EE 604 Image Processing

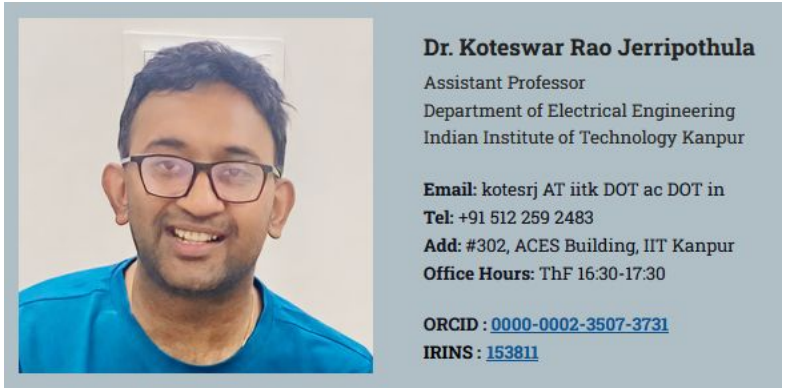
Lec 01: Introduction

Lecture Outline

- **Course Overview** 
- Guidelines & Course Policies
- Introduction to Image Processing

EE 604 Team

Instructor



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TAs

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Logistics

Course Schedule: Wednesdays and Fridays, 3:30 to 5:00 p.m. (L07)

Office Hours: Wednesdays and Fridays, 5:00 to 5:30 p.m.

- @ my office, ACES 302
- Take appointment before coming

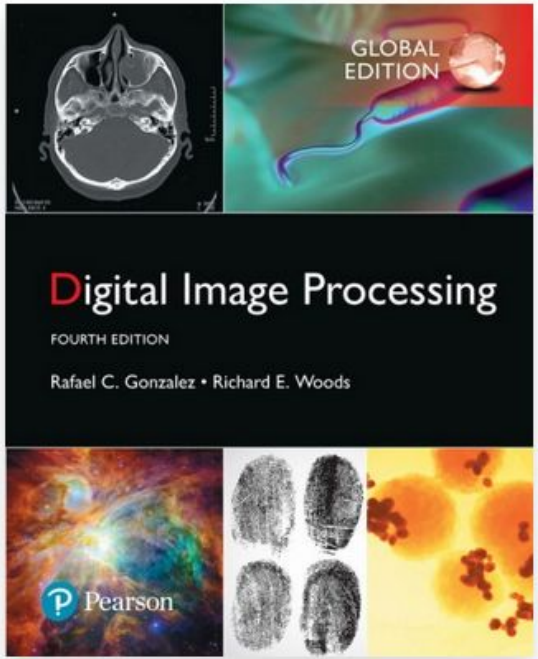
Course Objectives

At the end of the course, the student should be able to:

- **Understand** the fundamentals of image formation, processing, and analysis
- **Explore** the broad range of applications of image processing techniques
- **Develop** the ability to choose appropriate methods for different scenarios
- **Apply** the learned concepts to design and implement a real-world image processing system

Contents

Primary Reference



Rafael Gonzalez, Richard Woods

Digital Image Processing

Global Edition

4th edition
Publication year: 2017
Print-ISBN: 978-1-292-22304-9
E-ISBN: 978-1-292-22307-0
Pages: 1024

The fourth edition is available online. Just search for “gonzalez dip”

Other References

Jain, A.K. (1989) Fundamentals of Digital Image Processing. Prentice Hall, Cliffs.

Szeliski, Richard. *Computer vision: algorithms and applications*. Springer Nature, 2022.

Research Papers:

1.	IEEE/CVF Conference on Computer Vision and Pattern Recognition	450	702
2.	European Conference on Computer Vision	262	417
3.	IEEE/CVF International Conference on Computer Vision	256	412
4.	IEEE Transactions on Pattern Analysis and Machine Intelligence	217	376
5.	IEEE Transactions on Image Processing	165	217
6.	IEEE/CVF Winter Conference on Applications of Computer Vision (WACV)	131	211
7.	Medical Image Analysis	126	197
8.	Pattern Recognition	126	178
9.	IEEE/CVF Computer Society Conference on Computer Vision and Pattern Recognition Workshops (CVPRW)	117	194
10.	International Journal of Computer Vision	109	211
11.	Pattern Recognition Letters	92	132
12.	International Conference on Pattern Recognition	68	106
13.	IEEE/CVF International Conference on Computer Vision Workshops (ICCVW)	63	99
14.	British Machine Vision Conference (BMVC)	57	96
15.	International Conference on 3D Vision (3DV)	56	94
16.	IEEE International Conference on Image Processing (ICIP)	55	89
17.	Asian Conference on Computer Vision (ACCV)	52	81
18.	IET Image Processing	52	73
19.	Image and Vision Computing	51	84
20.	Computer Vision and Image Understanding	46	91

Evaluation

Components	Weightage	Remarks
Homeworks (10)	10%	Simple questions; once a week; binary marking
Quizzes (2)	20%	MCQ, T/F, FITB & SA type question; announced; closed-book
Assignments (2)	20%	You will have 1-2 weeks; late submissions aren't allowed.
Course Project	20%	Presentation (5%) + Implementation (10%) + Write-up (5%)
Endsem Exam	30%	Theoretical & numerical questions; closed-book

Grading Policy

Grade	[Min	Max)
A*	95	100
A	M+*p**S	95
B+	M+*q**S	M+*p**S
B	M	M+*q**S
C+	M-*q**S	M
C	M-*p**S	M-*q**S
D+	40	M-*p**S
D	35	40

M=Mean
S=Standard Deviation

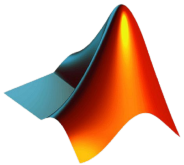
p will be decided such that 10% students will get A or above
q will be decided such that 25% students will get B+ or above

Lecture Outline

- Course Overview
- **Guidelines & Course Policies** 
- Introduction to Image Processing

Guidelines

- The best way to reach the instructor is via email to: ee604.iitk@gmail.com
- Homeworks, Assignments & Course Project should be submitted at Hello IITK.
- Quizzes & End-sem exam will be conducted offline, and they will be closed-book.
- Maximum team-size in the course project: 4
- A list of projects will be shared soon.
- Assignments will be entirely programming-based.



