198:334 Introduction to Imaging and Multimedia
Fall 2021 - Course Syllabus

Instructor: Dr. Ahmed Elgammal -- email: elgammal a-t cs.rutgers.edu
Office hours: Tuesday 6:00-7:00pm.

Email policy: please include "CS334" in the subject line. Ignoring this in the subject line might results in email being missed. Student should expect to receive a response within **24 hours** on weekday

TA:
Yuting Wang - yw632@scarletmail.rutgers.edu Office hours: Friday TBD

Grader: TBD

Regular class time: (All classes will be online)
Lectures: Mondays and Wednesdays 5:00PM-6:20PM ONLINE
recitations: Sec 01 Wed 7 PM - 7:55 PM Busch PH-111 ON CAMPUS
Sec 02 Wed 9 PM - 9:55 PM Busch Hill 116 ON CAMPUS

Lectures will be live at lecture time and recorded and made available after 24 hours for asynchronous access.

Class Web page: Sakai page

TECHNOLOGY REQUIREMENTS: Internet connection that allows zoom/webex interaction and access to sakai/canvas for course materials and timed quizzes.

Course Goals
The aim of CS334 is to introduce 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, representations, 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 Python.

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

Pre-Requisites:
- 01:198:112 OR 14:332:351 (Data Structures)
- 01:198:206 OR 14:332:226 OR 01:640:477 (Discrete Mathematics and Probability)
- 01:640:250 (Linear Algebra)

Topics:
- Introduction to Multimedia: Historical overview, multimedia representations.
- 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.

- Multimedia compression basics: Lossless Compression: Variable length coding, Dictionary based coding. Basics for Lossy Compression: Fourier Transform, Discrete Cosine Transform. Application to image compression (JPEG compression)
- 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.

Programming Assignments:
Course assignments will be using Java, and Python. We will use ImageJ, which is an image processing library using Java.

Prior knowledge of Python is not required.

Textbooks

- W. Burger & M. Burge "Digital Image Processing: An algorithmic introduction using Java", Springer - Second Edition ISBN 978-1447166832

  Available online through Rutgers Libraries
  https://link-springer-com.proxy.libraries.rutgers.edu/book/10.1007%2F978-1-4471-6684-9

- Ze-Nian Li, Mark S. Drew, Jiangchuan Liu "Fundamentals of Multimedia", Springer 2014, Second Edition ISBN 978-3-319-05289-2

  Available online through Rutgers Libraries
  https://link-springer-com.proxy.libraries.rutgers.edu/book/10.1007%2F978-3-319-05290-8

- **Optional:** P. Havaldar and G. Medioni "Multimedia Systems – Algorithms, Standards and Industry Practices", Cengage Learning – 978-1-4188-3594-1 (recommended for some topics – not required)

Course Load

- Homework/programming assignments and small projects: (70%) 4-6 assignments. All assignments are equally weighted
- Quizzes: ~6 quizzes (20%) All quizzes are equally weighted.
- Weekly reading assignment.
- Presentation: 10% can be achieved by researching and presenting a relevant technology review topic – individuals or groups of 2.

Tentative Class Calendar (subject to change)

FM: Fundamentals of Multimedia textbook
DIP: Digital Image Processing text book

Week	Lecture and recitations
Week 1	▪ Introduction to Multimedia - FM Ch 1
Week 2	▪ ImageJ introduction ▪ Image formation and Cameras - DIP Ch 2 ▪ Image Formats - DIP Ch 2 or FM Ch 3
Week 3	▪ Image Histograms and applications – DIP Ch 4 ▪ Point Operations –DIP Ch 5
Week 4	▪ Image Filters & Convolution - DIP Ch 6 ▪ Extra topic: Deep Convolution Neural Networks) ▪ Edges and Contours – DIP Ch 7

Week 5	▪ Edges and Corners – DIP Ch 7 & 8 ▪ Perceptual Grouping: Curves and Hough transform - DIP Ch 9
Week 6	▪ Binary Image Analysis and Morphology – DIP Ch 10 ▪ Region Descriptors – DIP Ch 11
Week 7	▪ 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 8	▪ Fourier Transform, Discrete Fourier Transform, Discrete Cosine Transform – DIP Ch 13 & 14
Week 9	▪ Lossless compression: Variable length coding, Dictionary-based coding, LZW compression – FM Ch 7
Week 10	▪ Lossy Compression, Image Compression standards, JPEG, JPEG 2000 - FM Ch 8, FM Ch 9 ▪ Concepts of Video – FM Ch 5
Week 11	▪ Video Compression: Motion Compensation, H.261 standard – FM Ch 10
Week 12	▪ Video Compression, MPEG1, MPEG2, MPEG4- FM Ch 11 ▪ Basics of Digital Audio – FM Ch 6
Week 13	▪ Audio Compressions: Temporal and Frequency Masking. MP3 – FM Ch 14
Week 14	▪ Presentations

Academic Integrity:

Rutgers University takes academic dishonesty very seriously. By enrolling in this course, you assume responsibility for familiarizing yourself with the Academic Integrity Policy and the possible penalties (including suspension and expulsion) for violating the policy. As per the policy, all suspected violations will be reported to the Office of Student Conduct. Academic dishonesty includes (but is not limited to):

- Cheating
- Plagiarism
- Aiding others in committing a violation or allowing others to use your work
- Failure to cite sources correctly
- Fabrication
- Using another person's ideas or words without attribution–re-using a previous assignment
- Unauthorized collaboration
- Sabotaging another student's work in doubt, please consult the instructor

Use of external website resources such as Chegg.com or others to obtain solutions to homework assignments, quizzes, or exams is cheating and a violation of the University Academic Integrity policy. Cheating in the course may result in grade penalties, disciplinary sanctions or educational sanctions. Posting homework assignments, or exams, to external sites without the instructor's permission may be a violation of copyright and may constitute the facilitation of dishonesty, which may result in the same penalties as plain cheating.

Please review the Academic Integrity Policy