CS 755/855 Computer Vision

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Overview

The course discusses how common computer vision techniques work. This require understanding many concepts from linear Algebra, Bayesian probability, machine learning, signal- and image-processing and integrating them to interpret images and videos. The classes develop the intuition and mathematics of various computer vision methods such as image filtering, feature detection, object/face recognition, camera calibration, depth from stereo, structure from motion, and convolutional neural networks. The assignments use standard image datasets to teach students how to make the methods work in practice. The course will cover convolutional neural network based deep learning architectures for object and activity recognition as a contemporary topic.

Prerequisite: MATH 539 or MATH 644, and Programming course or permission of instructor. At least Junior standing is required to attend this course.

Attribute

CS elective with a minimum passing grade of D-. This is designated as a ***theory intensive*** course**.**

Textbook:

Lectures are prepared based on the following textbooks.

1. Digital Image Processing, by Gonzalez and Woods (paper copy available at UNH library)
2. Computer Vision: A Modern Approach, by Forsyth and Ponce (paper copy available at UNH library)
3. Computer Vision: Algorithms and Applications by R. Szeliski (available online).
4. Multi-view Geometry by Hartley and Zisserman (paper copy available at UNH library).

Grades:

- 8 Assignments: 70 points.
- Take-home final exam: 30 points.
- Graduate specific components: Assignments have theory and/or programming problems that require advanced understanding of the materials. Only Graduate students are required to solve these advanced problems. Undergraduate students get bonus points for solving advanced problems.

Programming:

Students are encouraged to use Matlab. It is ok if you have never used Matlab before. Students are allowed to use Python but there will be no support; All starter codes are in Matlab.

A Tentative Schedule: *This schedule will be adjusted frequently based on the progress of the class. The instructor reserves all rights to change the lecture topics, exam dates, and due dates for assignments and labs during the semester.*

Week 1

- Course Introduction

Week 2

- Concepts from Linear Algebra: Vector, Matrix, Rank, Transformation matrices Eigen vector, Eigen value, SVD,
- **Assignment 1 out: Linear Algebra basics (10 points)**

Week 3

- Matlab Tutorial
- Image Filtering: Spatial domain

Week 4

- Frequency domain filtering
- **Assignment 2 out: Image filtering (10 points)**

Week 5: 2/21

- Feature detection: Canny edge detector
- Feature detection: Hough transformation
- **Assignment 3 out: Canny and Hough theory (7 points)**

Week 6: 2/28

- Feature Detection: Harris Corner

Week 7: 03/07

- Feature Detection: Scale Invariant Feature Transform (SIFT)
- **Assignment 4 Out: Harris and SIFT for image matching (12 points)**
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Week 8: Spring Break

Week 9: 03/21

- SIFT presentation by students
- Machine Learning crash course I: Generative and discriminative classification, Clustering (k-means)

Week 10: 3/28

- Recognition: Bag of visual words
- RANSAC
- **Assignment 5 Out: Bag of visual word theory (5 points)**

Week 11: 4/4

- Boosting and Viola-Jones classifier for face detection
- **Assignment 6 Out: Viola Jones (15 points) Due**

Week 12: 4/11

- Camera optics: properties of camera
- Camera calibration I

Week 13: 4/18

- Camera calibration II
- Stereo Introduction, Epipolar geometry
- **Assignment 7 Out: Camera calibration theory (10 points)**

Week 14: 4/25

- Essential and Fundamental matrix
- **Assignment 8 Out: Epipolar geometry and fundamental matrix calculation (10 points)**

Week 15: 5/2

- Convolutional neural networks (contemporary topic)

Week 16: May 9: The last day of the semester

- Exam Review

Take home final exam (30 points): Bag of visual words for scene recognition