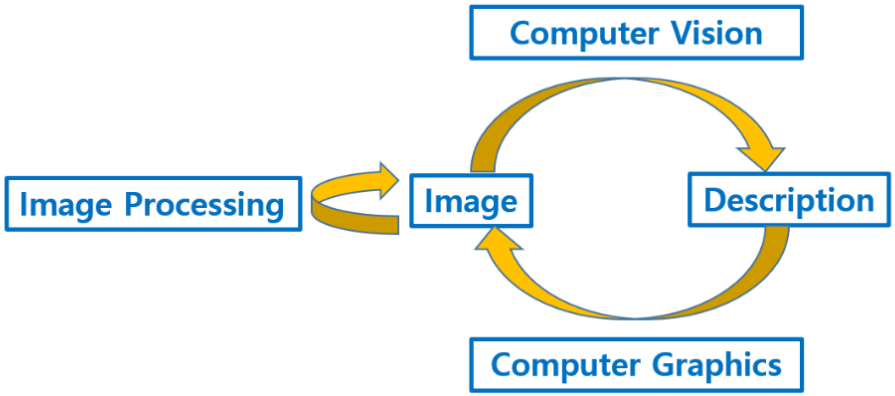
Introduction

- Image Processing and Computer Vision
  - A computer vision system uses the image processing algorithms to try and perform emulation of vision at human scale.
  - Image Processing is the field of enhancing the images by tuning many parameter and features of the images.
  - Image Processing is the subset of Computer Vision.



Evolution's Big Bang: Cambrian Explosion, 530-540million years, B.C.

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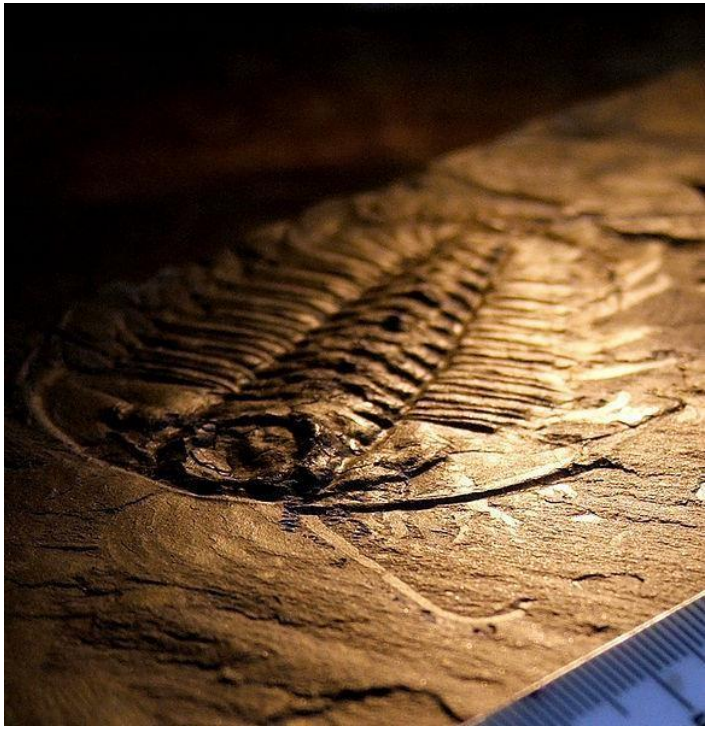

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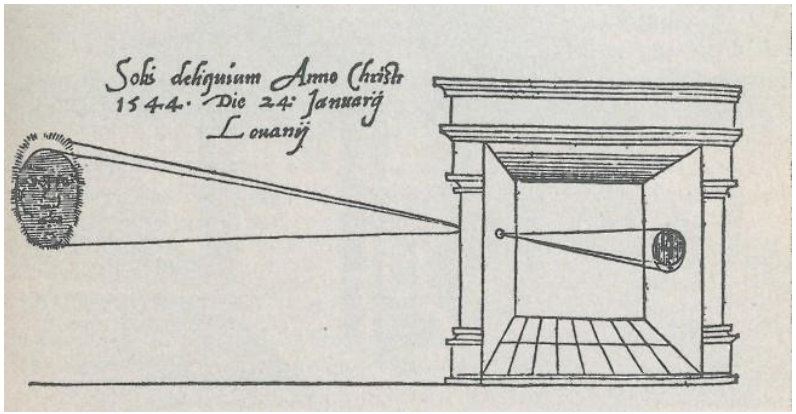
Camera Obscura

