Overview

Image Processing
CSE 166

What is an image?
• A two-dimensional function $f(x,y)$, where $x$ and $y$ are spatial coordinates
• The amplitude of $f$ at the coordinates $(x,y)$ is called the intensity or gray level at that point
• A digital image is composed of a finite number of elements at discrete points
  – The elements are called picture elements (pixels, pels) or image elements

What is image processing?
• A discipline in which both the input and output of a process are images
  – Some believe this to be limiting, including the authors of the textbook
  – There are usually other input parameters to the process
• Related disciplines
  – Image analysis, machine vision, computer vision

CSE 166: Image Processing
• Today
  – Course overview
  – Logistics
  – Some mathematics
  – MATLAB
• Lectures will be boardwork and slides
  – Take written notes or take pictures of the board

Representing an image

History
• In the early 1920s, newspapers transmitted and received digital pictures by cable across the Atlantic (without computers)
  – Reduced transport time from over a week to less than three hours
History

• 1940s: Modern digital computers
• 1950s: High-level programming languages and the integrated circuit
• 1960s: Operating systems
• 1964: Computer-based digital image processing
• 1970s: Microprocessor
• 1980s: Personal computers (PCs)

Examples

• Gamma-ray imaging
• X-ray imaging
• Ultraviolet imaging
• Visible light imaging
• Infrared imaging
• Microwave imaging
• Radio imaging

Topics

• Image acquisition
• Image filtering and enhancement
• Image restoration
• Wavelets and other image transforms
• Color image processing
• Image compression and watermarking
• Morphological image processing
• Image segmentation

Image acquisition

Sampling and quantization
Image restoration

- Noise models
- Noise reduction

Wavelets and other transforms

- Basis vectors

Color image processing

- Color models
- Color transformations

Image compression and watermarking

- Lossless vs lossy compression

Morphological image processing

- Dilation and erosion
- Opening and closing

Image segmentation

- Thresholding
### Syllabus

- Instructor: Ben Ochoa
- TA: Rithwik Kollipara
- Tutor: Ashwin Srikant
- Course website
  - [https://cseweb.ucsd.edu/classes/fa17/cse166-a/](https://cseweb.ucsd.edu/classes/fa17/cse166-a/)
- 19 lecture meetings
  - No university holidays for MW classes, but no meeting on day before Thanksgiving (Wednesday, November 22)
- Weekly discussion section
- Class discussion
  - Piazza

### Academic integrity policy

Integrity of scholarship is essential for an academic community. The University expects that both faculty and students will honor this principle and in so doing protect the validity of University intellectual work. For students, this means that all academic work will be done by the individual to whom it is assigned, without unauthorized aid of any kind.

### Collaboration policy

It is expected that you complete your academic assignments on your own and in your own words and code. The assignments have been developed by the instructor to facilitate your learning and to provide a method for fairly evaluating your knowledge and abilities (not the knowledge and abilities of others). So, to facilitate learning, you are authorized to discuss assignments with others; however, to ensure fair evaluations, you are not authorized to use the answers developed by another, copy the work completed by others in the past or present, or write your academic assignments in collaboration with another person. If the work you submit is determined to be other than your own, you will be reported to the Academic Integrity Office for violating UCSD’s Policy on Integrity of Scholarship.

### Wait list

- Number of enrolled students is limited by
  - Size of room
  - Number of TAs and tutors
- General advice
  - Wait for as long as you can
- Concurrent enrollment (Extension) students have lowest priority
Some mathematics

Logical operations

Basic linear algebra
- Vectors and matrices
- Vector transpose and matrix transpose
- Vector-vector dot or inner product
- Matrix-vector multiplication
- Matrix-matrix multiplication

Elementwise vs matrix operations

In MATLAB, elementwise operations are proceeded by a ‘dot’
For example, A .* B and A ./ B

Getting started with MATLAB
Images in MATLAB

- Warning: MATLAB uses 1-based index, not 0-based
- A(100, 200, 2) is row 100, column 200, and channel 2

Displaying images in MATLAB

- Colorbar

MATLAB documentation

- Browse all documentation

MATLAB toolboxes

- Unless specified in the assignment, you may not use MATLAB functions contained in the toolboxes
- If you are unsure about using a specific function, then ask the instructor for clarification

MATLAB documentation

- Documentation for a specific command

MATLAB help

- To view in command window, use help
Get MATLAB for your computer

MATLAB for University of California San Diego Students

University of California San Diego has a Total Academic Headcount (TAH) license for MATLAB, Simulink, and add-on products. Students may use these products for educational and instructional purposes. The license allows individuals to install the products on university-owned equipment, as well as personally owned computers.

Other ways to use MATLAB