

Digital Image Processing

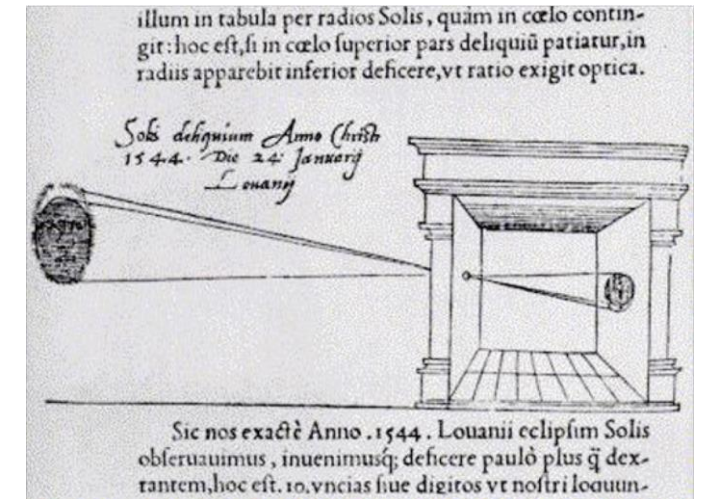
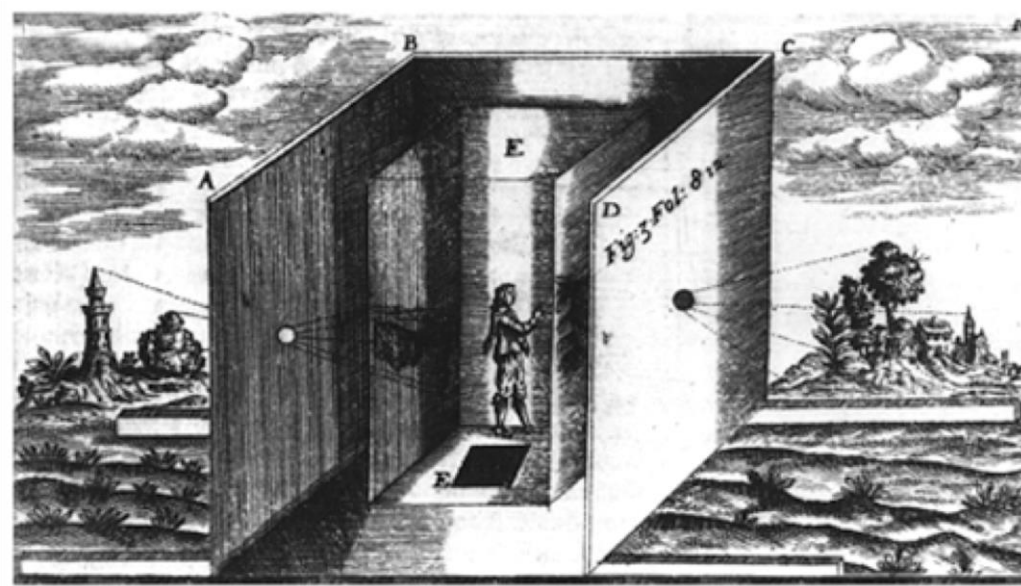
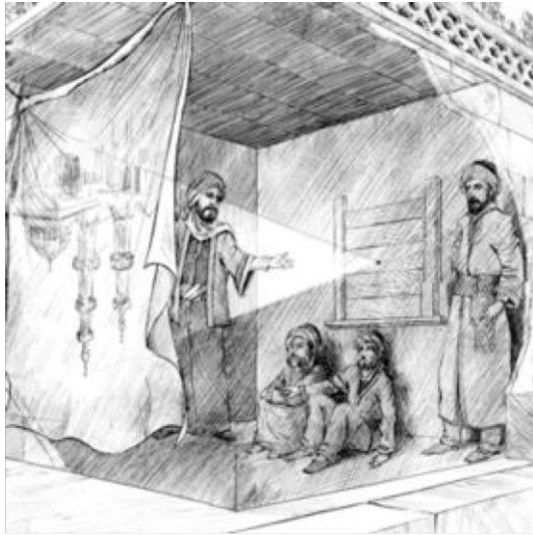
ECE 566

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Imaging



- ✓ **Image:** a visual representation in form of a function $f(x, y)$ where f is related to the brightness (or color) at point (x, y)
- ✓ Most images are defined over a rectangle
- ✓ Continuous in amplitude and space

