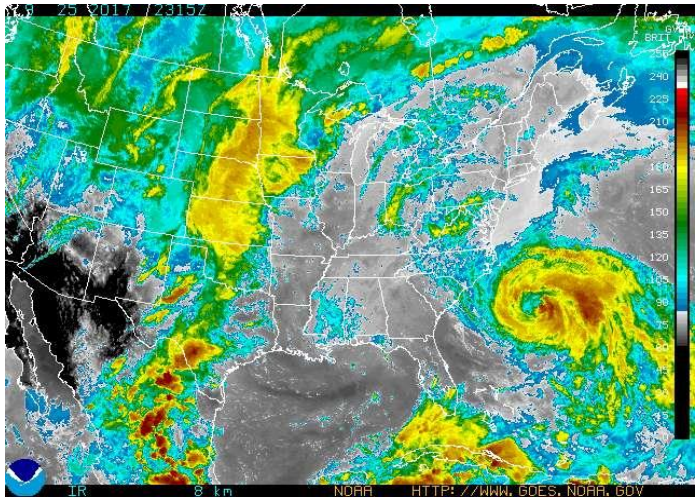
EE568
Digital Image Processing

Credits: 4

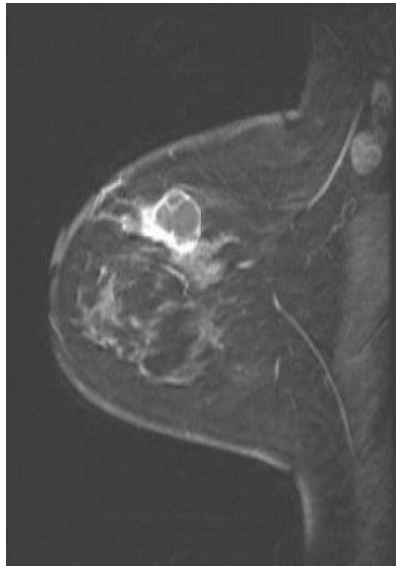
Prof. Ming-Ting Sun

Digital Images Everywhere

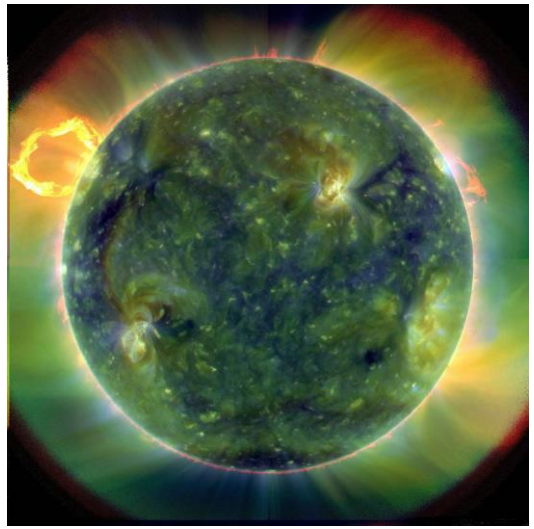
Picture taken by my cellphone



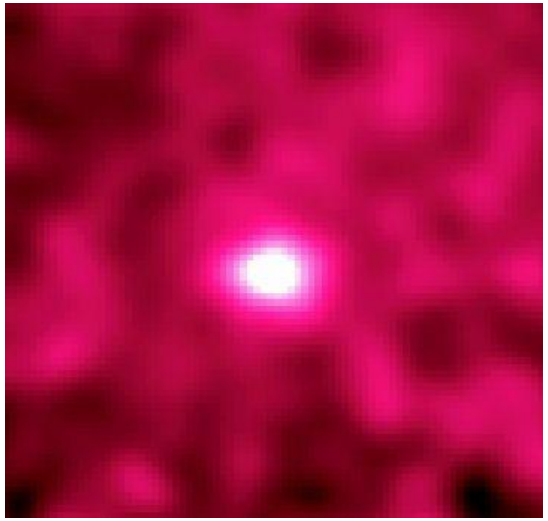
Eastern U.S. Infrared Image



X-ray medical imaging



Ultraviolet image of Sun



Moon in gamma ray range

Goal of the course:

- Introduce the basic theory, techniques, and recent important topics related to digital image processing.
- Introduce 2D-DSP, review DSP.