Gemma Frisius, 1545



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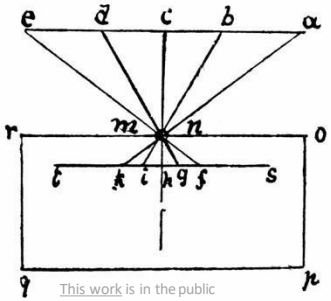

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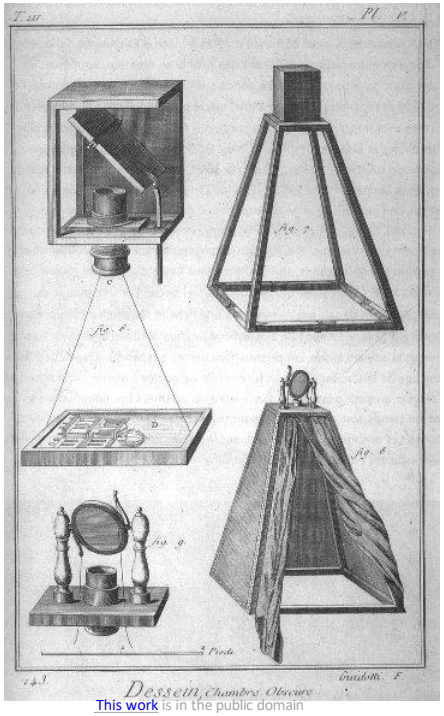
Leonardo da Vinci, 16th Century AD

Encyclopedia, 18th Century



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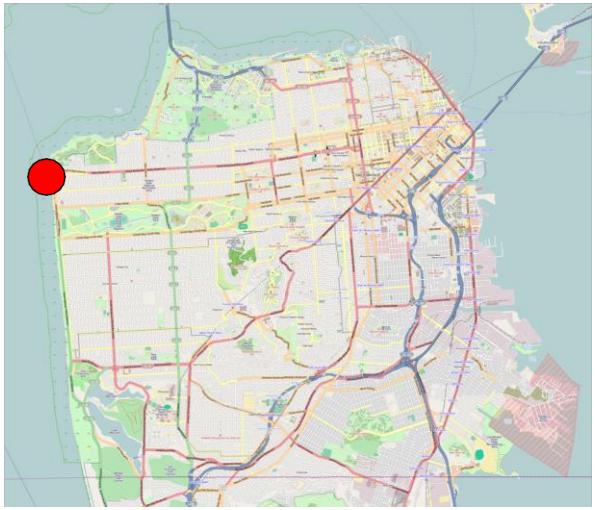
Camera Obscura

- Camera Obscura in San Francisco



What is an image?

- 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

[Albrecht Dürer, 1525]

Digital Images and Pixels

- 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“)

Why do we process images?

- 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 transmissio
  - 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