Course Policies

- It is expected that you will maintain academic honesty in every form.
- Please familiarize yourself with the general rules and laws of plagiarism.
- If plagiarism is detected, you'll be given zero marks in the entire evaluation component. That is,
  - If it's detected in any homework, you get 0 for entire 10% (weightage of homeworks).
  - If it's detected in any assignment, you get 0 for entire 20%
  - If it's detected in any quiz, you get 0 for entire 20%
  - If it's detected in any part of the course project, you get 0 for entire 20%
  - If it's detected in any question of the end-sem exam, you get 0 for entire 30%
- While attendance is not mandatory, it's important to attend lectures to do well in the homeworks' component, and the course at large.

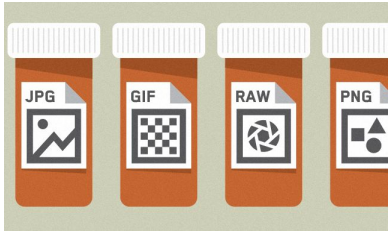
Lecture Outline

- Course Overview
- Guidelines & Course Policies
- **Introduction to Image Processing** 

Why study images?

- Image Enhancement

- Image Storage



- Image Transmission

- Information Extraction

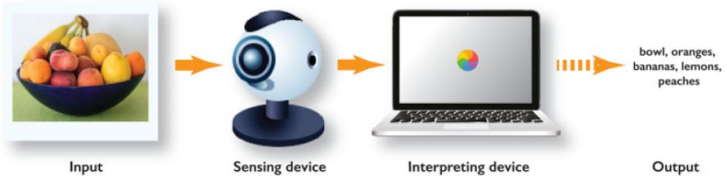
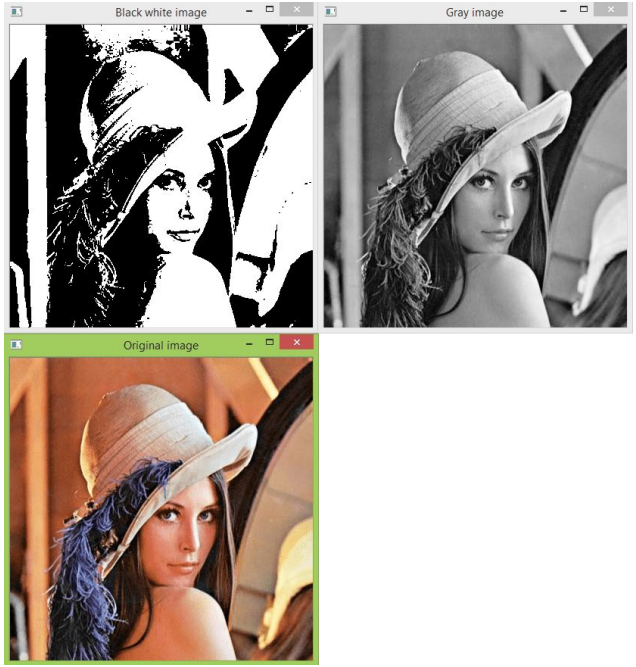
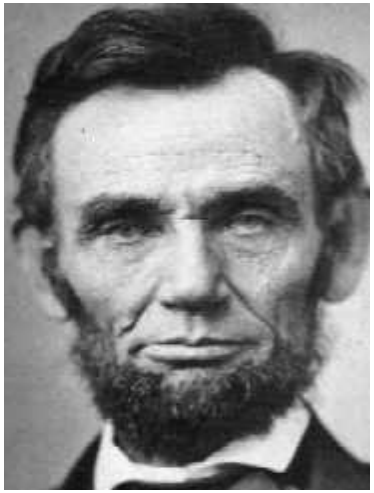
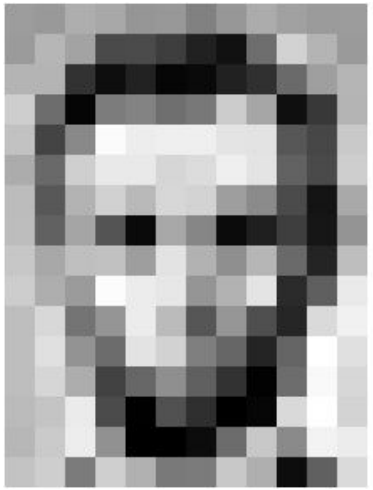
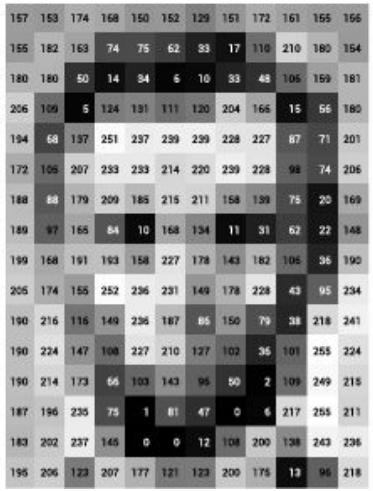


