Intro to Computer Vision

Yoni Chechik

Computer Vision course

contents

- **Course details**
- What is computer vision (CV)?
- Course outline
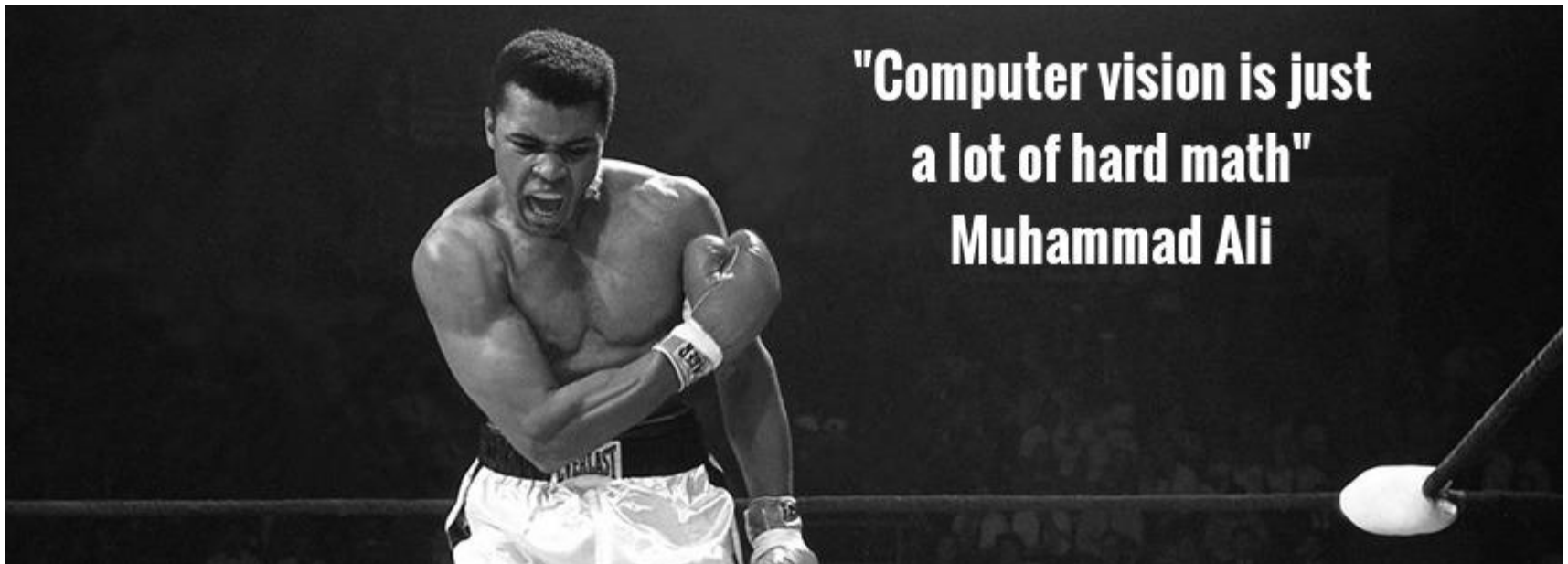- Intro to Python

References

- Lectures Based on the book: **Computer Vision: Algorithms and Applications**, 2010, Richard Szeliski (http://szeliski.org/Book/)

Course objectives

- The student will know and understand key algorithms in computer vision.

- The student will be familiar with the algorithmic R&D process, with an emphasis on understanding the advantages and disadvantages of various algorithms and building an algorithmic system that concentrates on computer vision and image processing.

- The student will be able to solve algorithmic problems with computer vision both at theoretical and practical level (in Python using NumPy, Matplotlib, OpenCV & TensorFlow packages).

Prerequisites

- No prior knowledge in signal/image processing is assumed.