Digital Image and Pixel

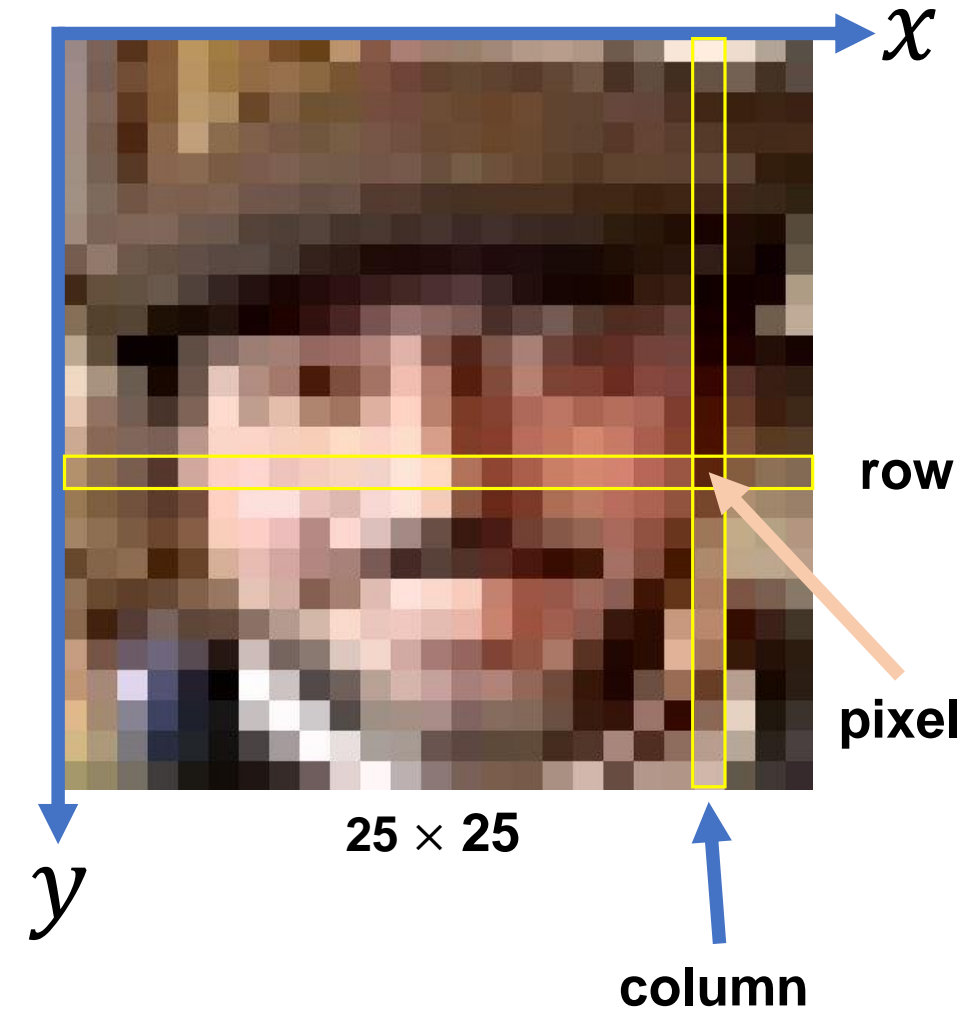
- ✓ **Digital image:** discrete samples $f[x, y]$ representing continuous image $f(x, y)$
- ✓ Each element of the 2-d array $f[x, y]$ is called a **pixel** or **pel** (from “picture element”)