Image Fundamentals









Pixels: picture elements

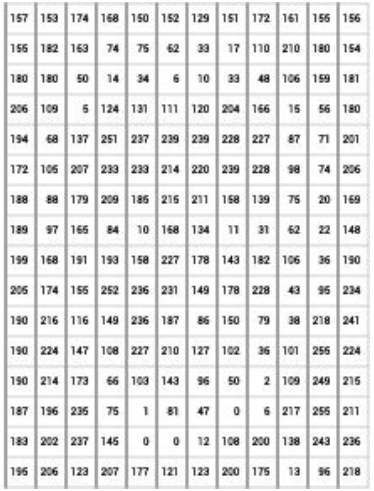
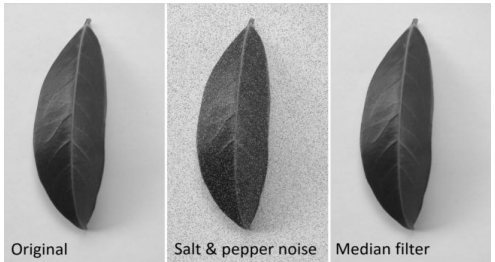
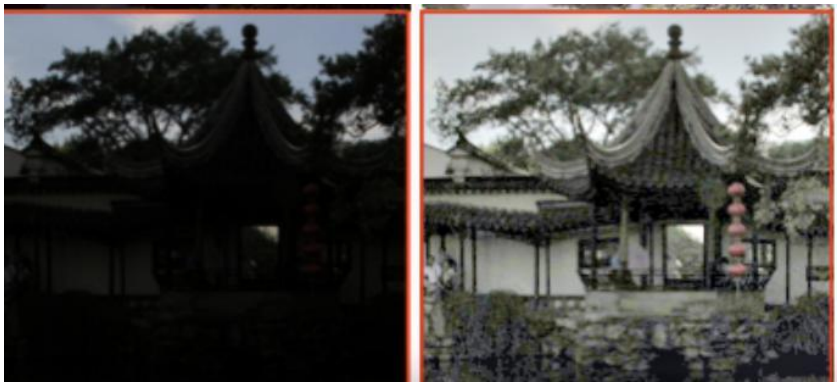
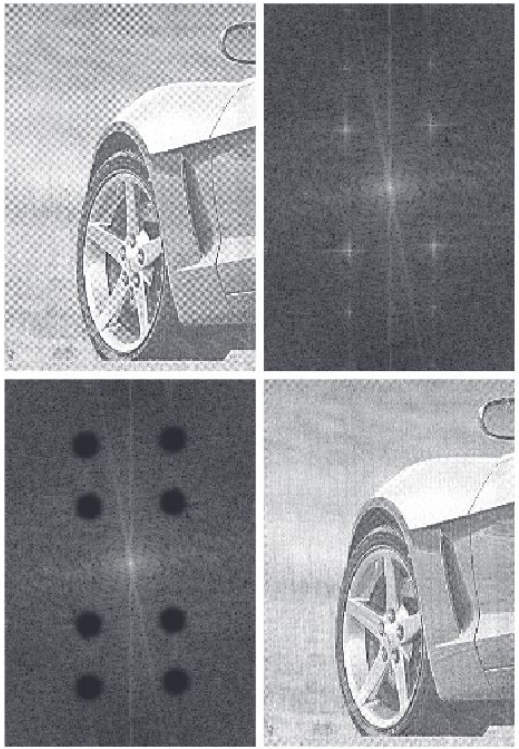


