198:334  Introduction to Imaging and Multimedia  
Fall 2015 - Course Syllabus

Instructor: Dr. Ahmed Elgammal -- email: elgammal@cs.rutgers.edu  
Office hours: Friday 12:30-1:30pm - CoRE 316

Email policy: please include CS334 in the subject line.

TA: Han Zhang (han.zhang@cs.rutgers.edu) - Office hours: Tuesdays 1:30-2:30pm in CBIM cubicle N.  
TA: Shaojun Zhu (sz313@rutgers.edu) - Office hours: Wednesdays 3-4 pm in CBIM cubicle E (near room 20)

Regular class time:
Lectures: Tue&Thu 3:20-4:40 PM - Livingston TIL-232  
Recitations: Sec 01 Tue 5:15-6:10 PM - Livingston TIL-103A  
Sec 02 Thu 6:55-7:50 PM - Busch SEC-202

Class Web page:  http://www.cs.rutgers.edu/~elgammal/cs334.htm, Also a Sakai page

Course Goals
The aim of CS334 is to introduce the student to fundamental techniques and concepts used in computational imaging and multimedia. Upon completion of this course, a successful student should be able to design and implement programs that deal with image, video, and audio data.

Description:
This is a basic undergraduate-level class that covers the fundamentals of image processing, computer vision, and multimedia computing. The students learn about the basics of image, video, and audio formation and processing, the basics of multimedia compression and representation. The students will be exposed to dealing with image and video data through programming assignments using Java and Matlab.

Recommended Background:
Linear algebra, basic probability and statistics. Java Programming and C++ programming.

Pre-Requisites:
• 01:198:112 OR 14:332:351 (Data Structures)  
• 01:640:250 (Linear Algebra)

Topics:
• Introduction to Multimedia: Historical overview, multimedia representations, software tools, authoring tools.  
• Basics of Image Formation: Camera and lenses, digitization, image formation, basic camera models and geometry. Standard image formats. Colors in images and videos.  
• Image Computing: Binary image analysis: The basics of processing 2D images, thresholding, convolution, edge and corner detection, mathematical morphology, and shape descriptors. Application: implementation of a simple Optical Character Recognition (OCR) System.  
• Video Processing: Fundamental concepts of video, image and video compression, MPEG video coding, MPEG4, 7, and beyond.  
• Audio Processing: Basics of digital audio, quantization and transmission of Audio. Audio compression, Audio MPEG.  
• Multimedia applications: content-based retrieval in digital libraries: case studies.
Programming Assignments:
Course assignments will be using Java, C++, and Matlab. We will use ImageJ, which is an image processing library using Java. Prior knowledge of Matlab is not required.

Textbooks

Course Load
- Homework/programming assignments and small projects: (60%) 4-5 assignments.
- Exams: Midterm (15%) and Final (25%).
- Presentation: (extra credit) 5% can be achieved by researching and presenting a technology review topic.

Tentative Class Calendar
MS: Multimedia Systems
DIP: Digital Image Processing text book

<table>
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<tr>
<th>Week</th>
<th>Lecture</th>
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| Week 1 | • Introduction to Multimedia - MS Ch 1  
          • Image formation and Cameras - DIP Ch 2 |
| Week 2 | • Image Histograms and applications – DIP Ch 4  
          • Point Operations – DIP Ch 5  
          • Image Formats DIP Ch 2 or MS Ch 3 |
| Week 3 | • Image Filters & Convolution - DIP Ch 6  
          • Edges and Contours – DIP Ch 7 |
| Week 4 | • Edges and Corners – DIP Ch 7 & 8  
          • Perceptual Grouping: Curves and Hough transform - DIP Ch 9 |
| Week 5 | • Binary Image Analysis and Morphology – DIP Ch 10  
          • Region Descriptors – DIP Ch 11 |
| Week 6 | • Color Images, Color spaces: Color spaces for TV and Video; Color spaces for Printing, Colorimetric color spaces. DIP Ch 12 or MS Ch 4  
          • Color quantization – DIP Ch 12 |
| Week 7 | • Fourier Transform, Discrete Fourier Transform, Discrete Cosine Transform – DIP Ch 13 & 14 |
| Week 8 | • Lossless compression: Variable length coding, Dictionary-based coding, LZW compression – MS Ch 6 |
| Week 9 | • Lossy Compression, Image Compression standards, JPEG, JPEG 2000 - MS Ch 7  
          • Concepts of Video – MS Ch 3 |
| Week 10 | • Video Compression: Motion Compensation, H.261 standard – MS Ch 8 |
| Week 11 | • Video Compression, MPEG1, MPEG2, MPEG4- MS Ch 8 |
| Week 12 | • Basics of Audio – MS Ch 3 |
| Week 13 | • Audio Compressions: Temporal and Frequency Masking, MP3 – MS Ch 9 |
| Week 14 | • Multimedia Applications: Content-based retrieval in digital libraries |