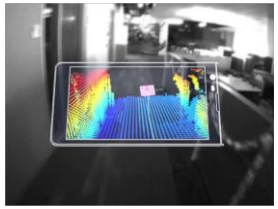
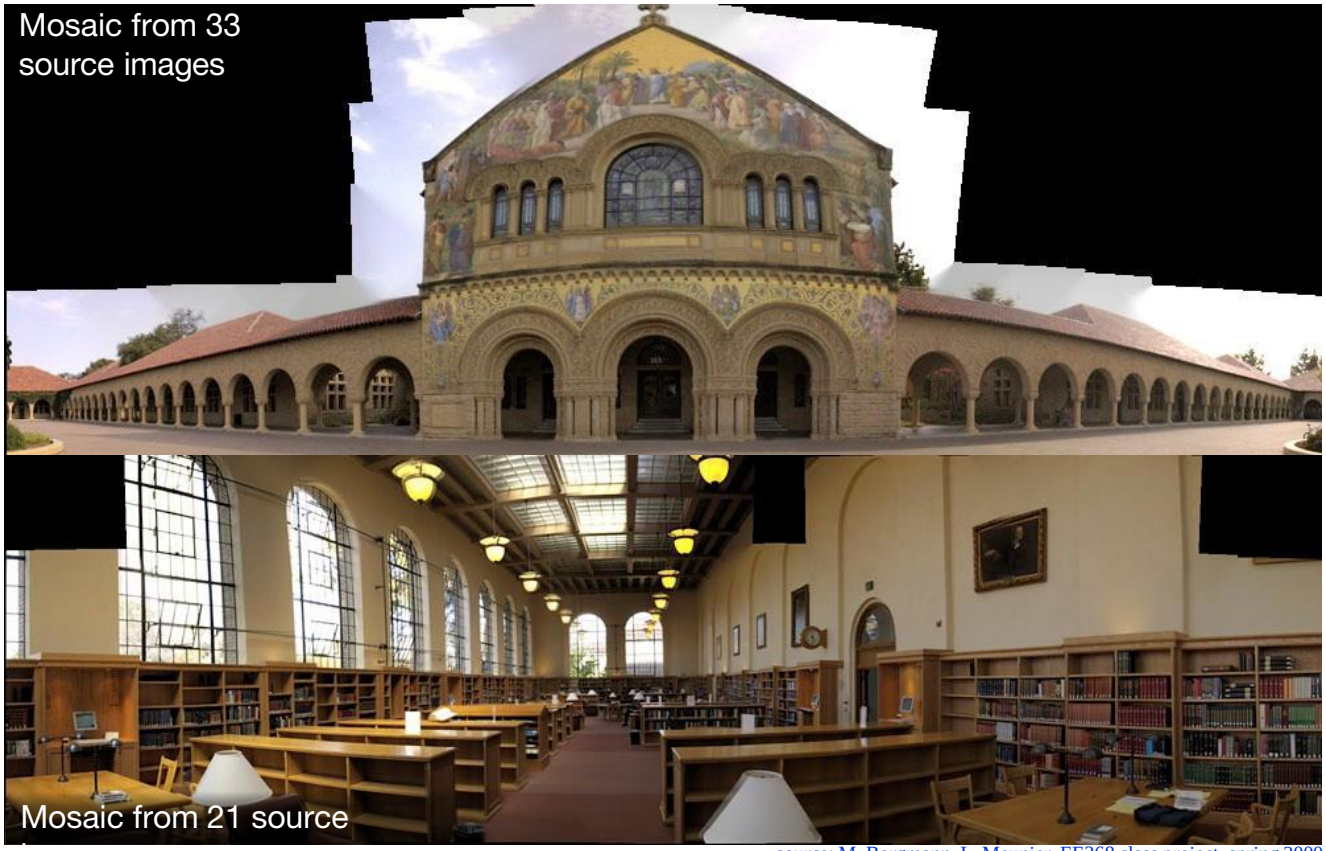


Image Processing Examples



source: M. Borgmann, L. Meunier, EE368 class project, spring 2000.