Image Enhancement & Spatial Filtering



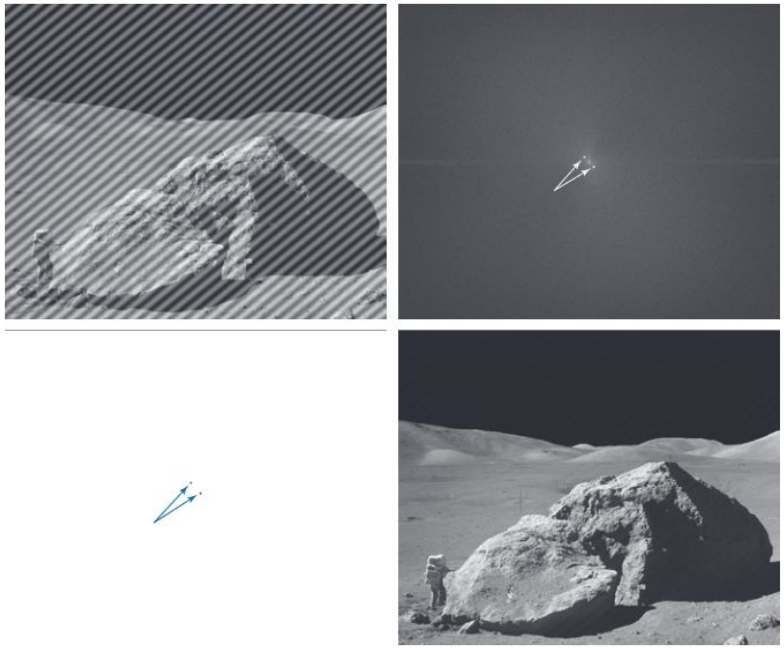


Filtering in Frequency Domain



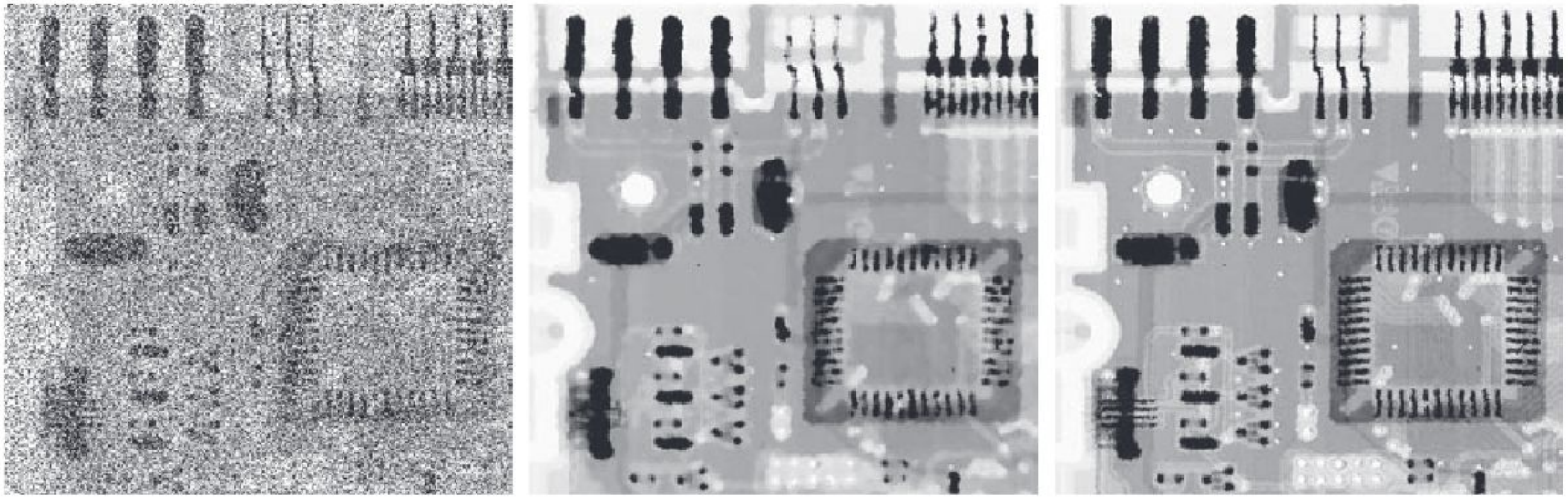
a b
c d

(a) Image corrupted by sinusoidal interference.
(b) Magnitude of the Fourier transform showing the bursts of energy caused by the interference (the bursts were enlarged for display purposes).
(c) Mask used to eliminate the energy bursts.
(d) Result of computing the inverse of the modified Fourier transform.
(Original image courtesy of NASA.)



Credits: Primary Reference

Image Restoration

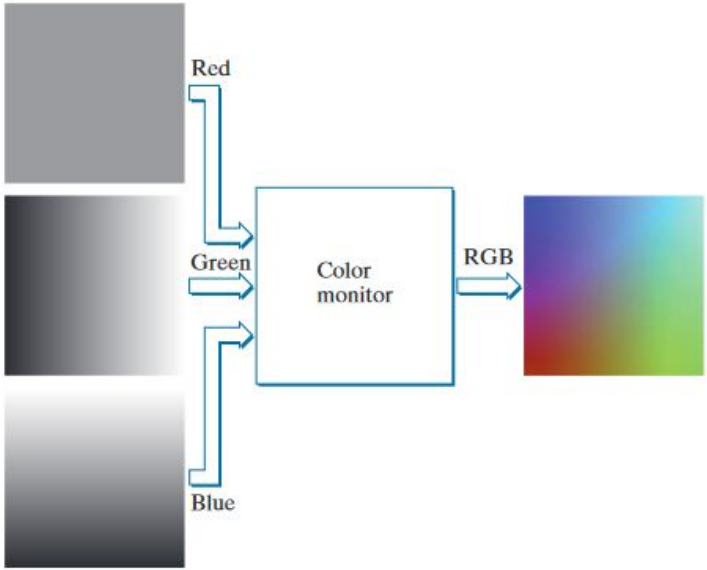


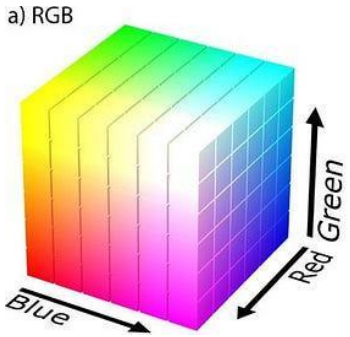
a b c

(a) Image corrupted by salt-and-pepper noise with probabilities $P_s = P_p = 0.25$. (b) Result of filtering with a 7×7 median filter. (c) Result of adaptive median filtering with $S_{\max} = 7$.

