



Digital Image Processing

Fall 2024

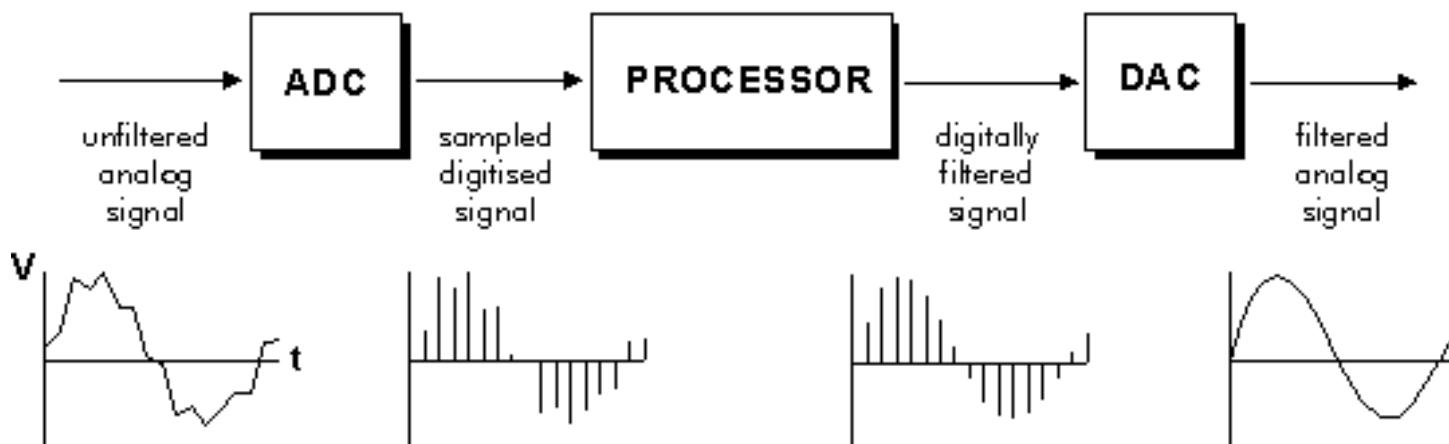
Yi-Ting Chen

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- NCTU EE B.S., Taiwan (2005-2009)
- UIUC ECE Exchange Student, USA (2009.01-06)
- Purdue University ECE Ph.D., USA (2010-2015)
- HP Inc. Imaging Science Intern, USA (2011.06-08)
- UC Merced, Computer Vision Researcher, USA (2014-2015)
- Google Inc. Visiting Scholar, USA (2015.01-04)
- Honda Research Institute USA, Senior Scientist (2015-2020)
- NYCU CS Assistant Professor, Taiwan (2021-Present)
- Director of HCIS Lab, Taiwan (2021-Present)



Signal Processing (3rd Undergrad@NCTU EE)



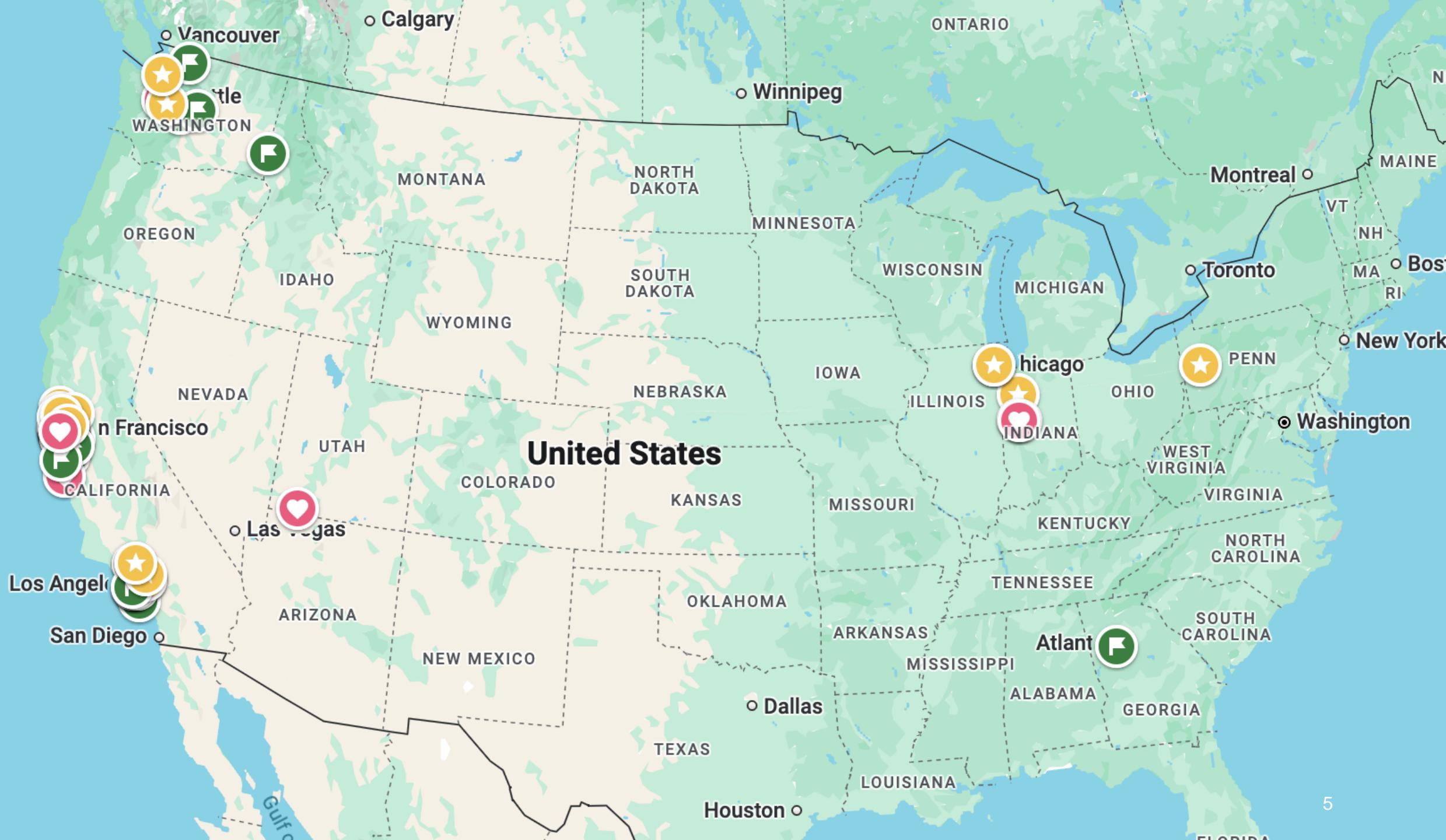
<https://mcube.lab.nycu.edu.tw/~cfung/>

My First Camera - Bridge Camera (2009/1)



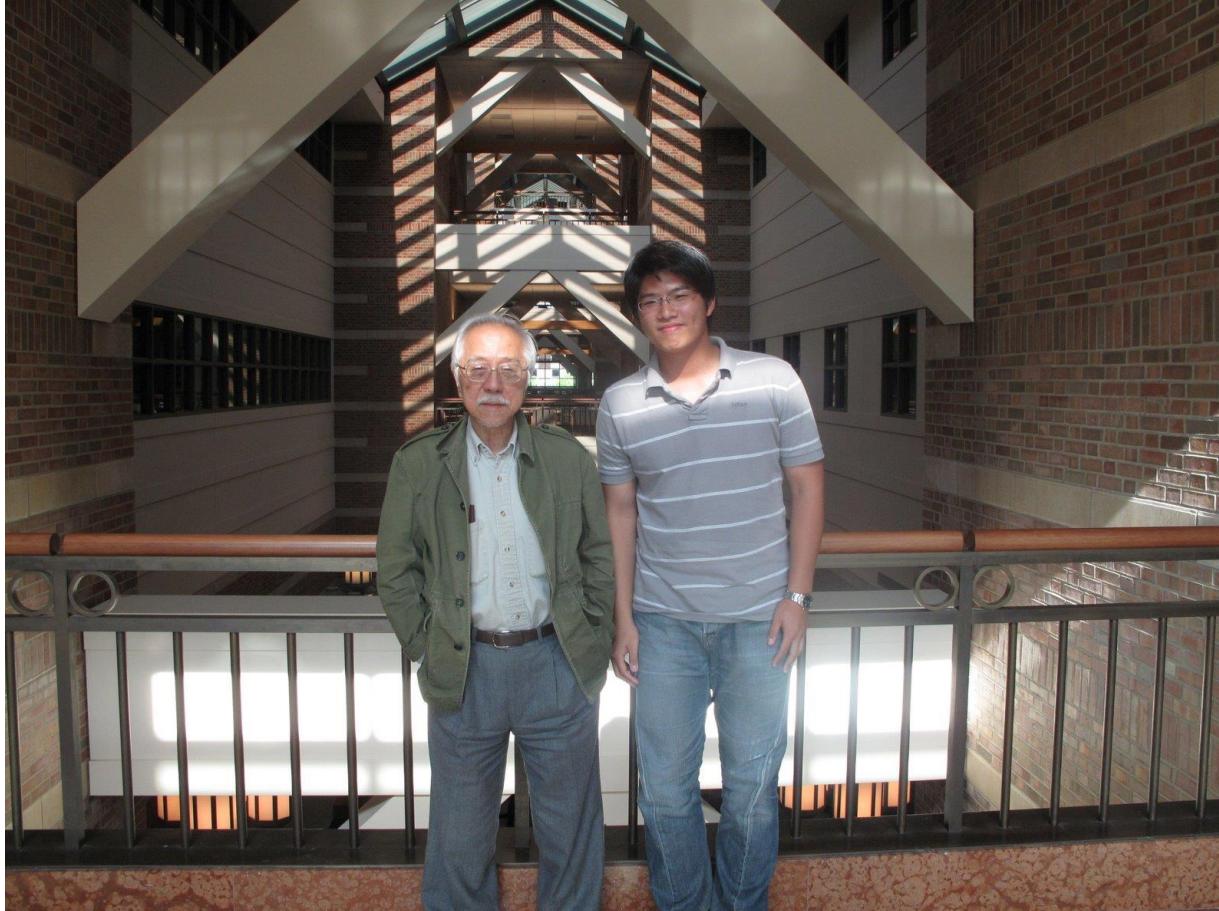
On the way to UIUC

United States





My Journey into Image Processing and Pattern Recognition (Prof. Thomas Huang@UIUC)