Image/Video Enhancement

12 megapixel 16-bit linear input
(tone-mapped for visualization)

tone-mapped with HDR+
400 – 600 ms

processed with our algorithm
61 ms, PSNR = **28.4 dB**

Gharbi et al. 2017 SIGGRAPH

(a) Original video frame

(b) Enhanced video frame

Image Denoising

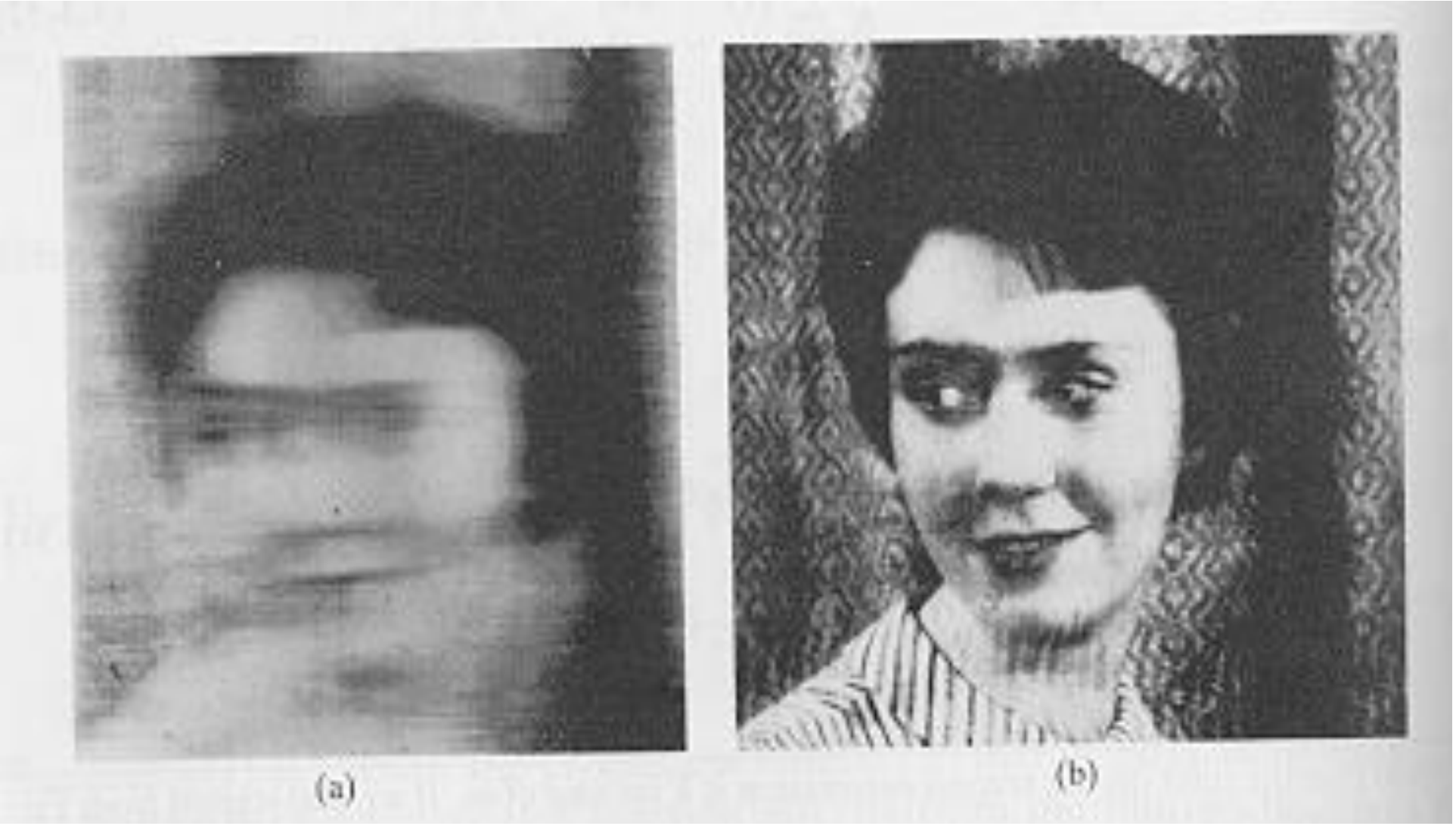
Stamatios Lefkimmiatis, 2017 CVPR

Image Deblurring

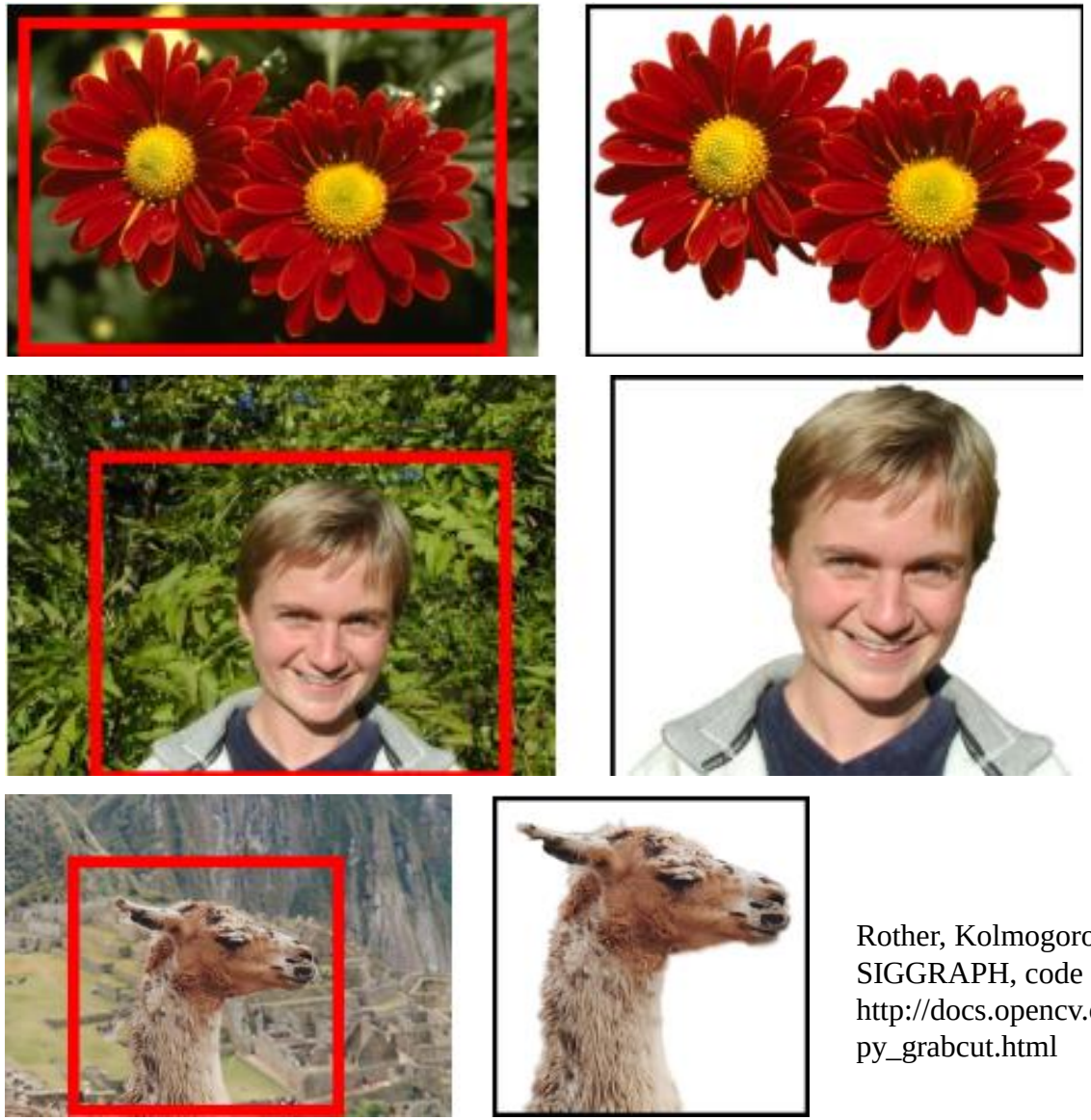
Pan et al. 2016 CVPR

Li Xu, Jiaya Jia, 2010 ECCV

Image Restoration