- Heavy use in algebra and calculus- mathematical maturity **is assumed.**

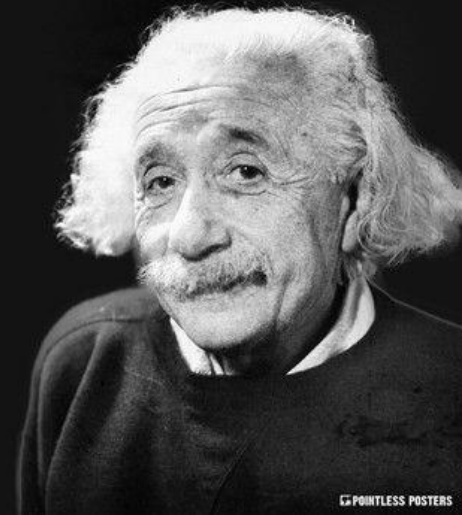"Computer vision is just a lot of hard math"
Muhammad Ali

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Don't believe everything you read on the internet just because there's a picture with a quote next to it.
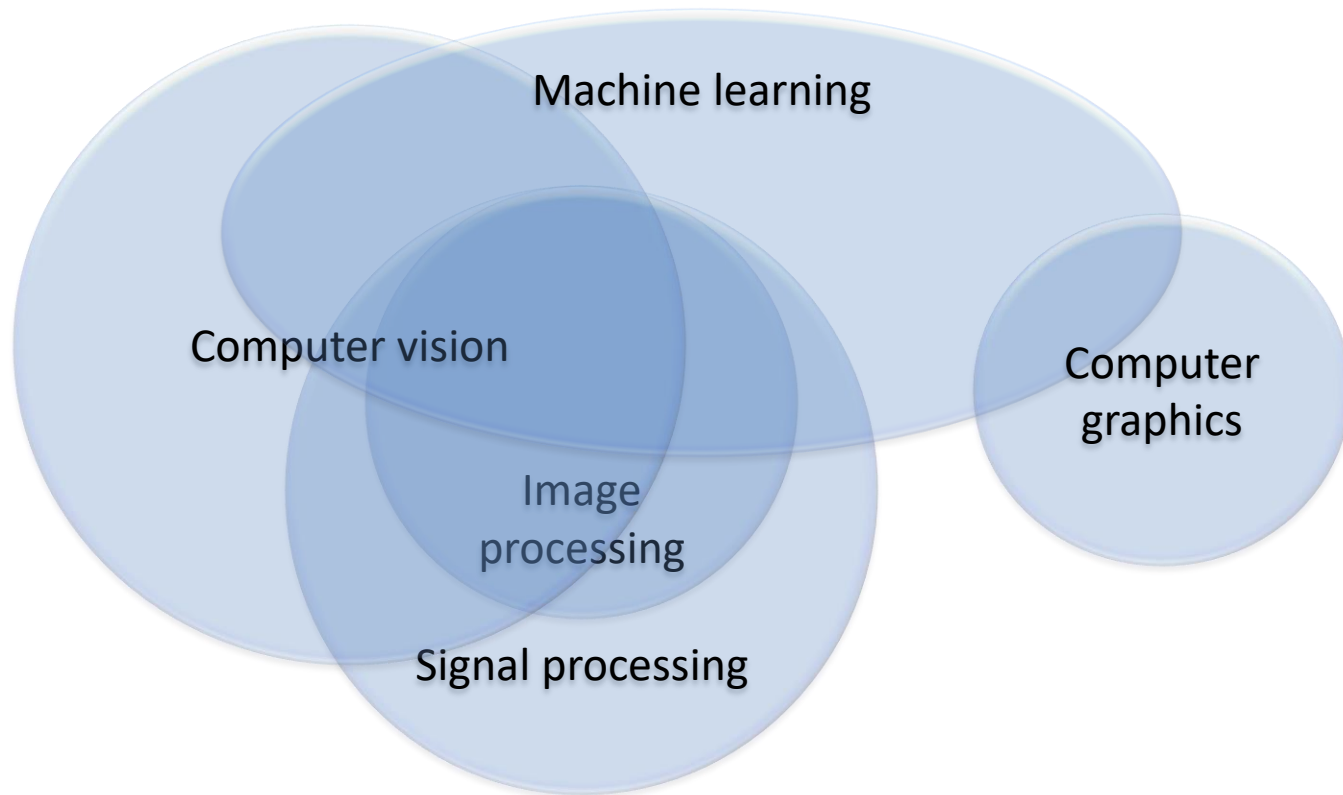
ALBERT EINSTEIN

What is CV?