A STUDY OF MULTI-VIEW GENDER RECOGNITION ON A LARGE DATABASE

Yi-Ting Chen, Zhen Li, Thomas S. Huang

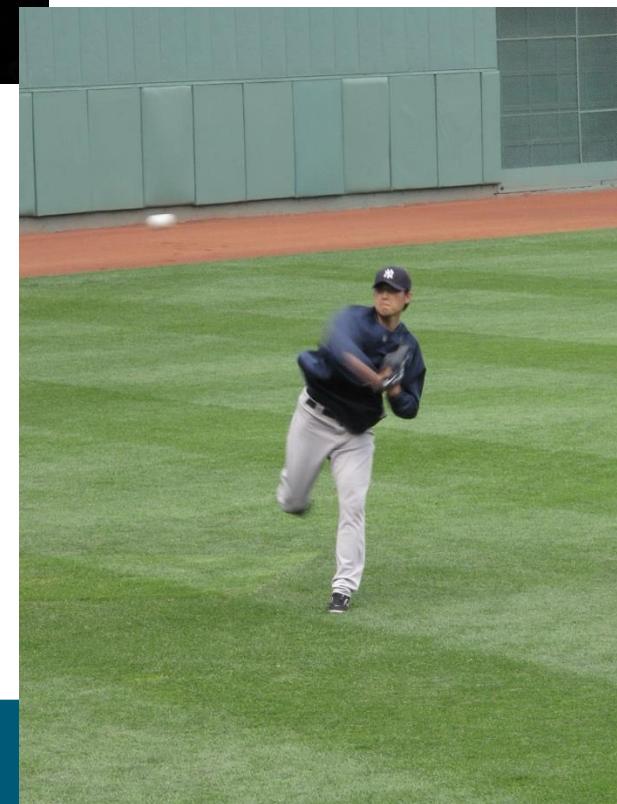
University of Illinois at Urbana-Champaign
Beckman Institute



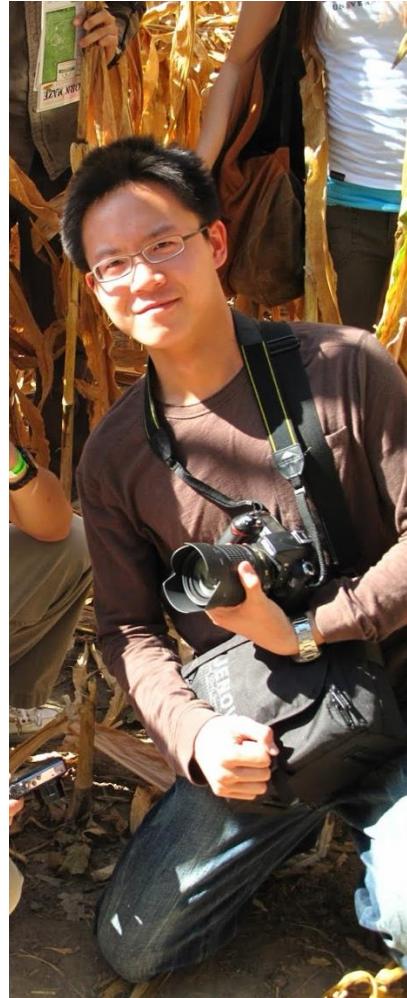
Fig. 1: Face images of a particular person under 32 different views (same illumination)



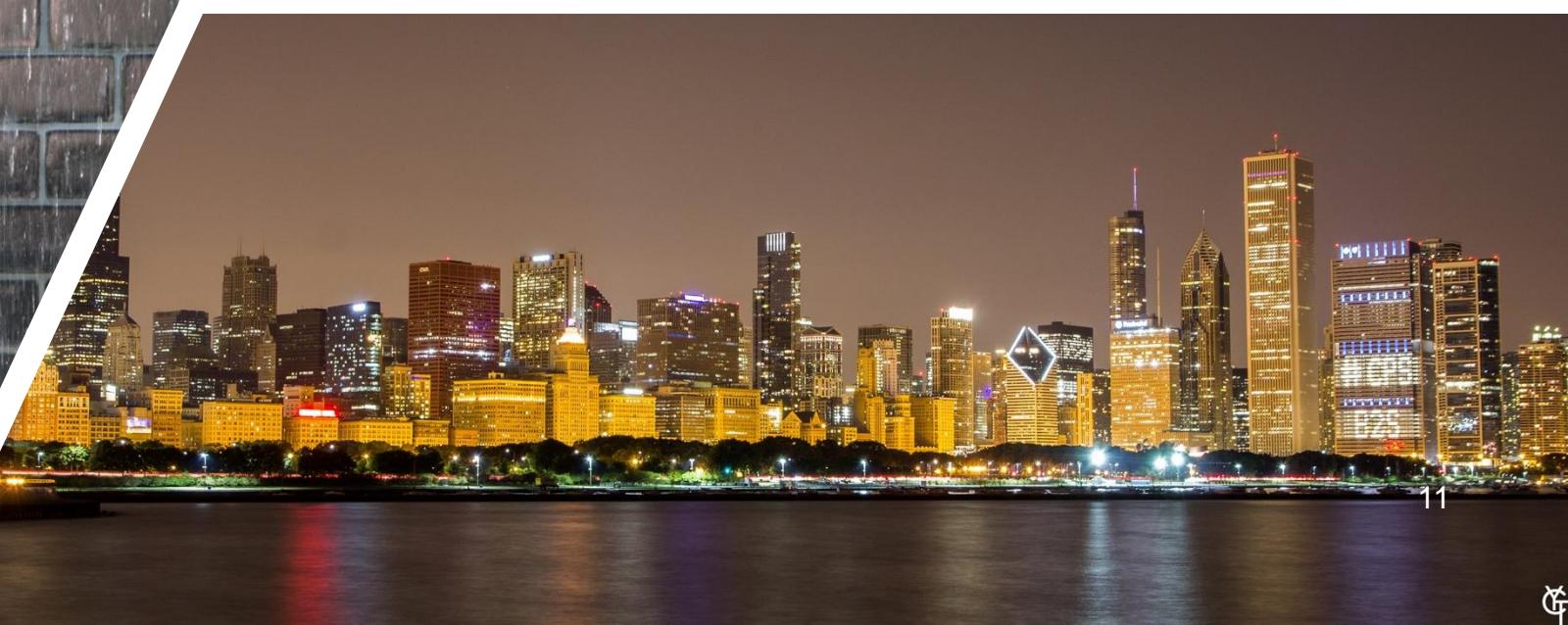
Fig. 2: Face images of a particular person under 3 different lighting conditions (frontal view).



My Ph.D Journey @ Purdue (2010)







▼ Navigator FIT FILL 1:1 3:1



Presets +

- ▶ Color
- ▶ Creative
- ▶ B&W
- ▶ Curve
- ▶ Grain
- ▶ Sharpening
- ▶ Vignetting
- ▶ User Presets

Snapshots +

- ▶ History x

Collections +

- Filter Collections
- ▶ Smart Collections

Copy Paste

RAW YY Soft Proofing

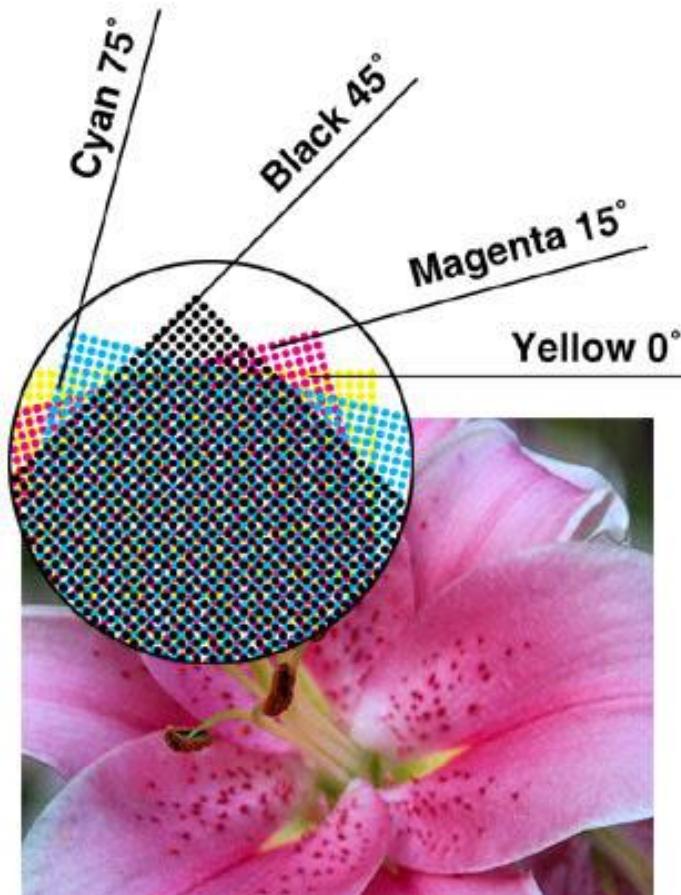


<https://thewonderlusters.com/enhance-photos-with-lightroom/>

Library | Develop | Map | Book | Slideshow | Print



Color Halftoning (Imaging)