100×100



50×50

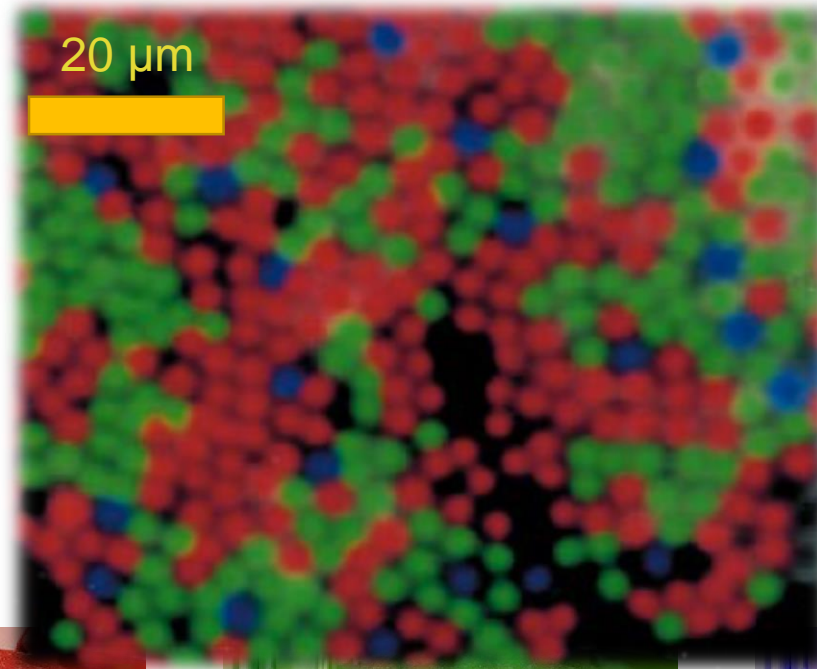


Color Components

Monochrome image



$$R[x, y] = G[x, y] = B[x, y]$$



Red $R[x, y]$



Green $G[x, y]$

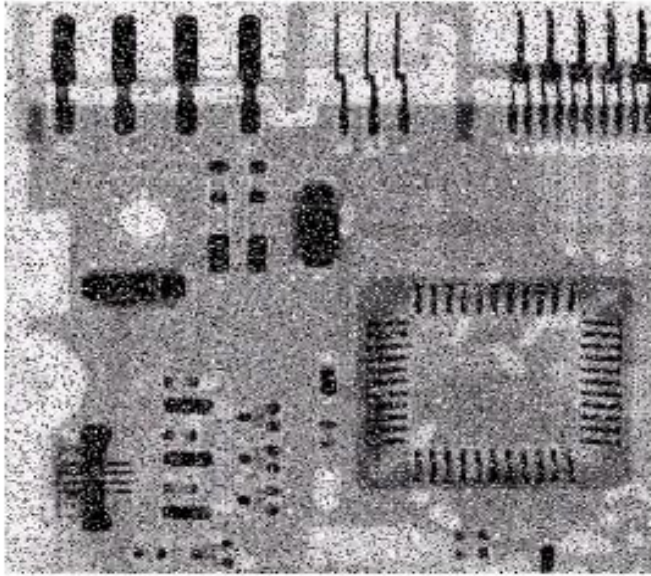


Blue $B[x, y]$

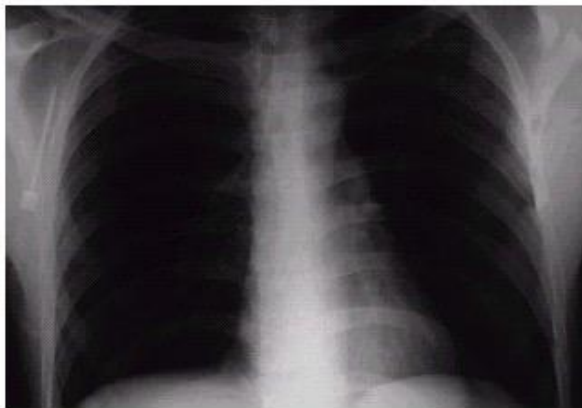
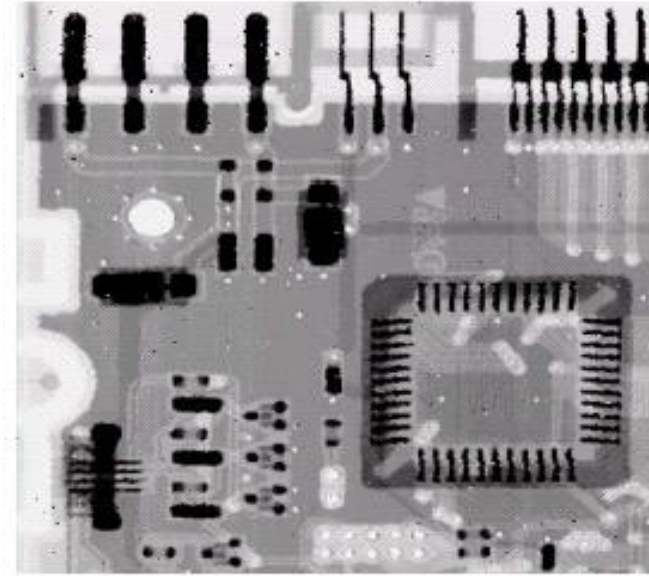
Why image processing?