Google Jump

facebook 360

light.c
o

Image Processing Examples

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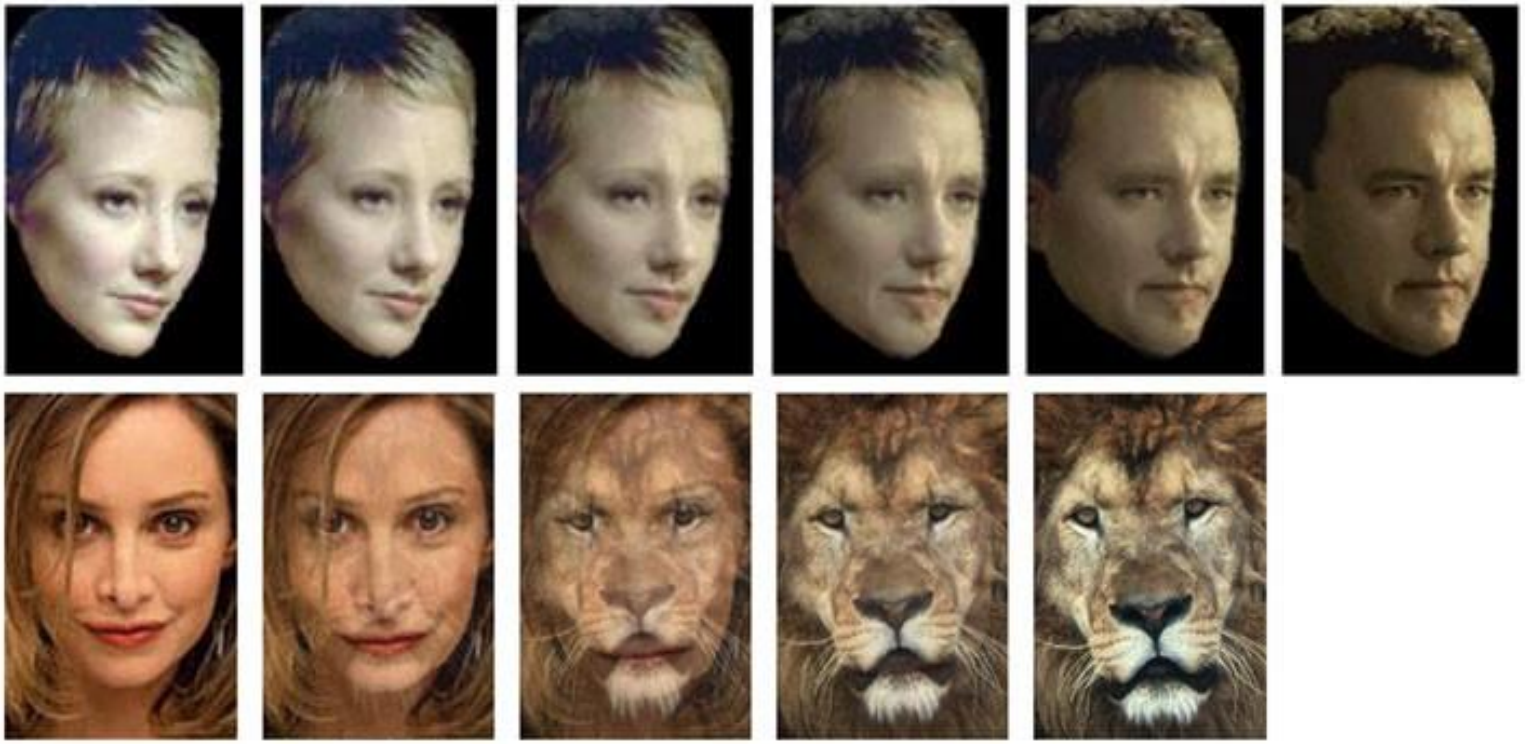
Face morphing



Source: Yi-Wen Liu and Yu-Li Hsueh, EE368 class project, spring 2000.

Image Processing Examples

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Face Detection

source: Henry Chang, Ulises Robles, EE368 class project, spring 2000.

Image Processing Examples

source: Michael Bax, Chunlei Liu, and Ping Li, EE368 class project, spring 2003.