Prof. Jan Allebach

Yi-Ting Chen

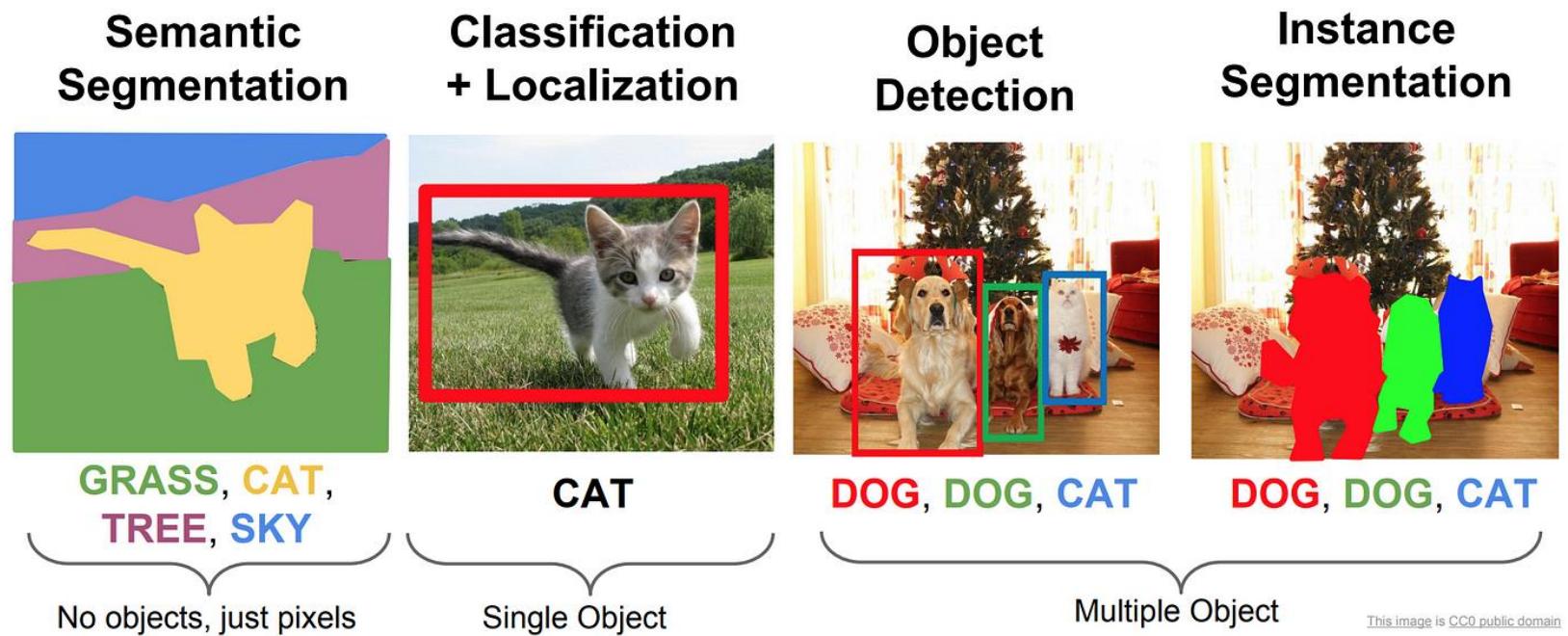
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Computer Vision @UC Merced (2015)



Prof. Ming-Hsuan Yang





<https://www.apple.com/tw/shop/buy-iphone/iphone-15-pro>



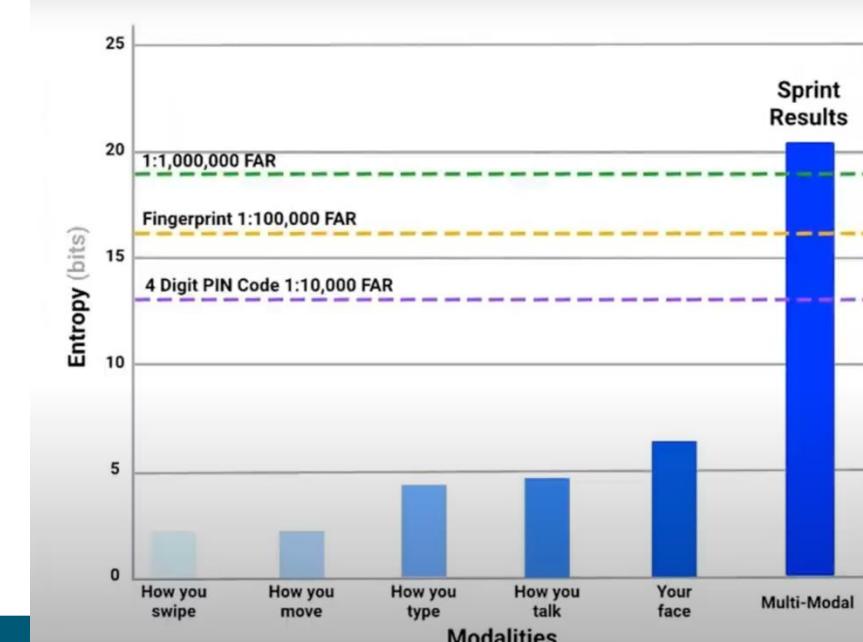
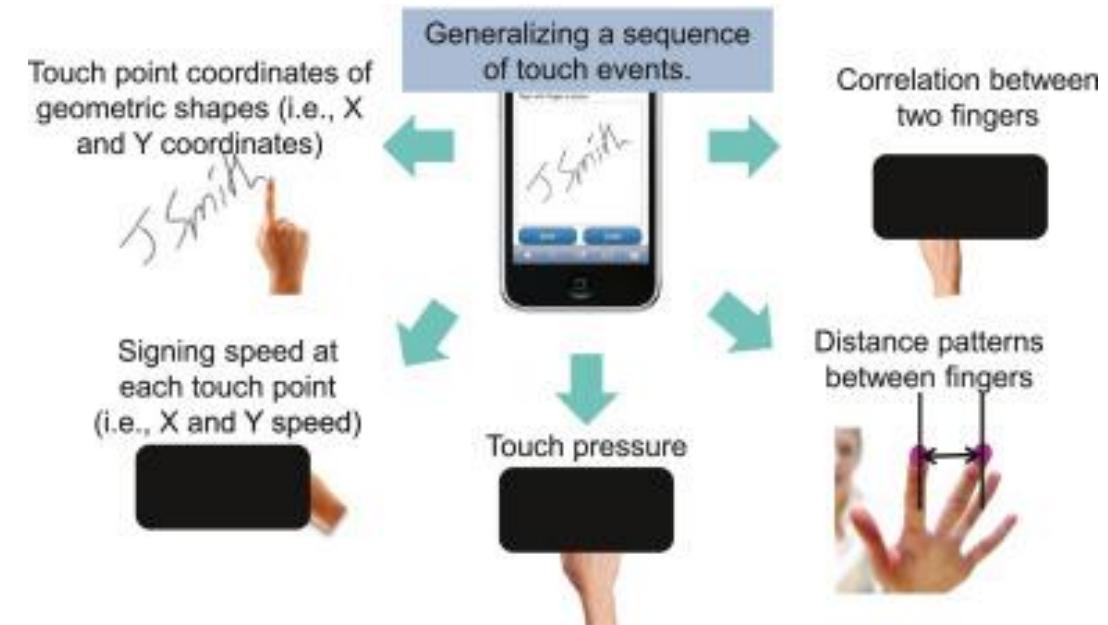
Google ATAP (2015)