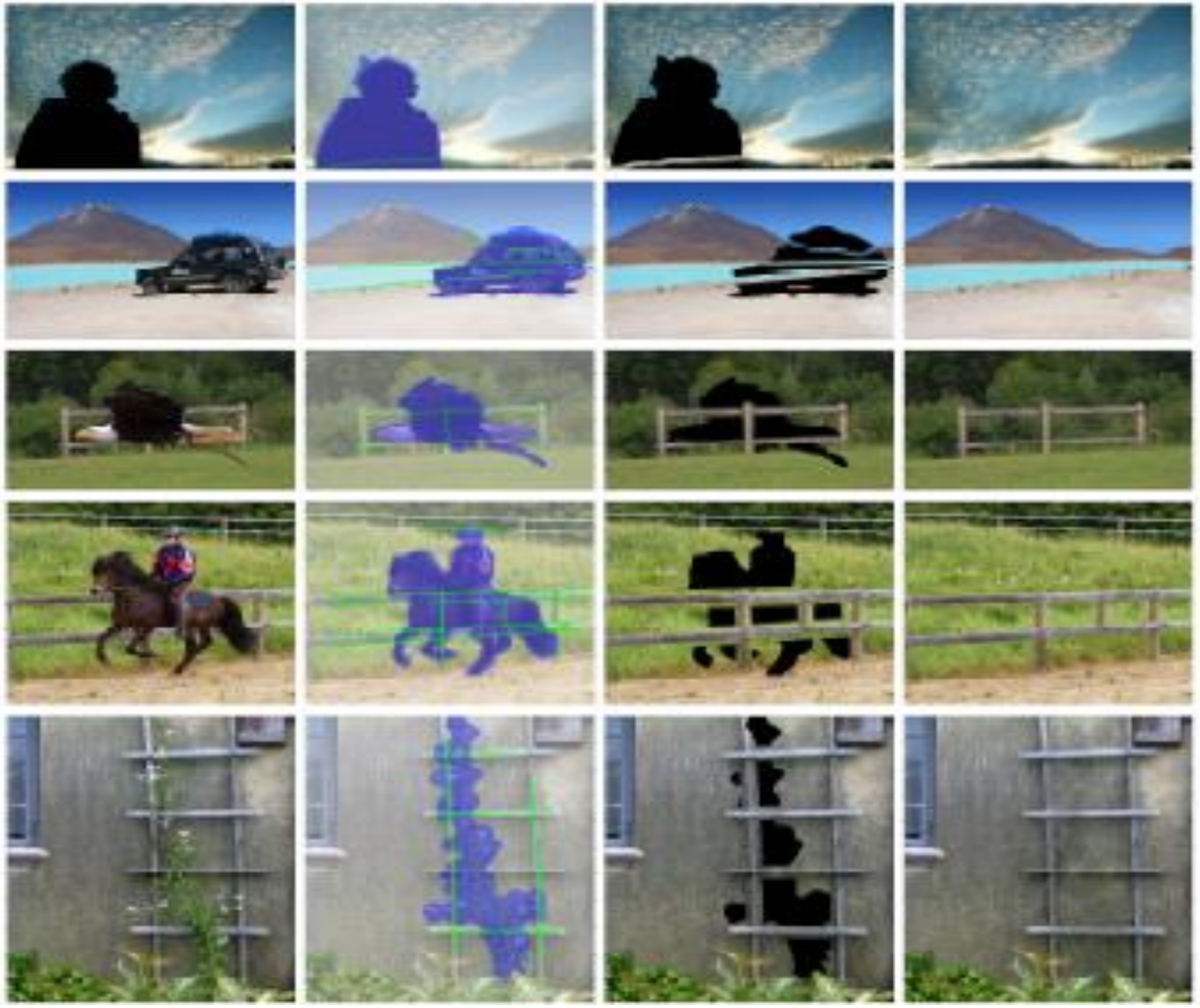


Object Segmentation



Rother, Kolmogorov, Blake, 2004
SIGGRAPH, code available in opencv:
http://docs.opencv.org/3.2.0/d8/d83/tutorial_py_grabcut.html

Image Completion (Inpainting)