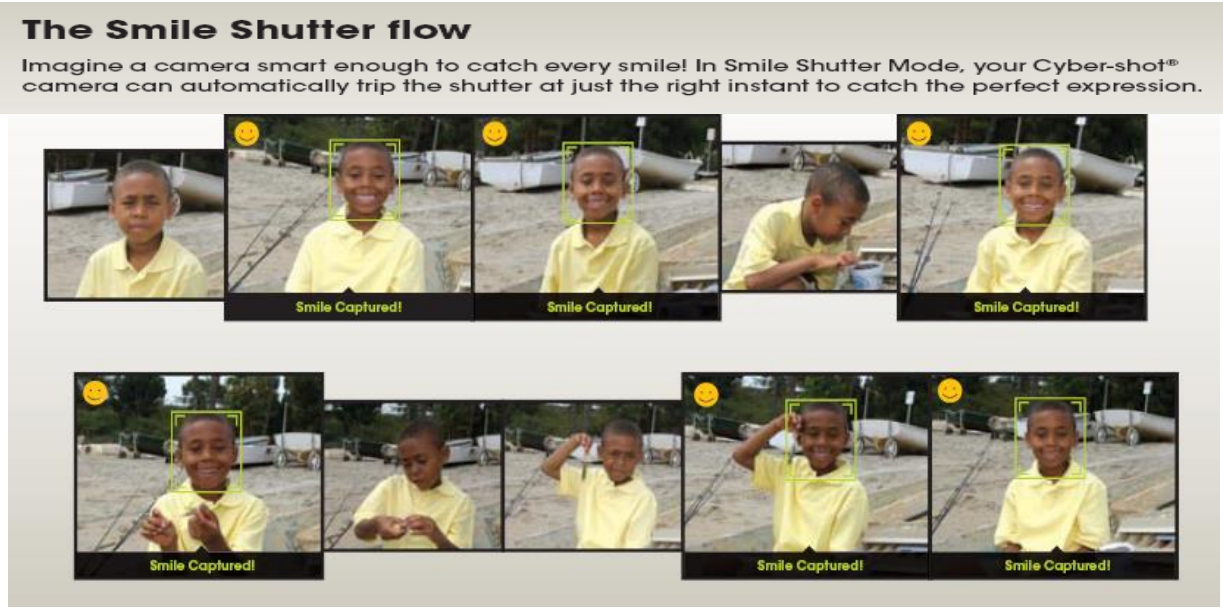
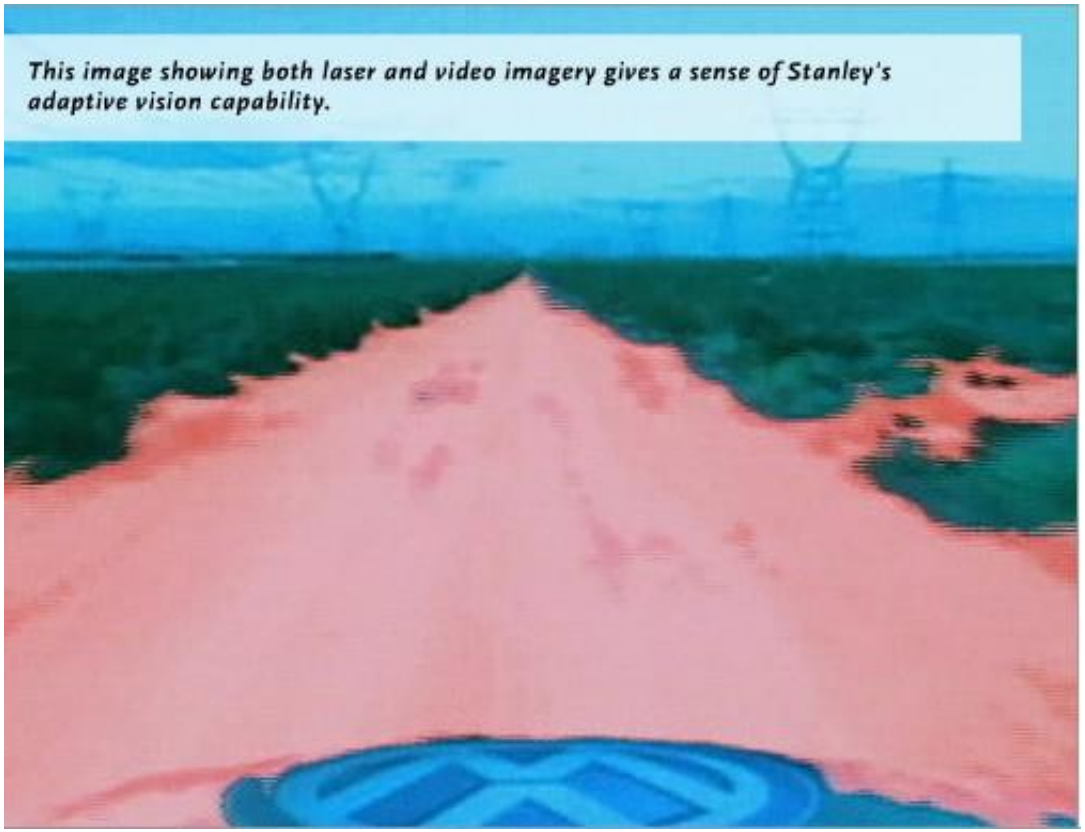


