CS 484: Image Analysis

Spring 2010

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Schedule: Wed 8:40-10:30, Fri 10:40-12:30 (EB 201)

Web page: http://www.cs.bilkent.edu.tr/~saksoy/courses/cs484/index.html

Catalog description: Image acquisition, sampling and quantization. Spatial domain processing. Image enhancement. Texture analysis. Edge detection. Frequency domain processing. Color image processing. Mathematical morphology. Image segmentation and region representations. Statistical and structural scene descriptions. Applications.

Course emphasis and goals: This course provides an introduction to image analysis and computer vision for undergraduates. We will start with low-level vision (early processing) techniques such as binary image analysis, filtering, edge detection and texture analysis. Then, we will cover mid-level vision topics such as image segmentation and feature extraction in detail. Finally, we will do case studies on several applications such as image retrieval and classification. The emphasis will be on feature extraction and image representations for recognition. Note that this course will not cover advanced computer vision topics such as motion analysis, multi-view geometry, 3D vision, and object recognition that are covered in the graduate level CS 554 Computer Vision course.

Prerequisites: Good programming background, data structures, linear algebra, vector calculus, basics of signal processing. No prior knowledge of image processing or computer vision is assumed.

Texts:
- L. G. Shapiro and G. C. Stockman, *Computer Vision*, Prentice Hall, 2001.
- R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, 3rd ed., Prentice Hall, 2008.
- D. A. Forsyth and J. Ponce, *Computer Vision: A Modern Approach*, Prentice Hall, 2002.
- D. H. Ballard and C. M. Brown, *Computer Vision*, Prentice Hall, 1982.
- R. Szeliski, *Computer Vision: Algorithms and Applications*, under preparation (draft available on the course web site).

Grading:

Homework:	35%
Quiz:	10%
Exam:	25%
Project:	25%
Class participation:	5%

Homework: There will be three homework assignments that will involve both programming and discussion. There will also be small assignments that will be done on an image that you will choose in the beginning of the semester.

Quiz: There will be at least two in-class quizzes.

Exam: There will be one midterm exam.

Project: There will be a term project that will involve application of multiple image analysis techniques on different data sets. Project topics will be related to the case studies that we will discuss toward the end of the semester. You will work in groups for the project.

Lecture schedule:

- Introduction
  - Overview
  - Example applications
- Digital Image Fundamentals
  - Acquisition, sampling, quantization
  - Image enhancement
  - Image formats
  - Linear algebra and MATLAB review
- Binary Image Analysis
  - Pixels and neighborhoods
  - Mathematical morphology
  - Connected components analysis
  - Automatic thresholding
- Linear Filtering
  - Spatial domain filtering
  - Frequency domain filtering
  - Image enhancement
- Edge Detection
  - Edges, lines, arcs
  - Hough transform
- Pattern Recognition Overview
  - Brief introduction to pattern recognition
  - K-means and hierarchical clustering
- Local Feature Detectors
  - Corners and other interest points
  - Invariants
- Color Image Processing
  - Color spaces and conversions
- Texture Analysis
  - Statistical approaches
  - Structural approaches
- Image Segmentation
  - Histogram-based approaches

- Clustering-based approaches
  - Region growing
  - Split-and-merge
  - Morphological approaches
  - Graph-based approaches

- Representation and Description

  - Image representations and descriptors
  - Region representations and descriptors

- Case Studies
  - Pattern recognition
  - Image retrieval
  - Image classification
  - Object recognition

Late submission policy for assignments:

Each assignment will have a specific due date and time. The assignments are expected to be turned in by that time on that date. For the late assignments, each student will be given a total of two grace days (whole or partial) for the whole semester. Once these late days have been exhausted, no late assignments will be accepted. As an example, if Student A submits her/his 1st assignment 19 hours late, s/he will have used one late day and have only one day left. If Students A then submits her/his 2nd assignment 5 hours late, s/he will have used her/his remaining late day. If Student A submits her/his 3rd assignment 1 minute late, this assignment will not be accepted.

You should upload your homework using the online submission form before the deadline. Check the homework description carefully about what is required in a submission. Homework grades will be posted to the STARS system. You can get feedback about your homework from the TA during office hours.

Honor code for assignments:

In the Computer Engineering Department at Bilkent, we take the academic integrity on homework assignments very seriously and expect you to take it seriously too. The aim of this section is to make our expectations as clear as possible to prevent possible academic integrity violations.

Students naturally want to work together and get help from others when they struggle. We believe that you learn a great deal by doing so and encourage such assistance. However, you should be careful not to violate the academic integrity. In response to this, the following rules will be in force for assignments in CS 484:

- You are allowed to discuss with your classmates in finding strategies for problem solving and debugging, but NOT in writing your codes. In other words, you may not discuss with your classmates how to solve the problem using a particular programming language (either actual code or the pseudocode); discussion on the actual code or the pseudocode will not be tolerated.

- All work on assignments must be done individually unless stated otherwise. You may not copy code in whole or in part from someone else. You may not share your code. You may not discuss your solution with others in detail (line-by-line or loop-by-loop).

- If you need detailed help, ask your instructor or your TA; such detailed discussion is limited to only these people. Rather than these people, you may not receive detailed help on your code from individuals or a book or the Internet unless stated otherwise. Similarly, you may not hire a tutor to get your homework done. If you just use some small hints from other sources (friends, books, websites, etc.), do not forget to cite them.

- If external assistance (from other people, Internet, books) is allowed for a particular assignment, you must indicate the source on your submission. If you make use of such assistance without giving proper credit, you may be guilty of plagiarism. It is also important to make sure that the assistance you receive consists of general advice that does not cross the boundary into having someone else write the actual code.

- You must not look at solution sets or program code from other years. It is a violation of academic integrity and it also will not help you in the long run. Whenever you seek help on an assignment, your goal should be improving your level of understanding and not simply having your homework done.

- You may not show your code to others as a means of helping them. Sometimes, very good students provide their code (sometimes "just a peek" at their code) or detailed help to struggling students for helping them. However, such good intentions may turn into the violation of the academic integrity. If you have such struggling friends, direct them to the instructor or the TA.

- You may not leave your code in publicly accessible areas. You may not share computers in any way. If you work in a public lab, delete all files related to the assignment when you leave; do not forget to empty the recycle bin. You may not use others' storage devices (others' CDs, USBs, etc) to save your work.

- You may not leave any printouts lying around anywhere and you may not dispose them in public trash cans until your assignment has been graded.

- You must be prepared to explain the solutions to any assignment you submit. All the comments regarding program code above are also valid for any essays you write and any theoretical solutions you are asked to provide.

- You may not rely on the assumptions regarding to this issue (experience of your friends or your experience in other courses). If you have any questions, you must ask them to the instructor. Similarly, if any of these rules is not clear for you, ask what they mean to the instructor.

In this course, we may use an automatic code comparison tool to help spot assignments that have been submitted in violation of these rules. It takes all assignments from all students (and several solutions that may exist on the Internet or solutions from past years) and compares them. By making use of its results, we check similar pairs of assignments ourselves carefully and make our own judgment. *Students caught cheating on assignments will be subject to disciplinary action.* Do not forget that it is much easier to explain a poor grade to others than to explain a cheating conviction.