- ✓ **Acquire an image**
 - Correct aperture and color balance
 - Reconstruct image from projections
- ✓ **Prepare for display or printing**
 - Adjust image size
 - Color mapping, gamma-correction, halftoning
- ✓ **Facilitate picture storage and transmission**
 - Efficiently store an image in a digital camera
 - Send an image from space
- ✓ **Enhance and restore images**
 - Touch up personal photos
 - Color enhancement for security screening
- ✓ **Extract information from images**
 - Read 2-d bar codes
 - Character recognition
 - Depth estimation
- ✓ Many more ... image processing is ubiquitous

Image processing examples: Image enhancement



Noise
reduction



Improve
quality

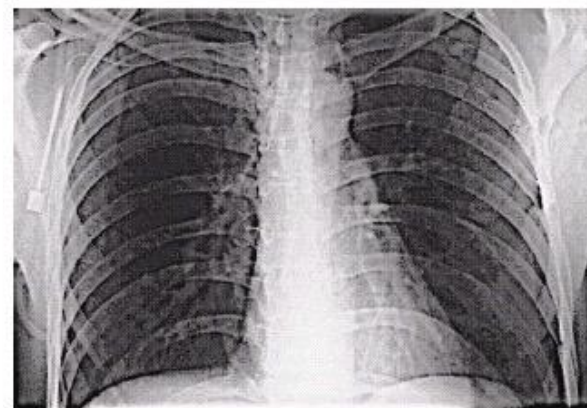


Image processing examples: Face detection

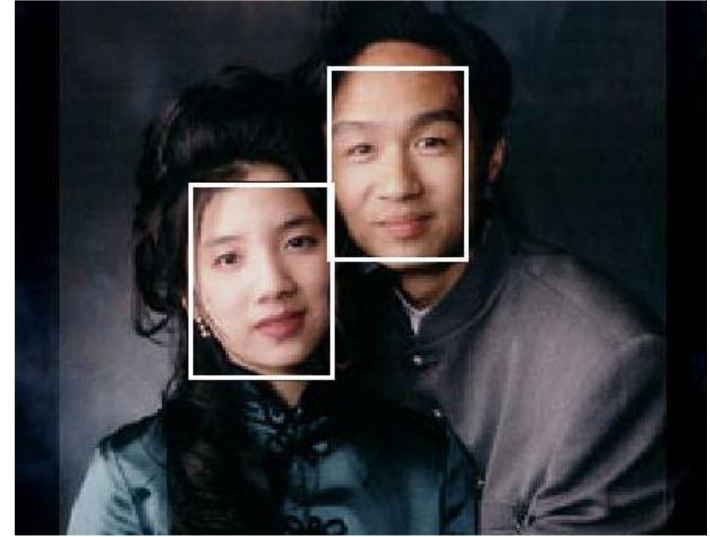
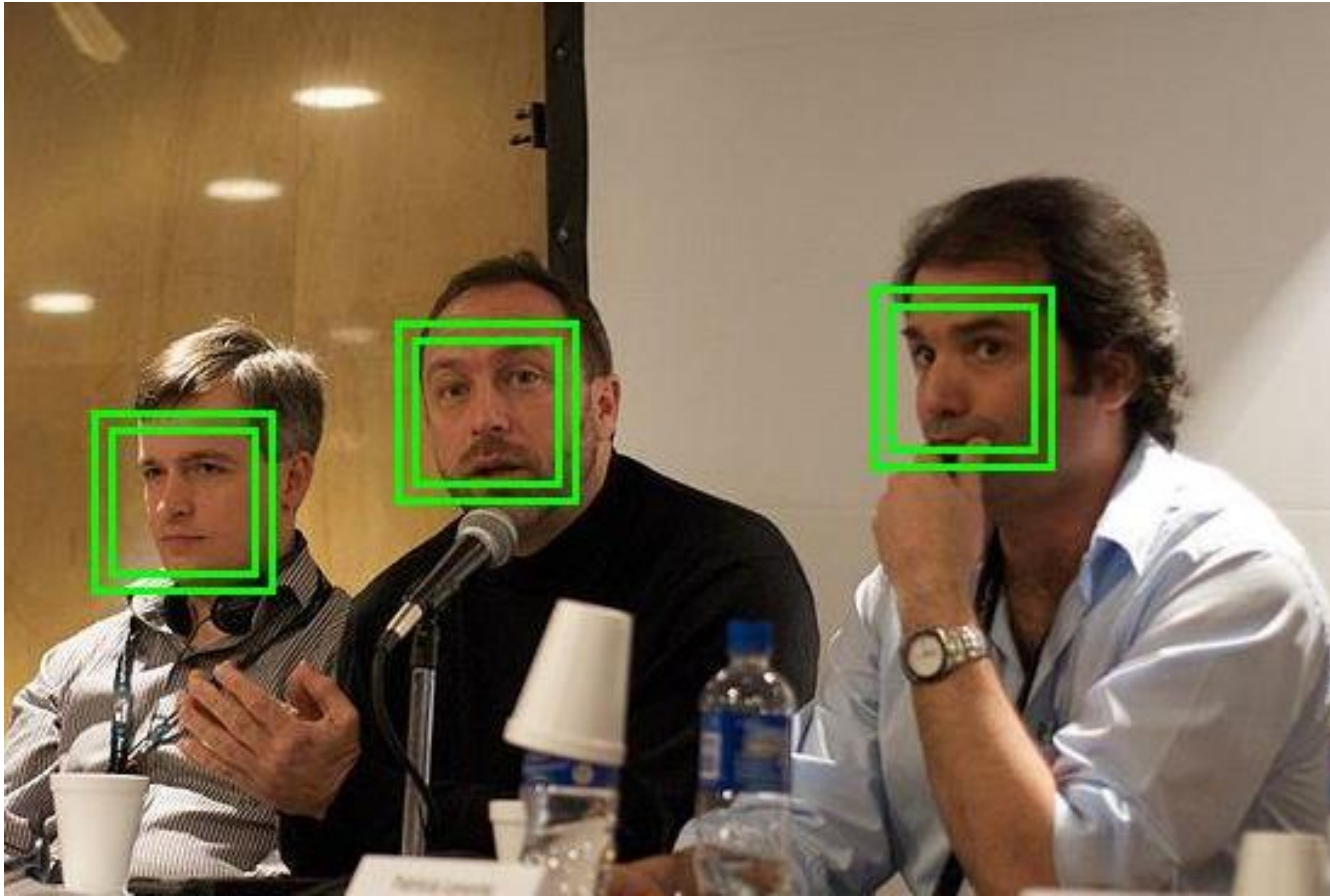