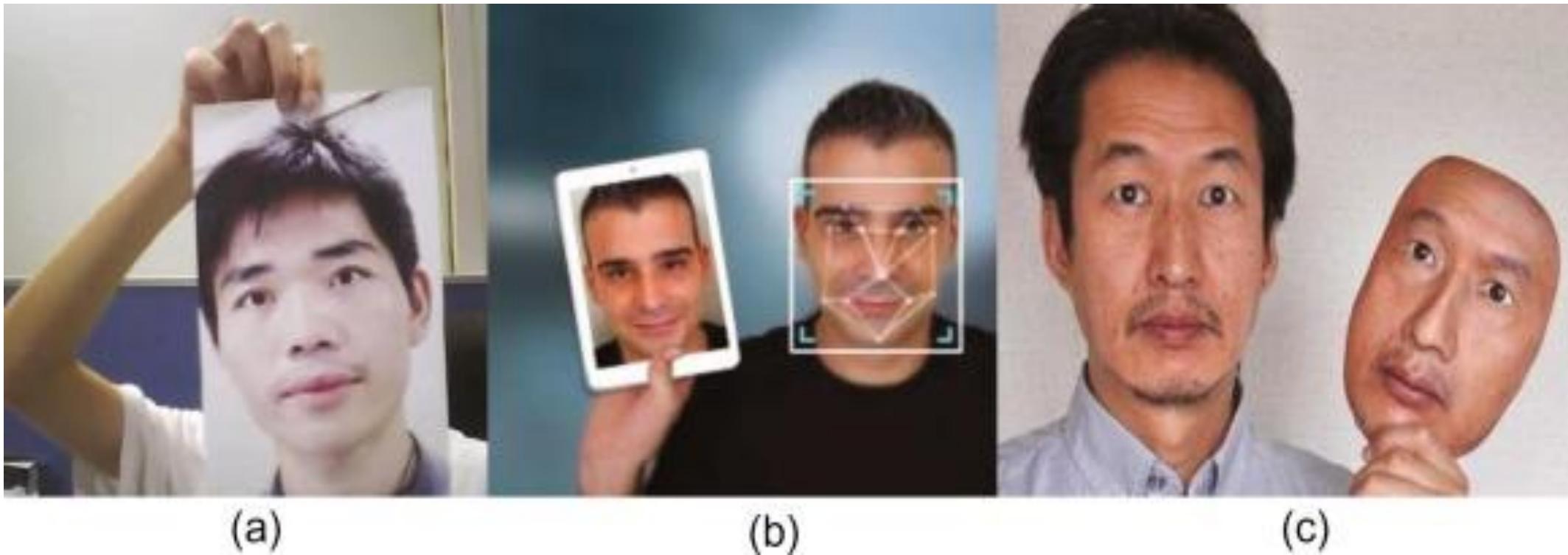
User Authentication



FaceID



Face Antispoofing



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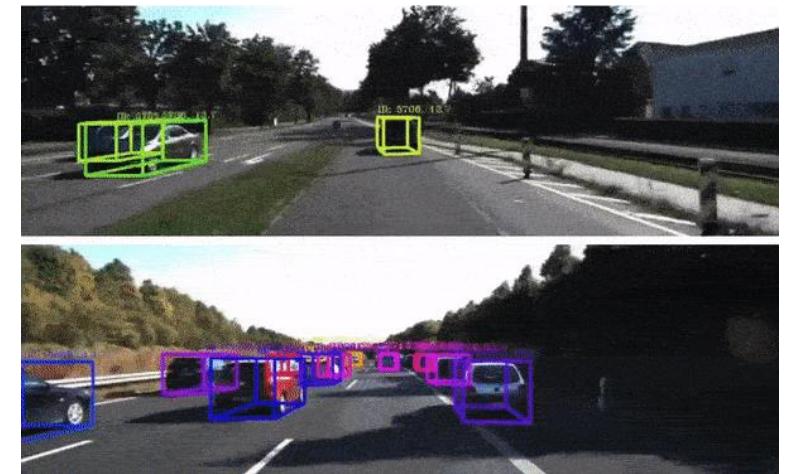
Image Analysis and Computer Vision (2015 ~)



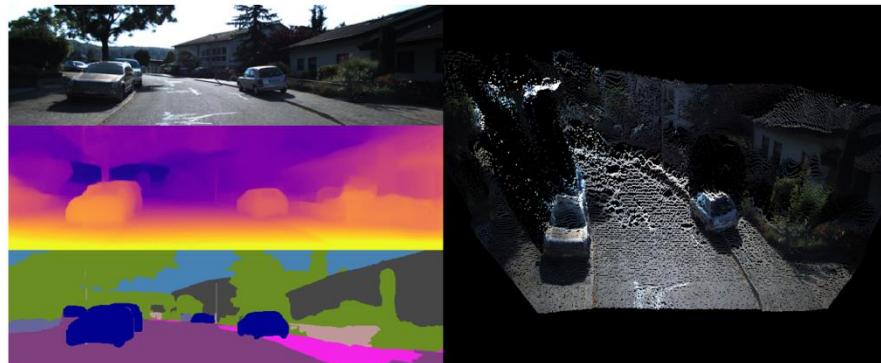
Object Detection



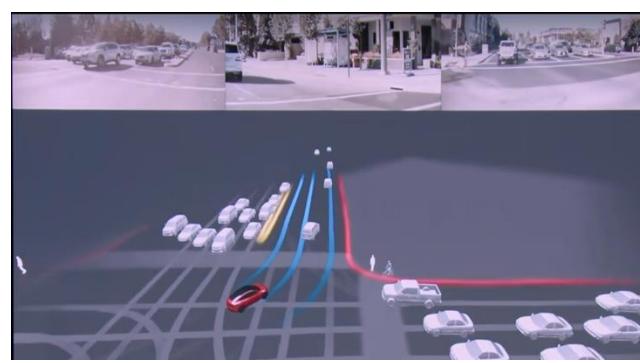
Panoptic Segmentation



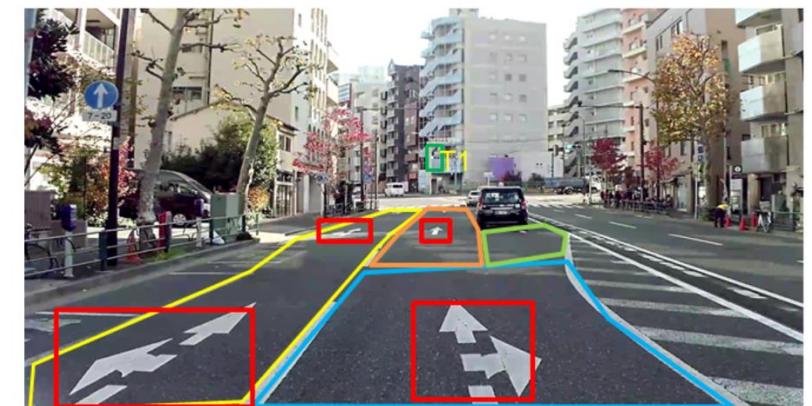
Multiple Object Tracking



Depth Estimation

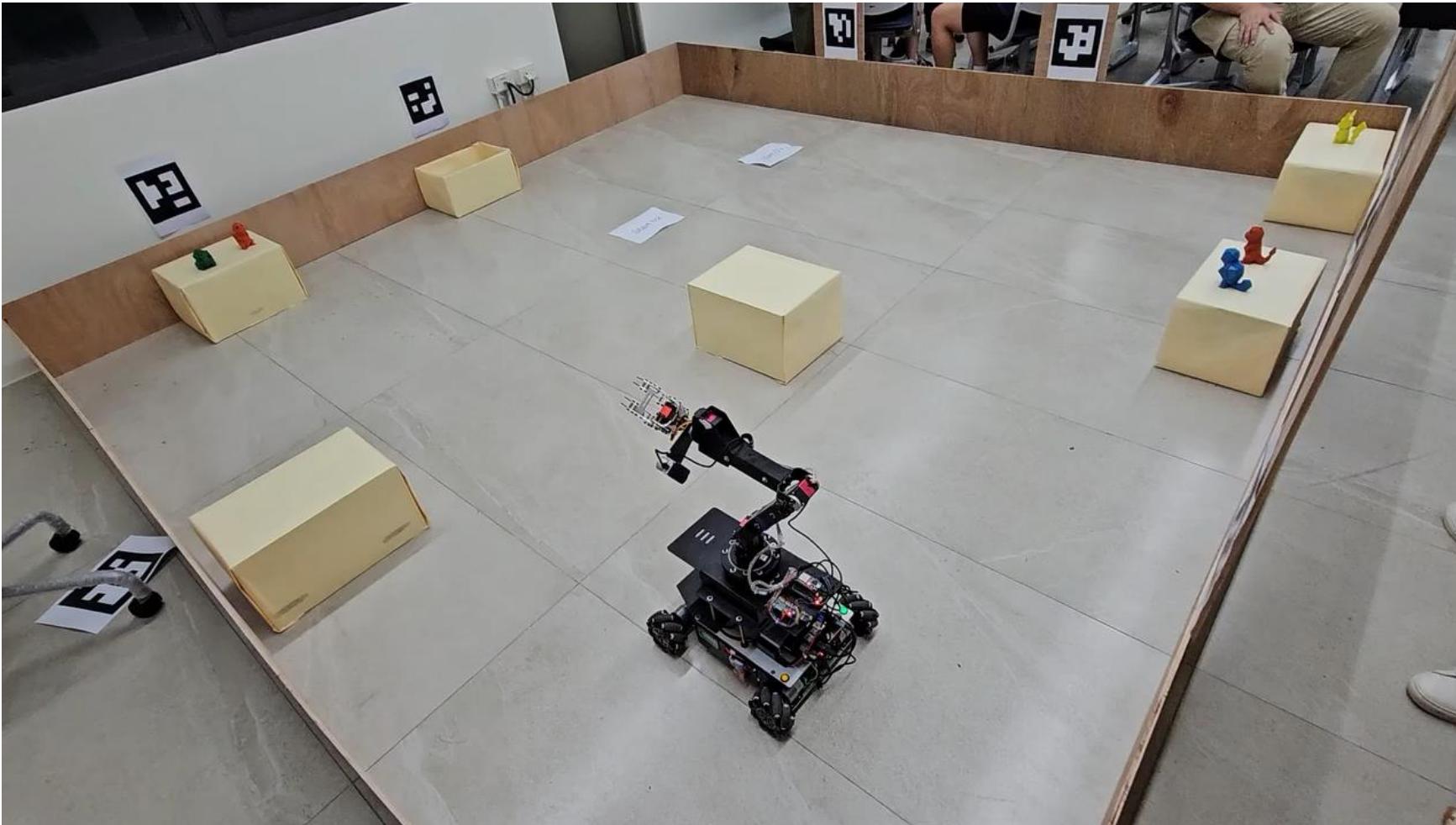


Road topology



Affordance

Computer Vision for Robotics (2021~)