Credits: Primary Reference

Color Image Processing





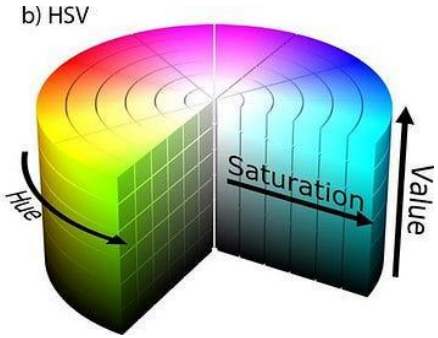
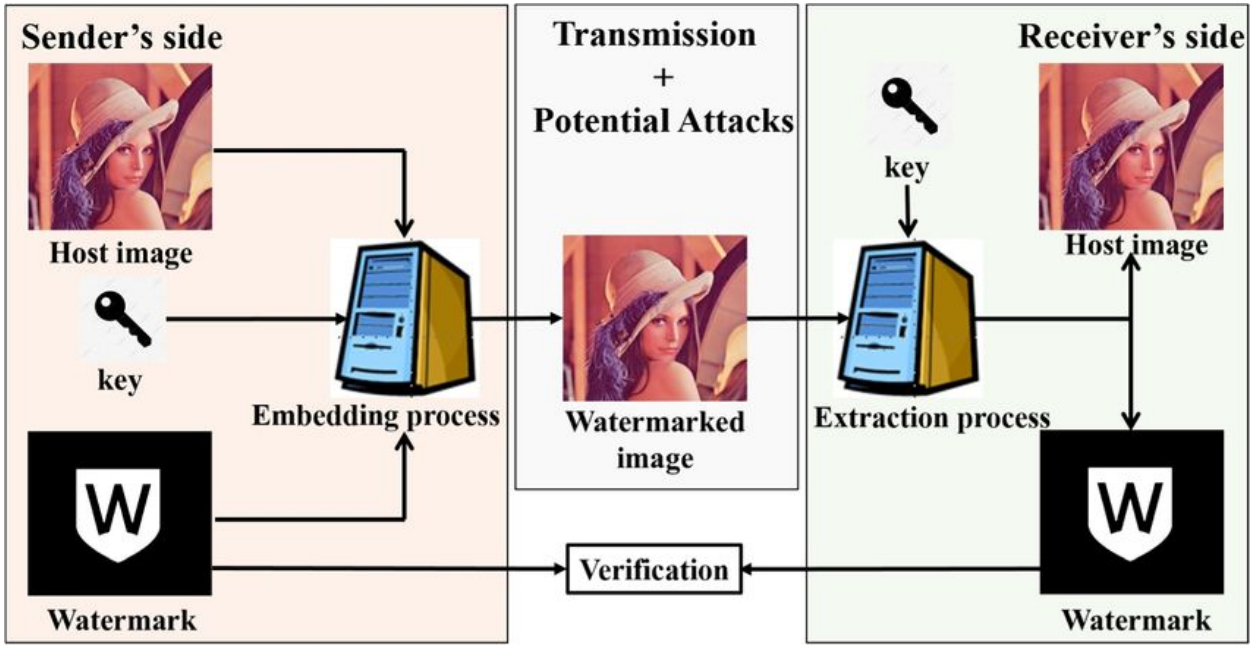
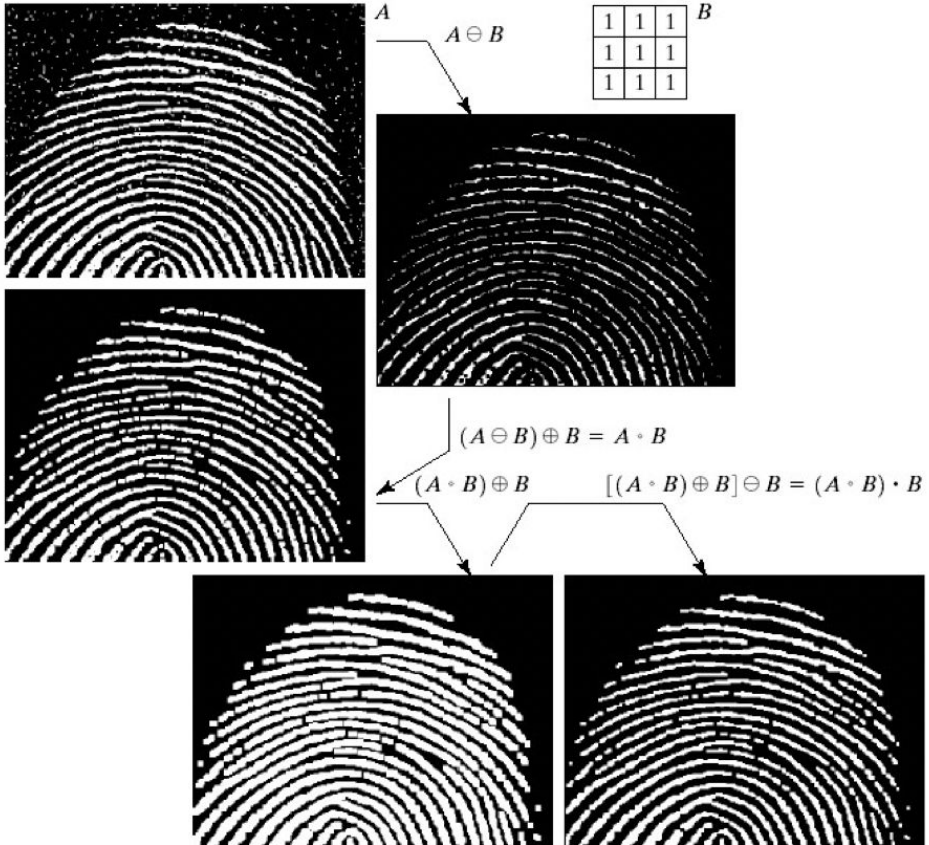