High Dynamic Range Imaging

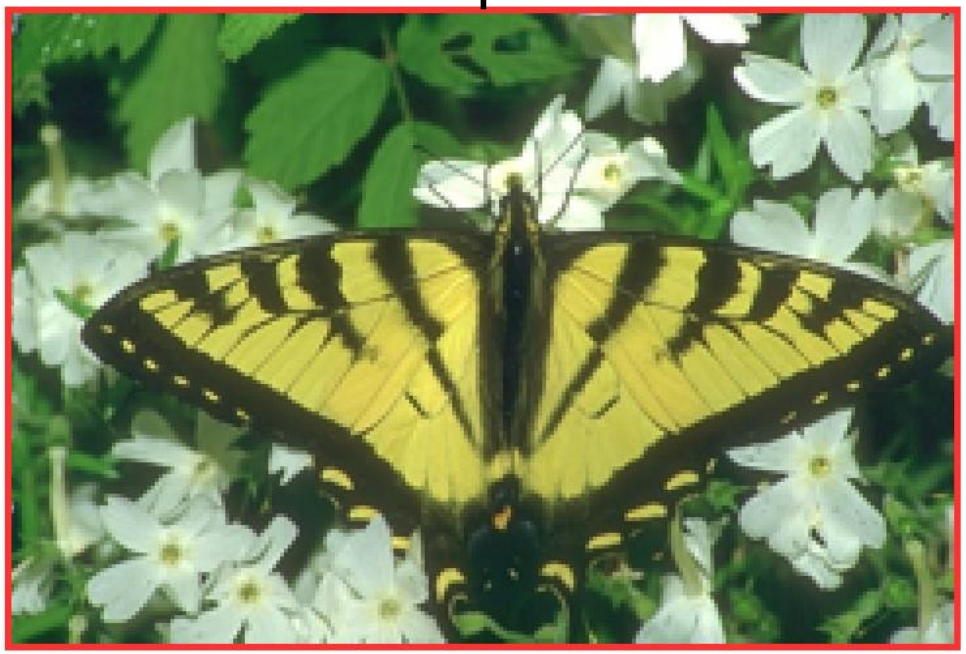
LDR IMAGE

HDR IMAGE

Image Super Resolution

Input Image

NN interpolation



Bicubic interpolation Interpolation

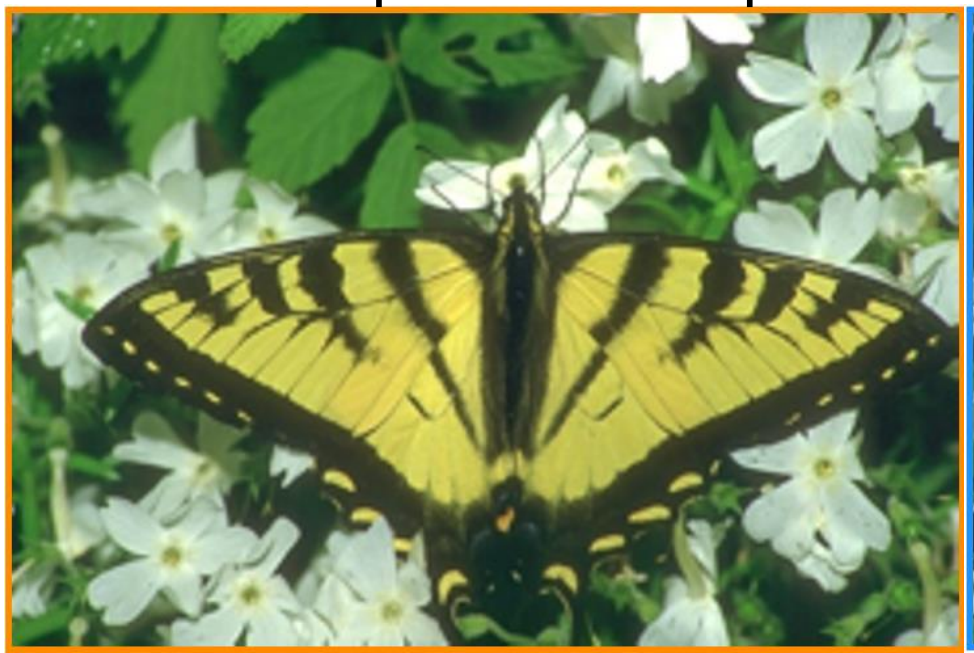


Image Retargeting

resizing

retargeting

Setlur et al. 2004 SIGGRAPH

Image Forensic

Original

Modified

Ahmet Emir Dirik and Nasir Memon, 2009 ICIP

Description

First part: provide the background and basic techniques for digital image processing.

Second part: cover various special topics such as image segmentation, image restoration, multi-resolution imaging with wavelet transform, and image registration.

The course consists of weekly lecture, homework (25%), Midterm (25%), Final (25%), and a final project (25%). The homework and final project are specifically designed towards providing hands-on experience on digital image processing. The students will implement an image processing demo for the final project.

Prerequisites:

EE 341 Discrete Time Signal Analysis, familiarity with MATLAB or Python, or permission of the Coordinator.

Textbook:

Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, 3nd Ed. Prentice Hall.

Course Contents:

1. Image Representations
   * Image acquisition, Sampling, resolution, Quantization
