It aims to prepare students to start academic research or challenging careers in industry.

Course Availability

CS677 is available for CS PhD credit but is also open to CS and EE MS students. In exceptional cases, undergraduate students may also be admitted. PhD students will be given priority in enrollment; however, MS students are expected to be the large majority of enrollment.
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It is expected that the course will be offered once a year. We are seeking to increase the frequency to every term if we can find additional instructors.

Prerequisites

1. Mathematics: Knowledge of and ability to use calculus, analytical geometry, linear algebra and probability theory.

2. Programming: Ability to program in Python.

No exam will be given to assess pre-requisites. However, GPA may be used to screen students for preparedness.

Textbooks

There is, unfortunately, not a single, modern textbook available to cover the topics in this course. We will use published papers and tutorials extensively. Nonetheless, following books will be helpful for study.

Required:
"Computer Vision: A Modern Approach", D. Forsyth and J. Ponce, 2010.

"Deep Learning: Algorithms and Applications", I. Goodfellow, Y. Bengio and A. Courville, 2017 (online version available at no cost for personal use).

"A Guide to Convolutional Neural Networks for Computer Vision", S. Khan, H. Rahmani, S. Shah and M. Bennamoun, 2018 (online version available from a USC account).

Recommended:
"Computer Vision: Algorithms and Applications", Richard Szeliski, 2010 (online version available at no cost for personal use).

Grading Breakdown:

There will be two exams: Exam1 and Exam2, each counting for 25% of the grade (for a total of 50%). There will be one or two mathematical assignments and four to six programming assignments. Large scale "projects" are not planned. Total assignment will count for 30% of the grade. 10% of the grade will be assigned to attendance and participation (does not apply to remote DEN students). Lastly, an end of the term, "term paper", will count for the remaining 10% of the grade.

Detailed Course Syllabus:

The topic of computer vision is evolving very rapidly. Recent advances have come largely from "data-driven" deep learning and neural networks. However, traditional, "model-based" methods continue to be of interest and use in practice. This course will cover both traditional and deep-learning approaches.

Following is a list of topics expected to be covered, in anticipated order, and with expected time to be spent on them. However, this list should be taken as being only indicative and actual topics, the order and the time may vary depending on various factors including student interests and preparation and new developments in the field.

1. **Introduction (1 week)**
   Background, requirements and issues, human vision
2. **Image formation: geometry and photometry (2 weeks)**
   Geometry, photometry (brightness and color), quantization, camera calibration
3. **Image segmentation (1 week)**
   Various methods of image segmentation, edge detection, object proposals
4. **Multi-view Geometry (2 weeks)**
   Shape from stereo and motion, feature matching, surface fitting, Active ranging
5. **Object Recognition: Traditional Methods (2 weeks)**
   HoG/SIFT features, Bayes classifiers, SVM classifiers
6. **Object Recognition: Deep Learning Methods (3 weeks)**
   Deep neural networks, classification networks, object proposal networks
7. **Motion analysis and Activity Recognition (1 week)**
   Motion detection and tracking, Inference of human activity from image sequences
8. **Selected Topics (1 week)**
   Examples: Face recognition, Image grounding, Visual question answering