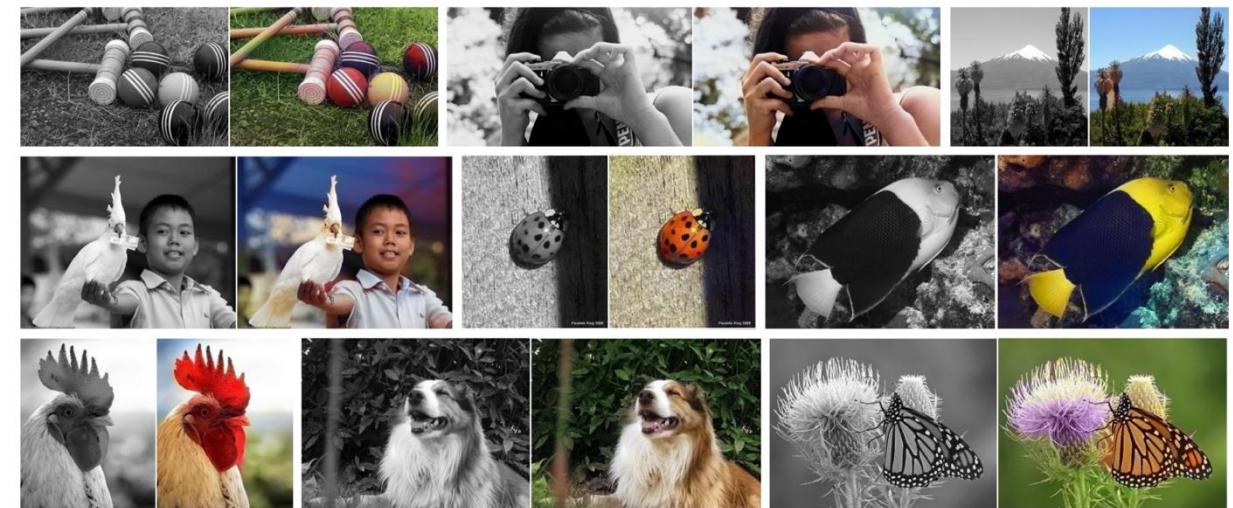
Generation for Safety Validation (2023~)



Topics be covered in this course

- Improve Pictorial Information
 - ✓ image enhancement and image restoration
- Image Storage & Transmission
 - ✓ image compression
- Autonomous Machine Perception
 - ✓ image analysis and computer vision
- Image Generation
 - ✓ Image conversion and image creation