Image Compression

Watermarking

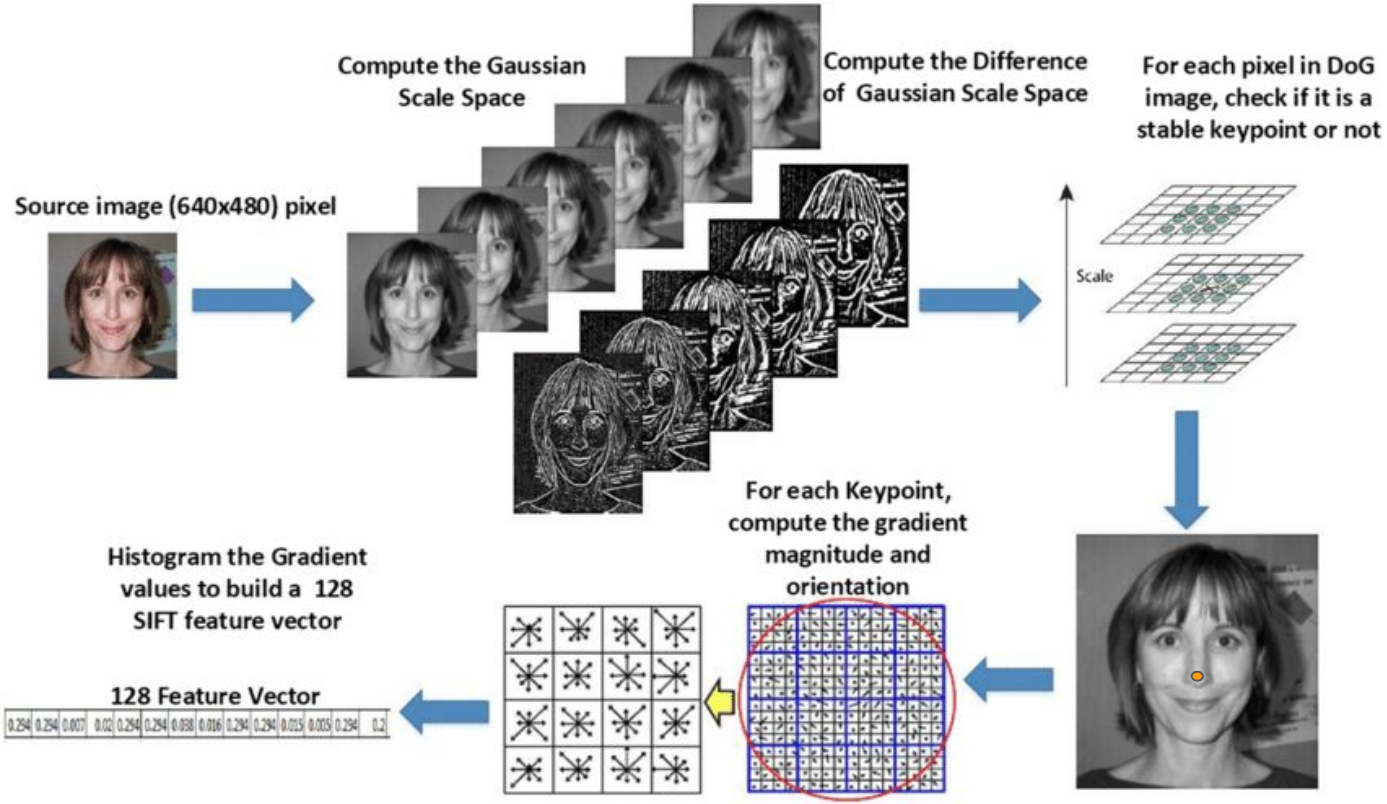


Morphological Image Processing



Feature Extraction

SIFT



Feature Learning

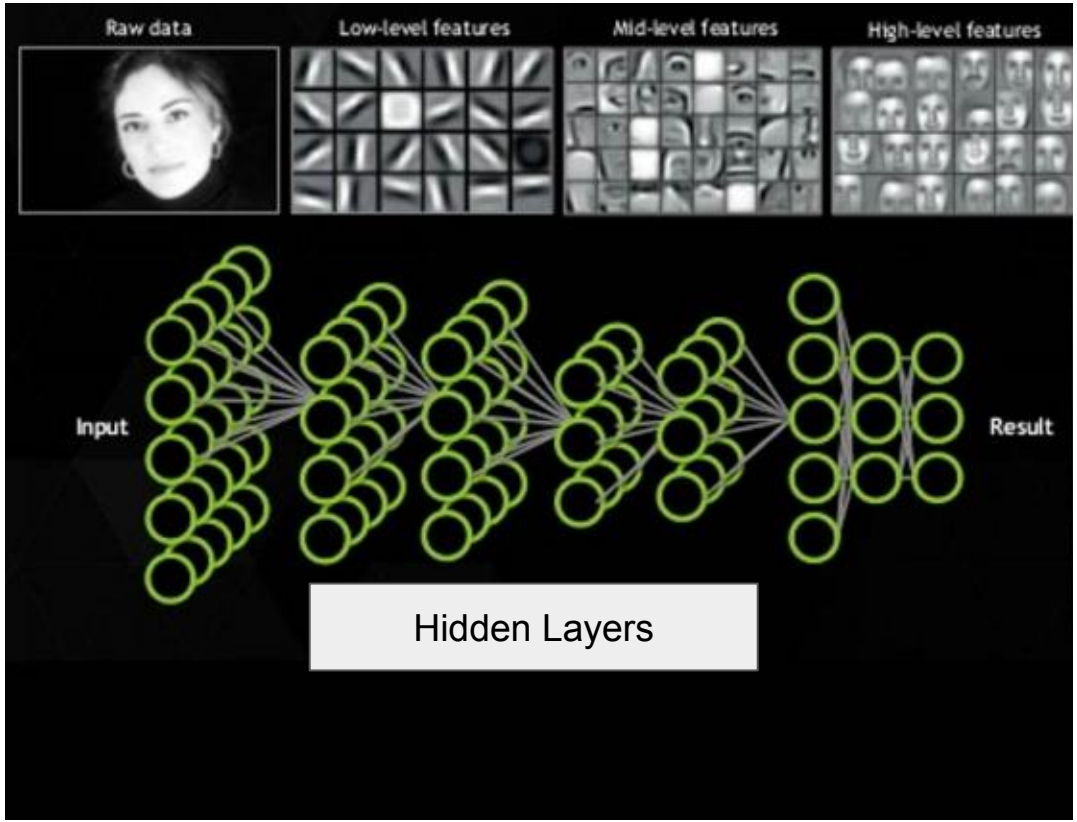
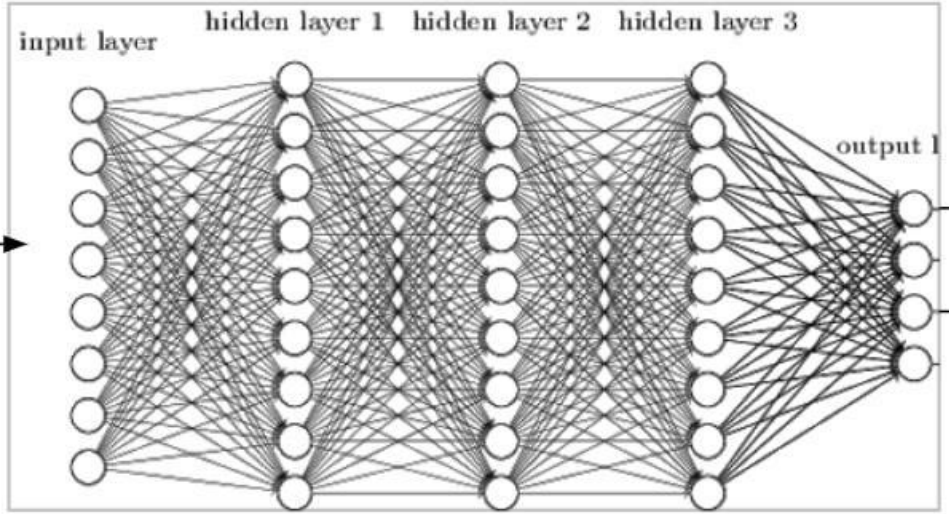