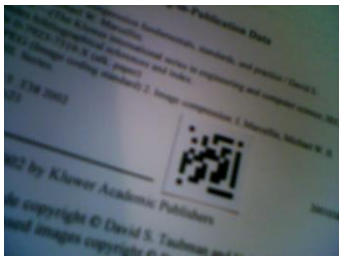
Image Processing Examples

Image Processing Examples



http://cs.stanford.edu/group/roadrunner/stanley.html

Image Processing Examples Visual Code Marker Recognition



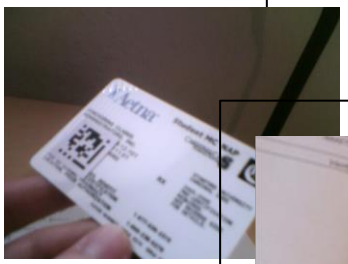
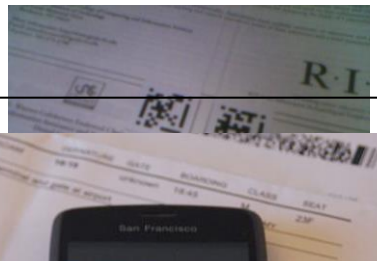
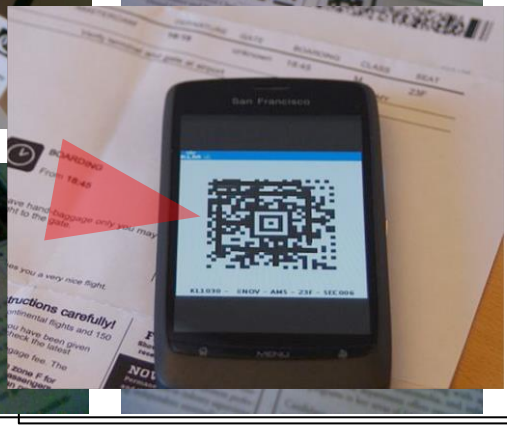
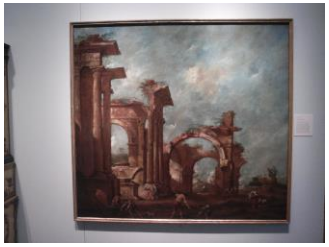




Image Processing Examples Painting Recognition



Amazon Go

Vision-based interaction (and games)