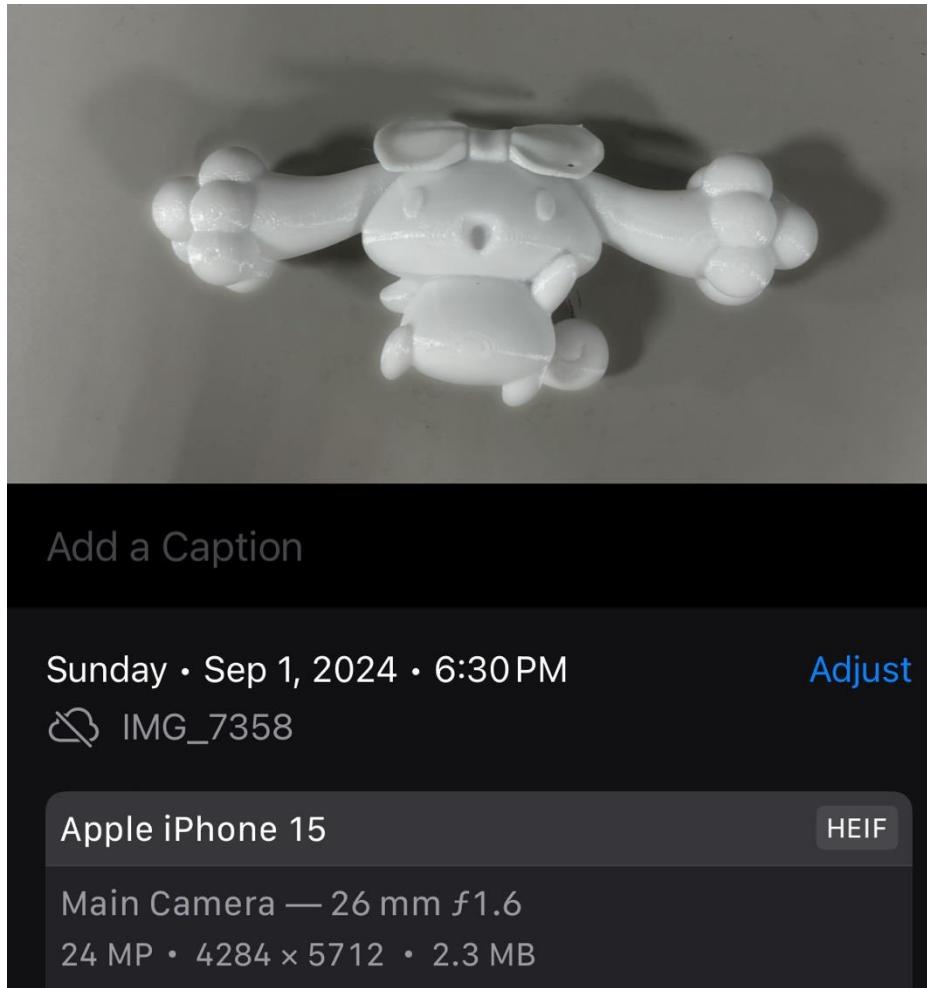
Image Enhancement and Restoration



<https://youtu.be/vL1Uz2x7MPg?si=w4YVK2yTLrd0JzhL>

Zhang et al., Colorful Image Colorization, ECCV 2016

Image Compression



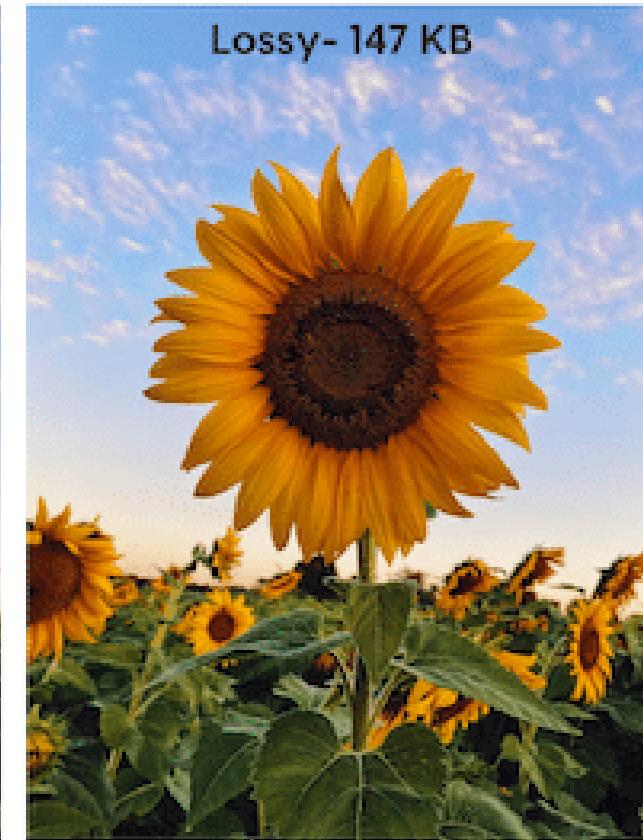
Original - 738 KB



Lossless - 630 KB



Lossy- 147 KB



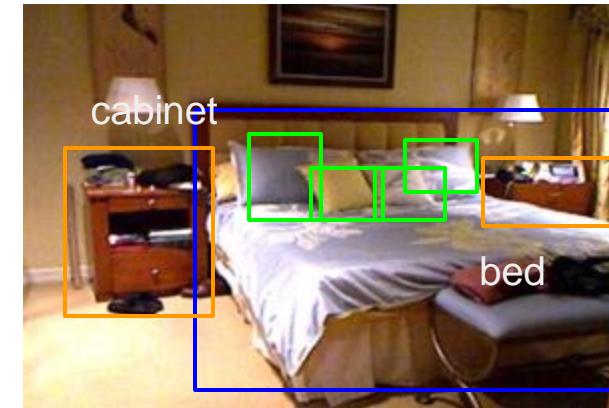
Lossy - 58 KB



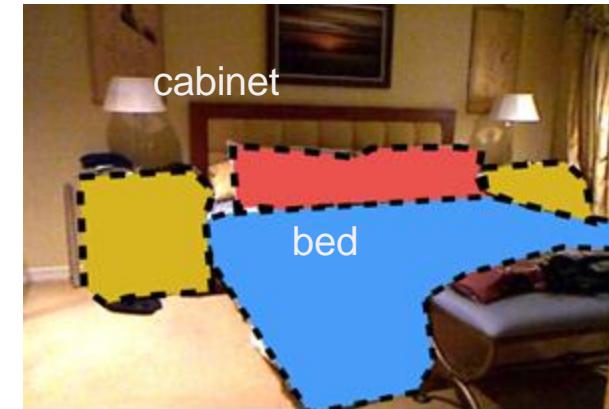
SMART COMPRESSION:
✓ QUALITY PRESERVED

OVERCOMPRESSED:
✗ IMPACTED QUALITY

Image Analysis and Computer Vision



Object detection



Semantic segmentation

Image Generation

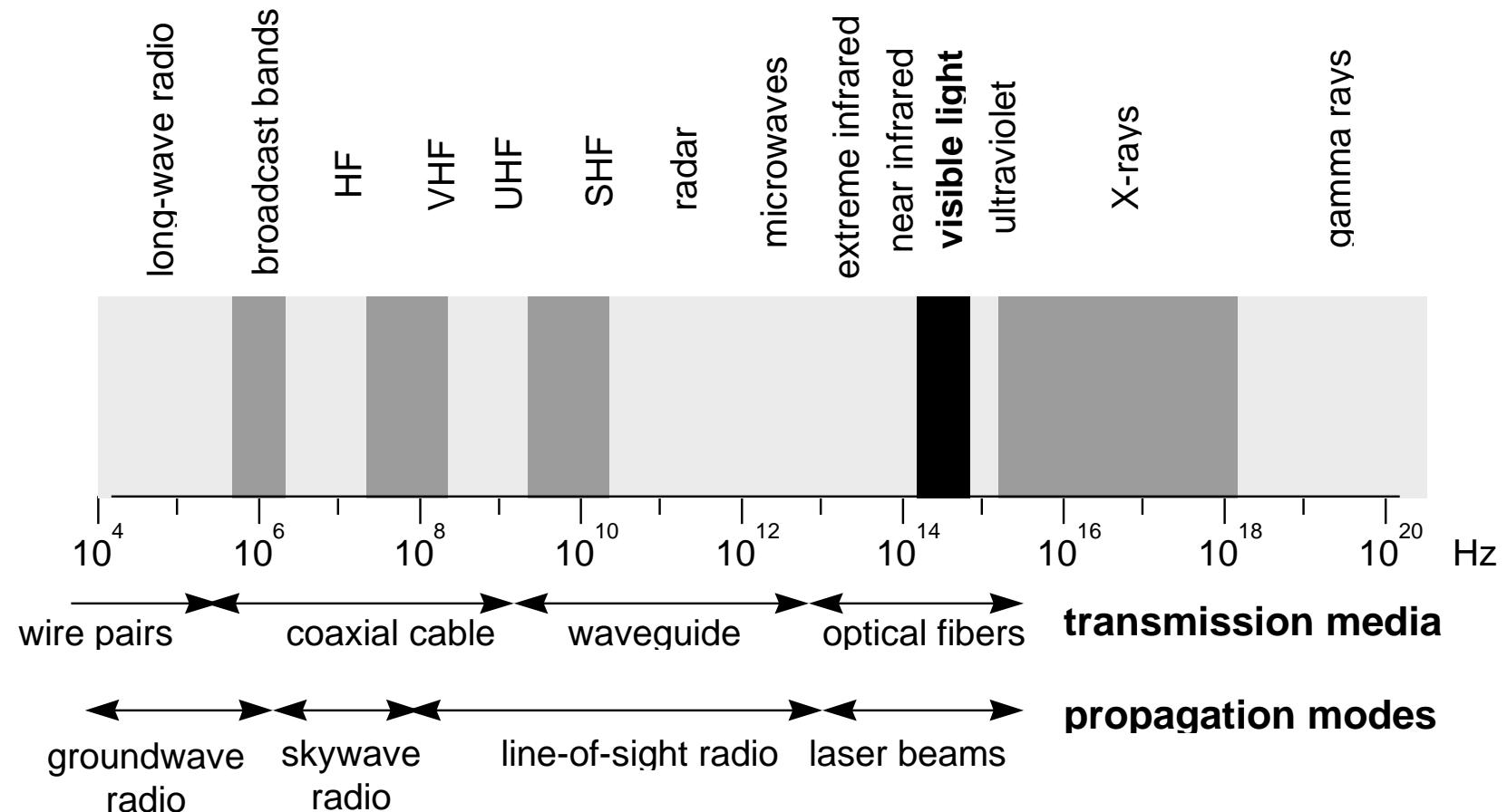
Could you please generate an image that involves 3 persons who dress cloths with red, green, blue, respectively.



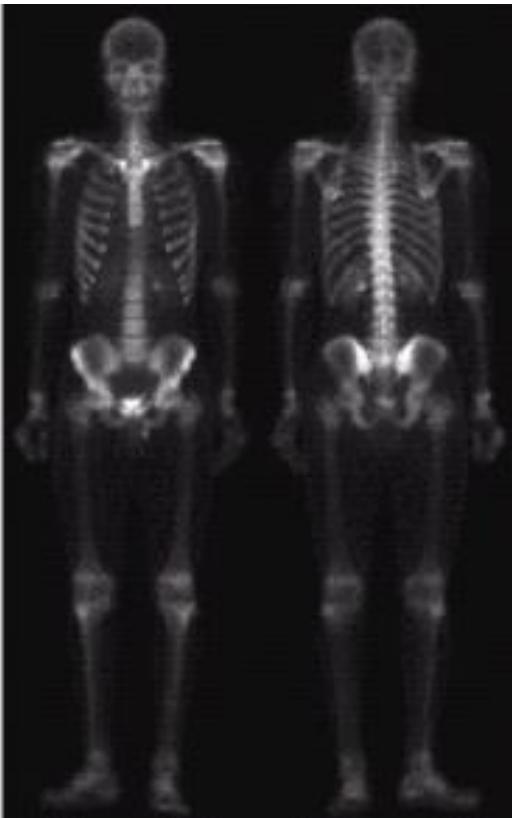
Here is the image you requested with three individuals, each dressed in red, green, and blue outfits. Let me know if there's anything else you'd like to adjust or create!

Fields that use Digital Image Processing

Electromagnetic Spectrum



X-rays



Gamma-Ray Imaging



X-ray Imaging



Visible Light

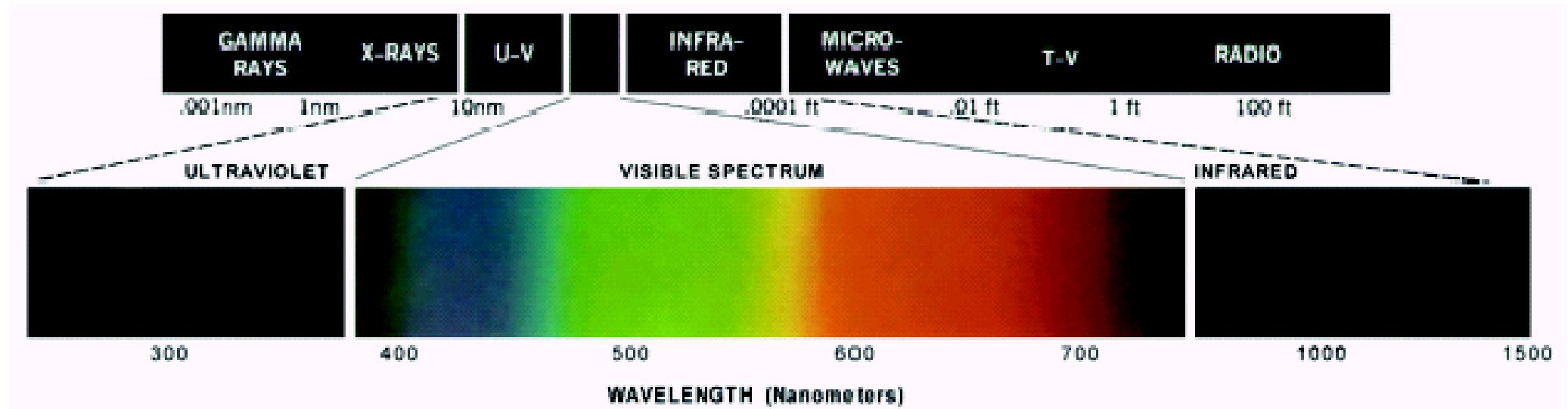
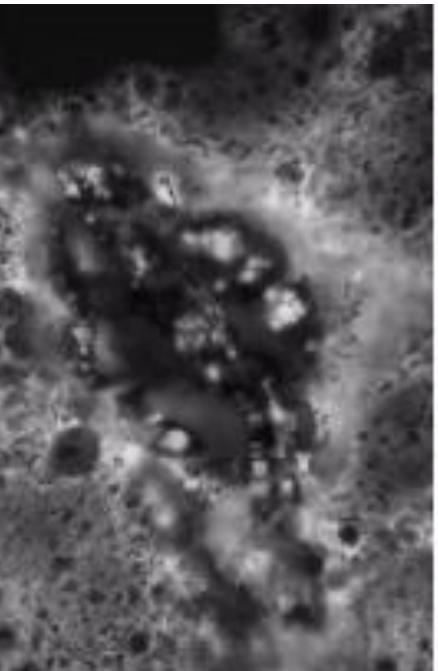
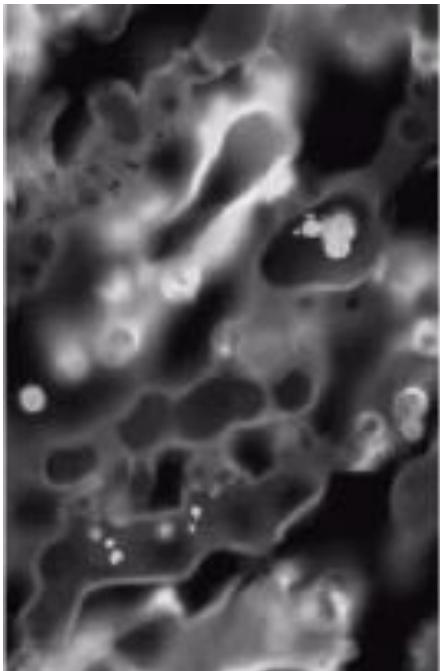
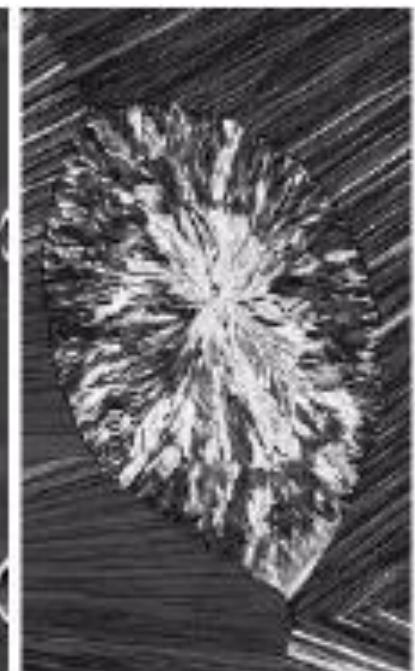