Image processing examples: Face blurring for privacy protection

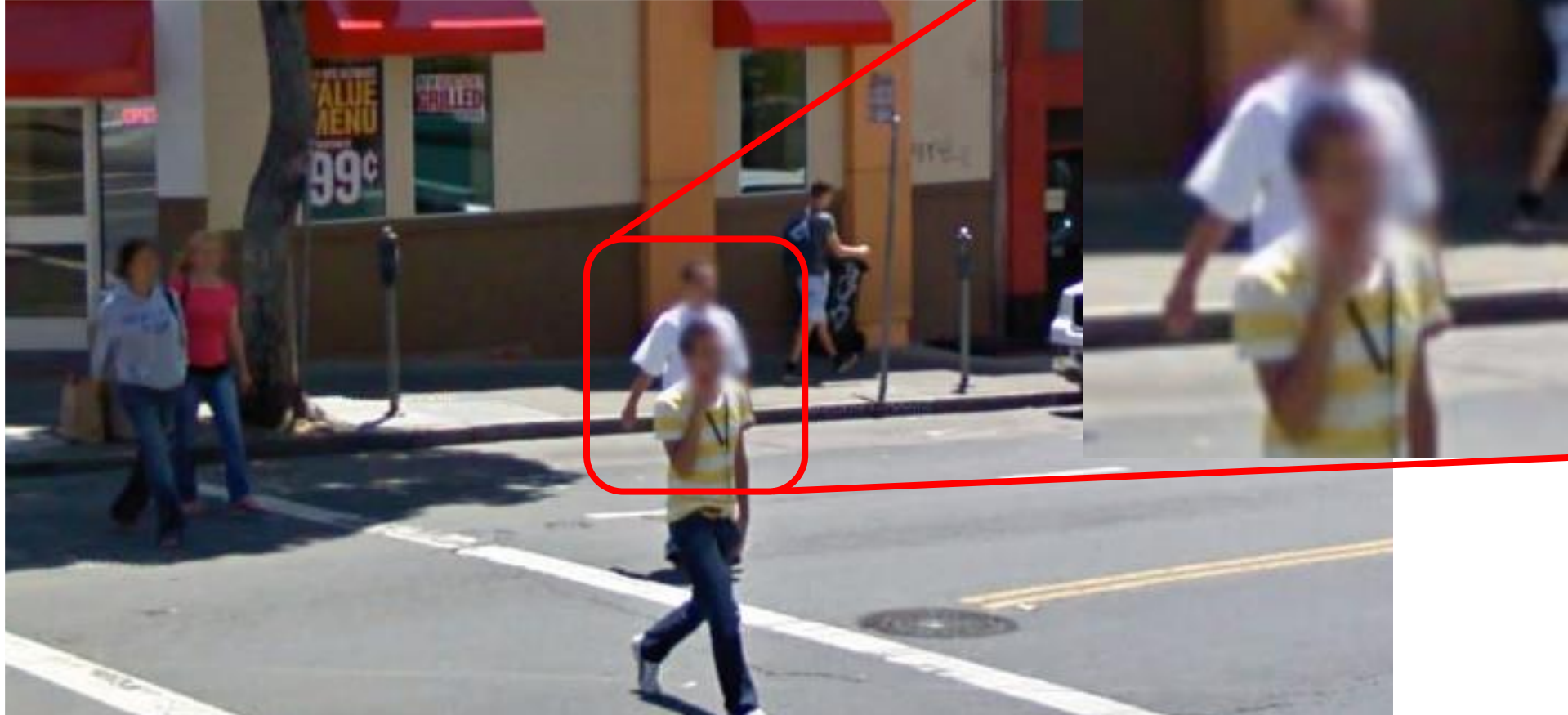


Image processing examples: Visual Code Marker

Recognition



Image processing examples: Template Matching



ECE 566 topics

- ✓ Image elements
- ✓ Interpolation
- ✓ Spatial transformation, filtering, and sharpening
- ✓ Frequency domain filtering
- ✓ Gradient, Harris corners
- ✓ Image restoration
- ✓ Image segmentation
- ✓ Neural networks
- ✓ Template matching (if time allows)

ECE 566 organization

Lectures: TuTh 11:30 am – 12:45 pm in EL 306 (Sep. 5 – Dec. 8)

Attendance are **not** mandatory, highly recommended.

Lectures will be recorded.

Office hours: TBD

TA: TBD

Weekly Assignments

- ✓ Weekly problem sets
- ✓ Handed out Mondays, correspond to the lectures of that particular week.
- ✓ About 8-12 hours of work, requires computer + MATLAB/Python.
- ✓ Discussions among students encouraged, however, individual solution must be submitted.
- ✓ Due 7 days later (next Monday 1 pm).
- ✓ Late submission: 30% penalty if submitted by next Friday 1 pm. No credit afterwards.
- ✓ First assignment released on Sep. 12, due Sep. 19.

Weekly Quizzes

- ✓ Weekly online quizzes, multiple choice questions.
- ✓ Review the corresponding module, if you are uncertain about your answer.
- ✓ First quiz will be on Sep. 14.

ECE 566 Grading

- ✓ Homework problems: 40%
- ✓ Midterm: 30%
- ✓ Final exam: 30%
- ✓ Online quizzes (Bonus): 5%

Reading

Slides available as pdf files on SPIRE/CANVAS

Popular text books

- William K. Pratt, "Introduction to Digital Image Processing," CRC Press, 2013.
- R. C. Gonzalez, R. E. Woods, "Digital Image Processing," 4th edition, Pearson, 2018.

Software-centric books

- R. C. Gonzalez, R. E. Woods, S. L. Eddins, "Digital Image Processing using MATLAB," 2nd edition, Gatesmark Publishing, 2009.
- A. Kaehler, G. Bradski, "Learning OpenCV 3," O'Reilly Media, 2017.

Journals/Conference Proceedings

- IEEE Transactions on Image Processing
- IEEE International Conference on Image Processing (ICIP)
- IEEE Computer Vision and Pattern Recognition (CVPR)