Multidimensional Digital Signal Processing

ECG782 Fall 25

http://www.egr.unlv.edu/~b1morris/ecg782

Professor:	Brendan Morris	Class:	TuTh 13:00-14:15, AEB 145
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Textbook

Digital Image Processing, Gonzalez and Woods, 3rd Edition ISBN: 978031687288

Recommended Text

Computer Vision: Algorithms and Applications, Szelisk [pdf] ISBN: 1848829345

Image Processing, Analysis, and Machine Vision, 4th Edition, Sonka, Hlavac, and Boyle ISBN: 9781133593607

Grading

Project:	25%	Sat 12/13
Final:	20%	Tu 12/09
Midterm:	20%	Tu 10/14
Homework:	15%	Weekly
Presentation	10%	Tu 12/02
Participation:	10%	Weekly

- Students may study together in groups but all assignments must be completed individually. Homework will be due via Webcampus (Canvas) on designated date. No late homework will be accepted unless prior notification and arrangements are made.
- Class participation will be recorded through online "quizzes" each week. These are high-level concept questions that are designed to ensure you can identify any material that requires further study.
- The course will have a final computer vision project. You will be required to submit a project report in the form of a conference styled manuscript for publication and make a presentation.
- Exams are cumulative but will emphasize new material.
- Exams should be i) completed by you alone ii) without the use of any books or reference material other than explicitly allowed iii) without access to internet outside of Webcampus and iv) should not be discussed with any other student until after the exam is closed.
- NOTE: Homework and exams will be submitted online via Webcampus. You must obtain tools to scan or make pdf images of your work.

Catalog Description

Theory and applications of multidimensional (M-D) digital signal processing. M-D signals and systems. M-D z-transform. M-D DFT and FFT. Design and implementation of M-D FIR and IIR filters. Applications to image processing such as image enhancement and restoration. Advanced topics chosen according to class interests.

Prerequisites: None

Course Description
Introductory graduate course in computer vision, machine leaning, and pattern recognition with real-time systems. The course will be divided into two parts: image and video processing. Image processing topics will include image formation, morphology and connected components, feature detection and representation, segmentation, and stereo imaging. Video processing techniques will focus on motion estimation, tracking, and object detection and recognition.

The course will have programming homework assignments and a final project. Readings will be assigned in from the textbook as well as recent papers from top academic publications.

Programming assignments will make use of popular vision tools such as Matlab, OpenCV, and Tensorflow.

Topics
Image Processing

1. Image Formation - geometric primitives, camera model, digital imaging (sampling and quantization)
2. Image Processing - point operations, color transformations, histogram equalization, spatial image enhancement and filtering, frequency domain processing, connected components, morphology, multi-resolution pyramids
3. Feature Detection and Representation - corner detectors, invariant features (SIFT, SURF), HoG, edge detection, Canny edge-detector, non-maximal suppression, Hough transform, RANSAC
4. Segmentation - thresholding, region-based segmentation, split-and-merge, mean-shift, graph cuts

Video Processing

1. Motion Estimation - optical flow, background modeling, mixture of Gaussians
2. Object Detection - nearest neighbor classification, correlation, Adaboost classifier, SVM
3. Object Recognition - Bayes classifier, Eigenfaces and Fisher faces, bag of words

Deep Learning

1. Mathematical fundamentals - neural networks, convolutional neural networks (CNN)
2. Network architectures for classification, detection, segmentation
3. Attention and Transformer networks

Additional course material not present in the textbook will be distributed to the class when needed. Extra examples and problems can be found in the recommended texts.

Course Outcomes
Upon completion of this course:

- Students will have a clear understanding of image processing and computer vision fundamentals as well as the challenges.
- Students will be able to design and implement computer vision algorithms for real-time video processing.
- Students will have an overview of deep learning for vision.
- Students will be able to design and implement deep CNN networks for computer vision applications.
- Students will be able to search for and read academic papers and critically evaluate their importance.

- Students will be able to present technical material orally in a clear and concise manner.

Course Policies

- There will be no make-up exams or late homework without prior arrangements.
- Extensions will only be granted for medical emergencies or due to the observance of a religious holiday. The instructor must be notified of the absence prior to the last day of late registration.
- As a university student it is your responsibility to conduct yourself ethically and with integrity as described in the Academic Misconduct Policy. Cheating and plagiarism will not be tolerated. Any student caught cheating will be given an F grade.
  (`https://www.unlv.edu/studentconduct/student-conduct`)

Academic Policies for Students

`https://www.unlv.edu/policies/students`