FIGURE 6.2 Wavelengths comprising the visible range of the electromagnetic spectrum. (Courtesy of the General Electric Co., Lamp Business Division.)



Ultraviolet Imaging



Infrared

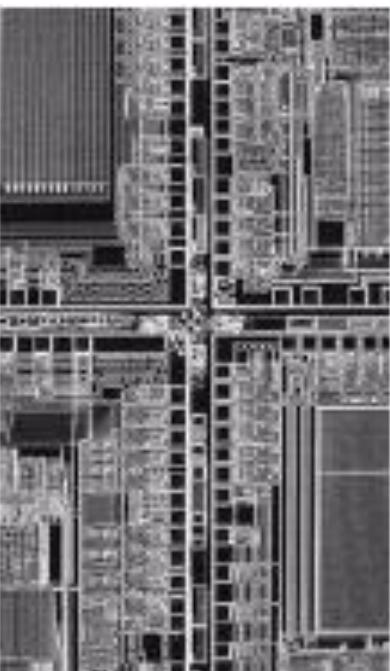
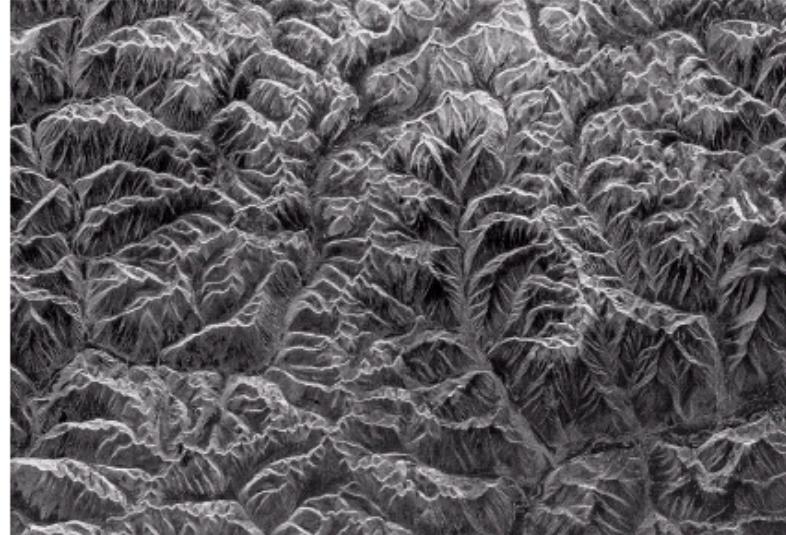
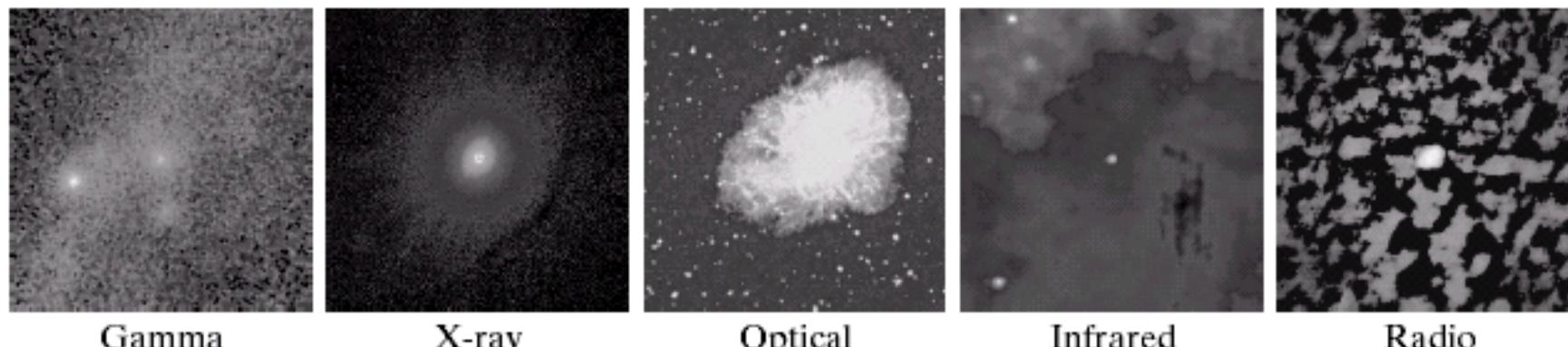


FIGURE 1.16
Spaceborne radar
image of
mountains in
southeast Tibet.
(Courtesy of
NASA.)



Microwave Imaging



Radio Band Imaging

FIGURE 1.18 Images of the Crab Pulsar (in the center of images) covering the electromagnetic spectrum.
(Courtesy of NASA.)