   * Bilinear interpolation
   * Examples of image processing topics
2. Visual Perception and Color Spaces
   * Physiological characteristics of the eye and image formation
   * Human color vision
   * Color models: CIE, RGB, CMYK, YUV, HSV, L*a*b*
3. Image Enhancement
   * Intensity transforms, histogram equalization
   * Pseudocolor image processing
4. Spatial Domain Image Enhancement and Filtering
   * Spatial domain 2-D LSI filtering * Median filtering
   * Bilateral filtering * Derivative operators
   * High-Boost filtering
5. Frequency Domain Image Filtering and Enhancement
   * 2-D Discrete Fourier Transform
   * Frequency domain LSI filtering
   * Enhancement in the frequency domain
6. Wavelets and Multiresolution
   * Subband decomposition * Wavelet transform
7. Image Restoration
   * Image degradation model * Inverse filtering
   * Wiener filtering
8. Detecting edges and lines
   * Canny Edge Detector * Hough Transform
9. Image Segmentation
   * Segmentation by thresholding
   * Otsu's method * Local processing
   * K-Means, EM, Gaussian Mixture Model
   * Segmentation by energy minimization, Graph Cuts
10. Mathematical Morphology
11. Geometric transforms and Image registration
   * Affine Transform * SIFT
   * RANSAC
12. Deep Learning in Image Processing