Image Classification

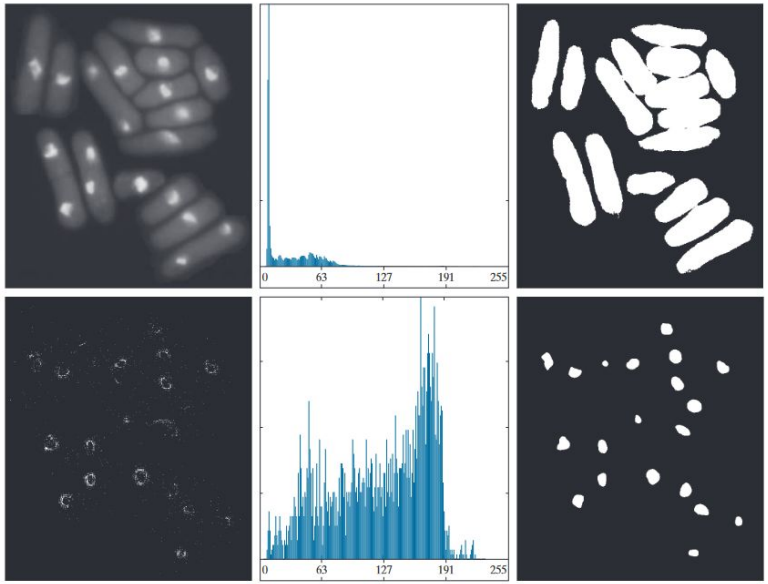
1. Input picture → **2. Analysis through deep neural network** → **3. Output class**