Multispectral Imaging

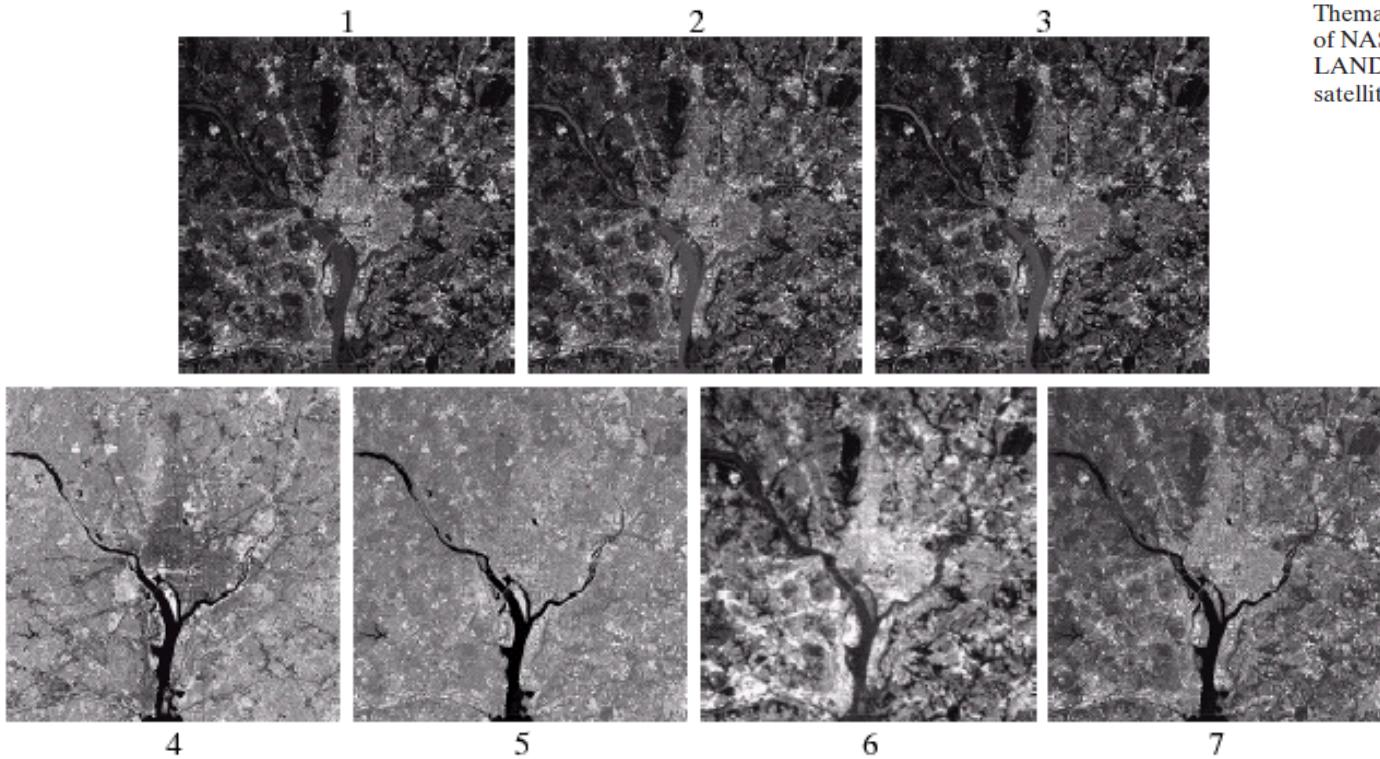
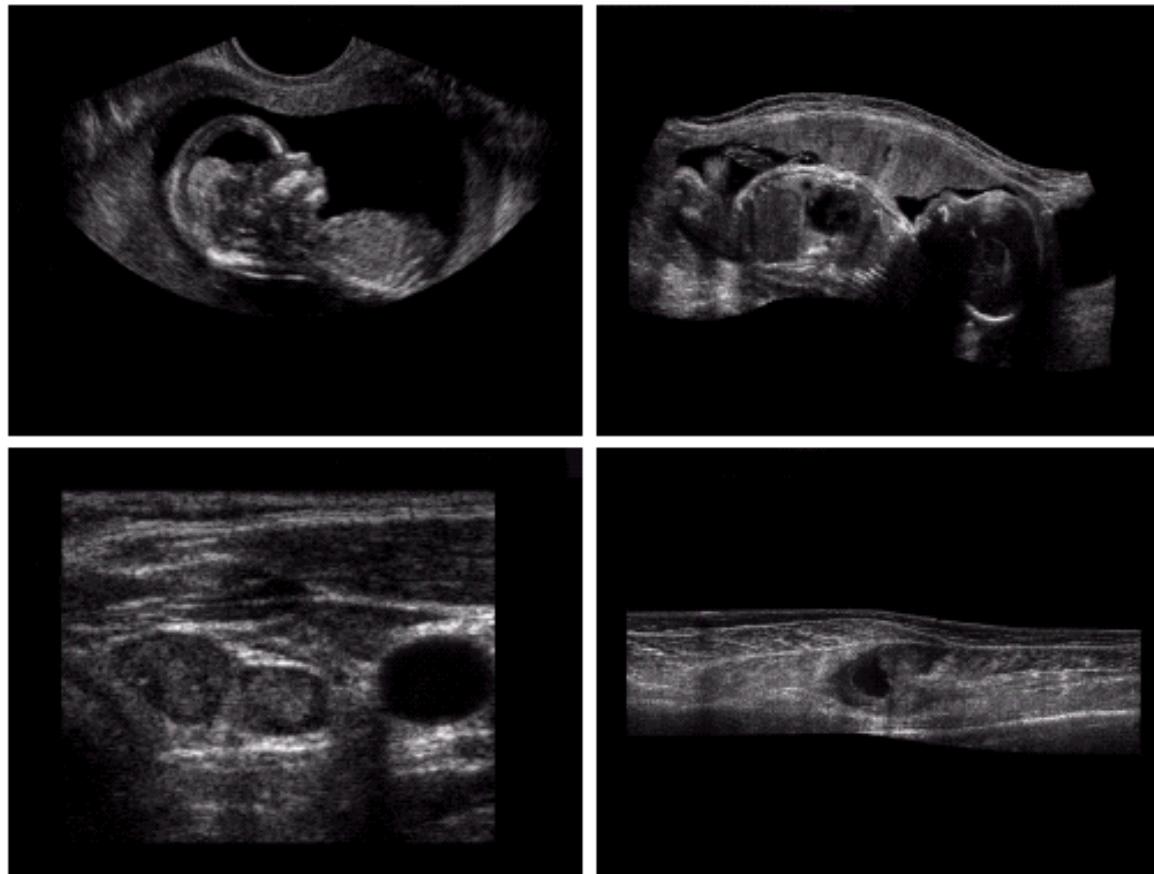


TABLE 1.1
Thematic bands
of NASA's
LANDSAT
satellite.

Band No.	Name	Wavelength (μm)	Characteristics and Uses
1	Visible blue	0.45–0.52	Maximum water penetration
2	Visible green	0.53–0.61	Measures plant vigor
3	Visible red	0.63–0.69	Vegetation discrimination
4	Near infrared	0.78–0.90	Biomass and shoreline mapping
5	Middle infrared	1.55–1.75	Moisture content: soil/vegetation
6	Thermal infrared	10.4–12.5	Soil moisture; thermal mapping
7	Short-wave infrared	2.09–2.35	Mineral mapping

FIGURE 1.10 LANDSAT satellite images of the Washington, D.C. area. The numbers refer to the thematic bands in Table 1.1. (Images courtesy of NASA.)

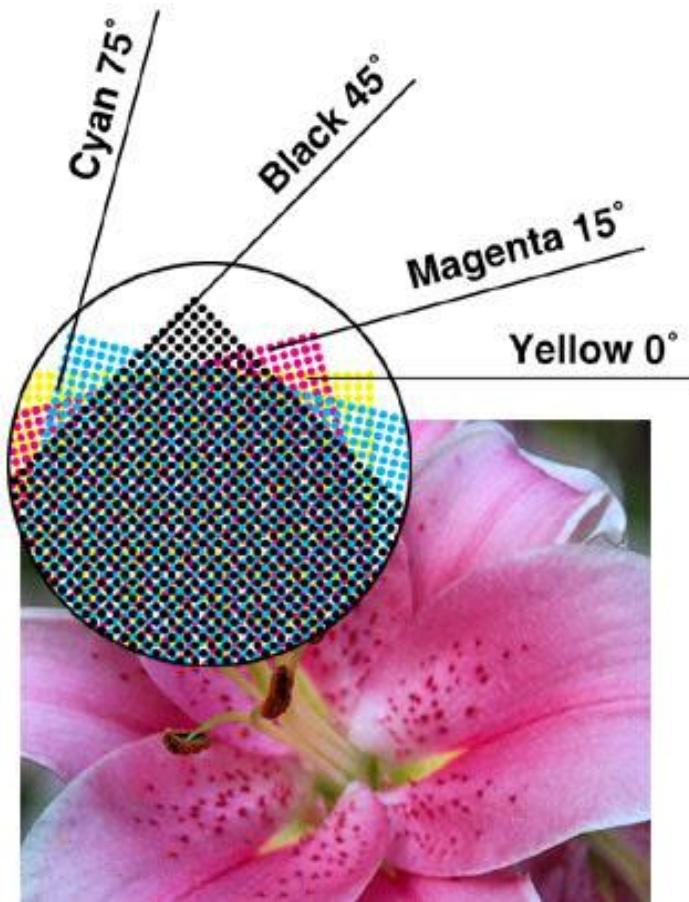
Ultrasound Imaging



a b
c d

FIGURE 1.20
Examples of ultrasound imaging. (a) Baby.
(2) Another view of baby.
(c) Thyroids.
(d) Muscle layers showing lesion.
(Courtesy of Siemens Medical Systems, Inc., Ultrasound Group.)

Color Halftoning (Imaging)



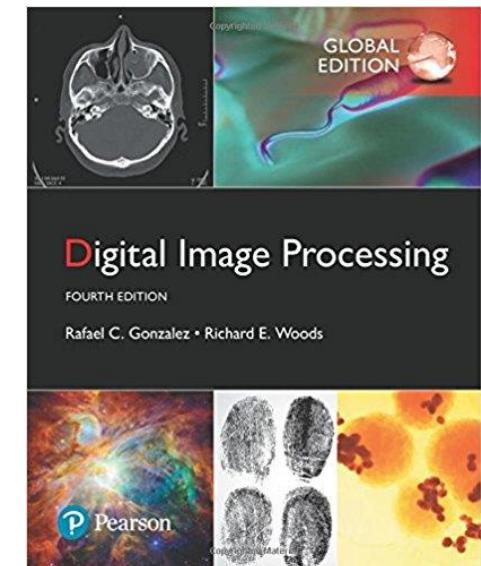
Course Logistics

Course Logistics

- Prerequisites
 - Linear Algebra
 - Signals & Systems
 - Digital Signal Processing (optional)
- Lectures
 - Tuesday 9:00 am – 9:50 am @ EC 122
 - Friday 1:20 pm – 3:10 pm @ EC 122
- Office Hours
 - By appointment

Course Logistics

- Textbook (optional)
 - Digital Image Processing, 4th Edition (Global Edition) by R.C. Gonzalez and R.E. Woods, Pearson, 2018.
- Language
 - Taught in English
 - Questions can be asked in either English or Chinese
- Contact:
 - The best way to reach me is via email!
 - ychen@cs.nycu.edu.tw
 - E3
 - Teams



Learning Activities and Assessment

- (H) Homework Assignments 50%
- (F-P) Final Project 30%
- (F-E) Final Exam 20%
- (L) Lecture

Course Outline

1. Background Knowledge (Image Fundamentals 、 Human Visual System 、 Color Science)
2. Image Operators
3. Image Transformations (Fourier Transform 、 Wavelet Transform)
4. Image Enhancement & Restoration
5. Morphological Image Processing
6. Image Analysis
7. Image Generation
8. Image Compression