Microsoft's Kinect

Sony EyeToy

Assistive technologies

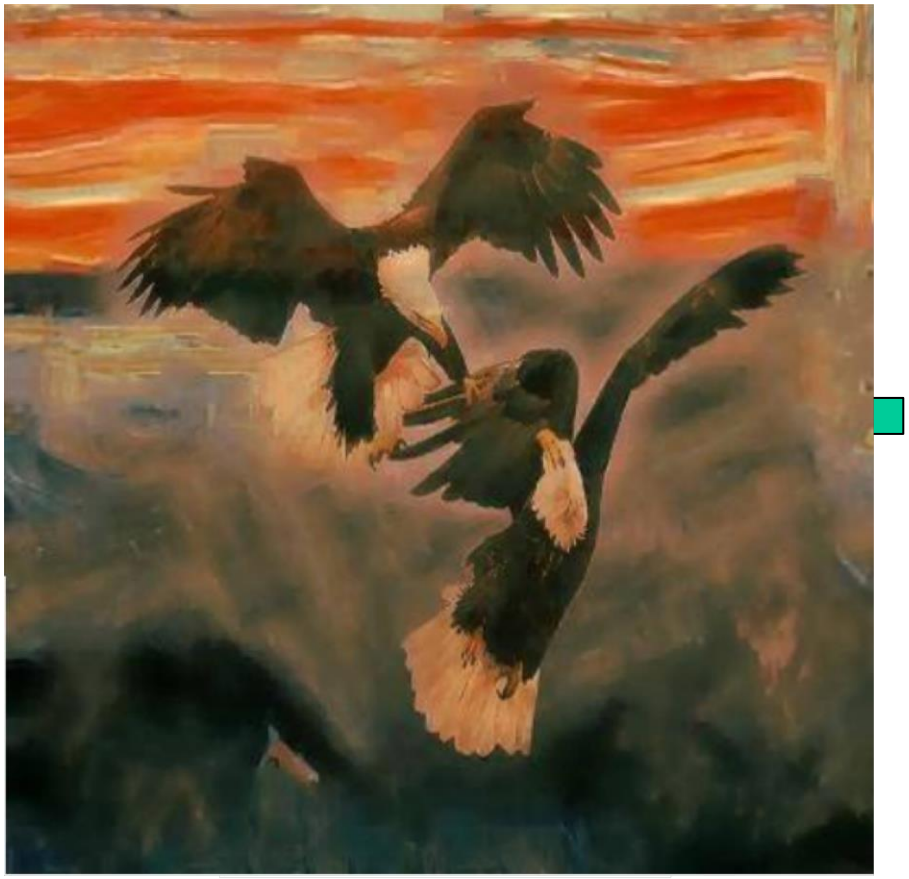
Source: S. Seitz

Augmented Reality

Virtual Reality

Image Processing Examples: Style Transfer

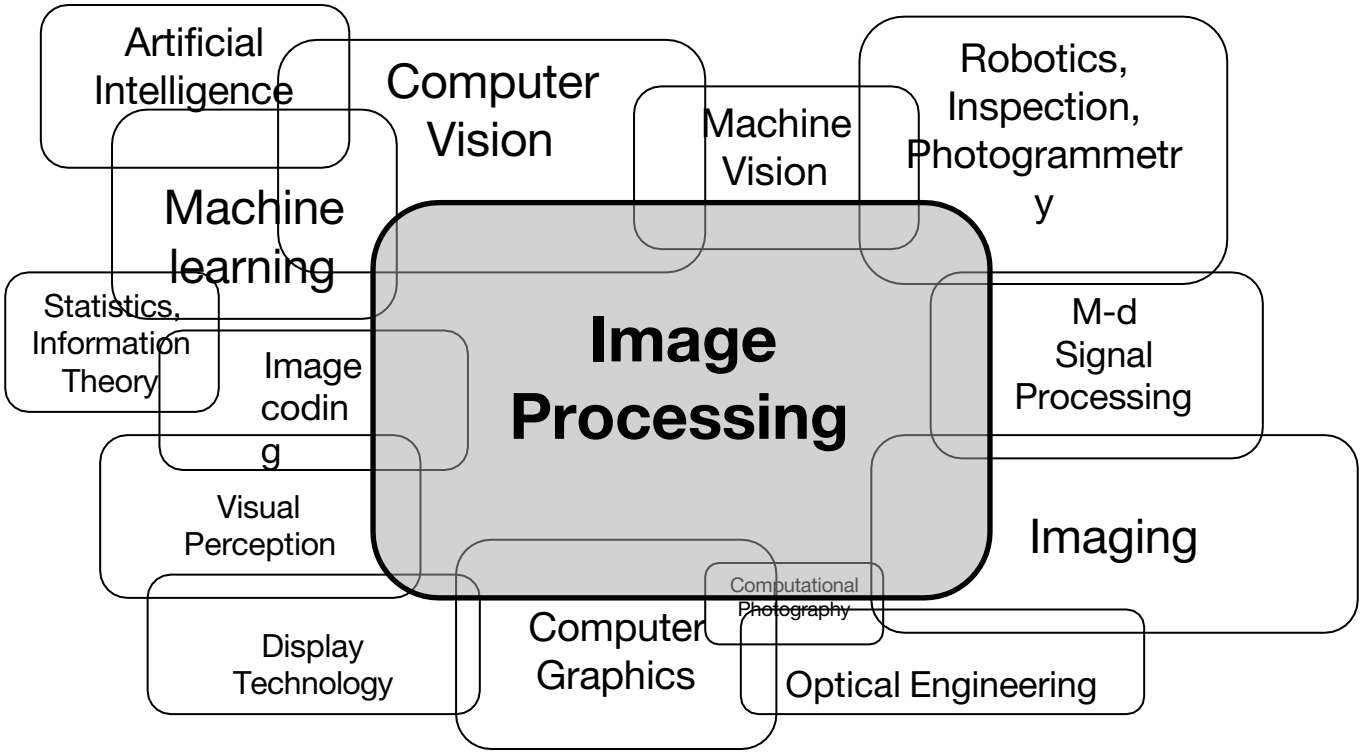
Original photos



Style examples

Elias Wang, Nicholas Tan, EE368, 2016/17

Image Processing and Related Fields



References

- Slides available as pdf files on the class website (click on
- .... for source code and data)
  http://www.stanford.edu/class/ee368/handouts.html
- 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)