Dog

Cat

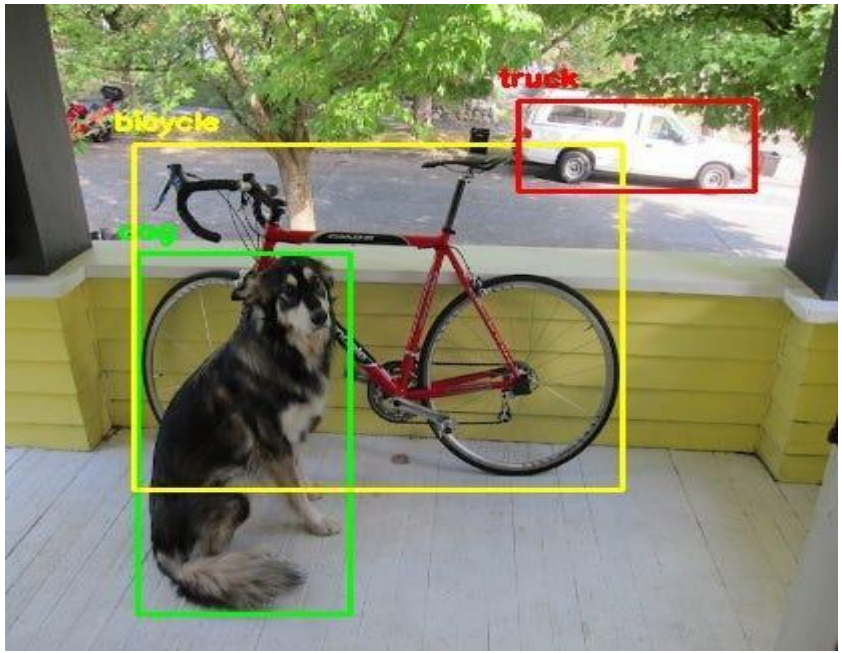
Image Segmentation



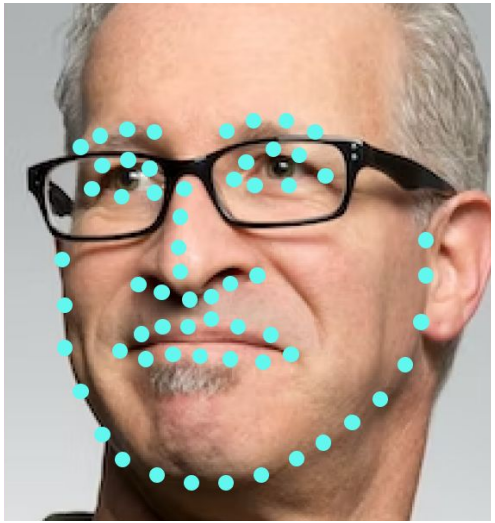
a b c
d e f

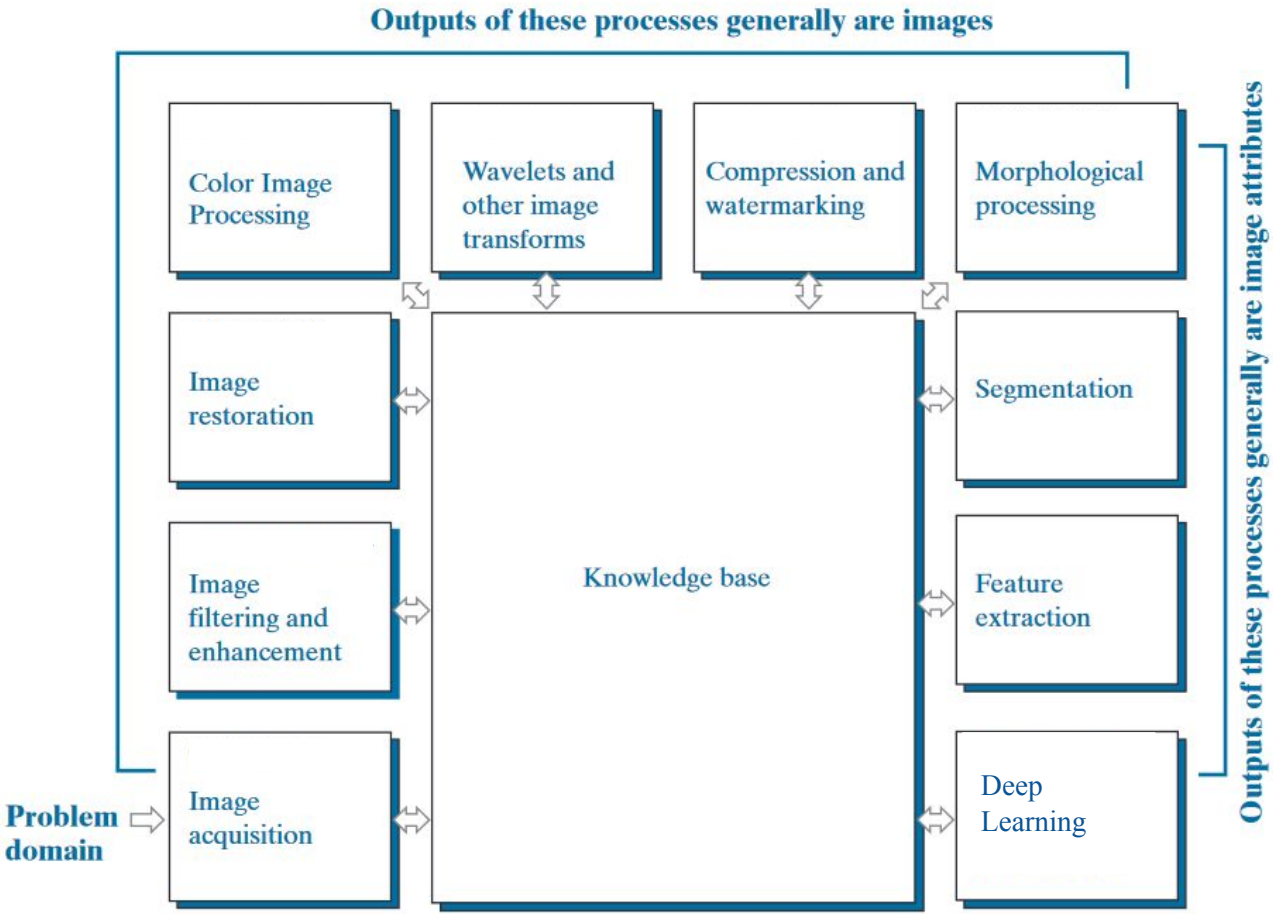
FIGURE 10.40 (a) Image of yeast cells. (b) Histogram of (a). (c) Segmentation of (a) with Otsu's method using the histogram in (b). (d) Mask image formed by thresholding the absolute Laplacian image. (e) Histogram of the non-zero pixels in the product of (a) and (d). (f) Original image thresholded using Otsu's method based on the histogram in (e). (Original image courtesy of Professor Susan L. Forsburg, University of Southern California.)

Object Detection



Landmark Detection





Credits: Primary Reference

Image processing (IP) vs Computer vision (CV)

- Loosely speaking
  - IP: Image -> Image
  - CV: Image -> high level information

  - IP: Wide range of image modalities
  - CV: mostly natural images

- In practice, we need both and do not differentiate!

Image Modalities