- **Computer vision** is an interdisciplinary scientific field that deals with how computers can be made to gain high-level understanding from digital images or videos. [Wikipedia]

- **Image processing** is an umbrella term for many functions that analyze images or convert one representation of an image into another.

What is CV?

Output Input	Data	Image
Data	Signal processing	Computer graphics
Image	Computer vision	Image processing

Machine learning

Computer vision

Computer graphics

Image processing

Signal processing

Why CV?

Top Public Company Acquirors

Company	Embedded Vision/Computer Vision M&A			
Alphabet	October – 2012 $45.0M	DNNresearch March – 2013 NA	Moodstocks July – 2016 NA	Undecidable! October – 2016 NA
Apple	PrimeSense November – 2013 $360.0M	flyby January – 2016 NA	EMOTIENT January – 2016 NA	REALFACE February – 2017 NA
COGNEX	DVT Vision Sensors May – 2005 $115.0M	AssistWare TECHNOLOGY July – 2008 $3.0M	AQsense enhancing 3D August– 2016 $2.4M	Chiaro Technologies November – 2016 $4.7M
(intel)	olaworks April – 2012 $31.0M	May – 2016 NA	Movidius September – 2016 $392.1M	MOBILEYE September – 2017 $15,300.0M
QUALCOMM	kooaba January – 2014 NA	EUVISION technologies September – 2014 NA	SCYFER August – 2017 NA	

PrimeSense == Kinect

- *Kinect for Xbox 360:* 3D scanner system using **Light Coding** approach for 3D reconstruction.

- KinectFusion [Newcombe et al., 2011] :
  https://www.youtube.com/watch?v=KOUSSlKUJ-A

Why CV?

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embedded VISION SUMMIT 2018

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WOODSIDE CAPITAL PARTNERS WCP

Mobileye

- **Mobileye** is an Israeli subsidiary of Intel corporation that develops vision-based advanced driver-assistance systems (ADAS) providing warnings for collision prevention and mitigation. [Wikipedia]

- https://www.youtube.com/watch?v=JDUb6CurYJM

- https://www.youtube.com/watch?v=fKXztwtXaGo (Tesla-cooler!)

Why CV?

More CV related topics

- Virtual/augmented reality

- navigation

- Gaming

- medicine

- And much more…

Segmentation Results
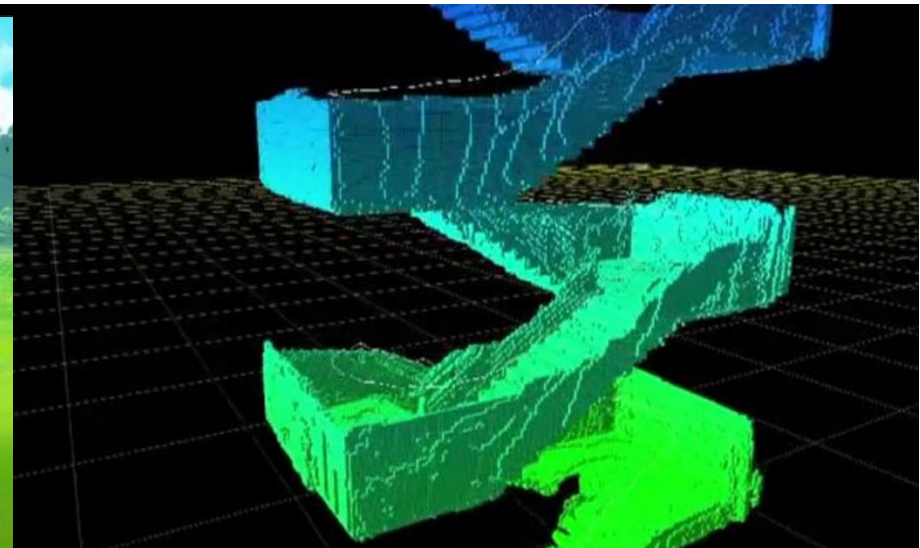
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Course outline

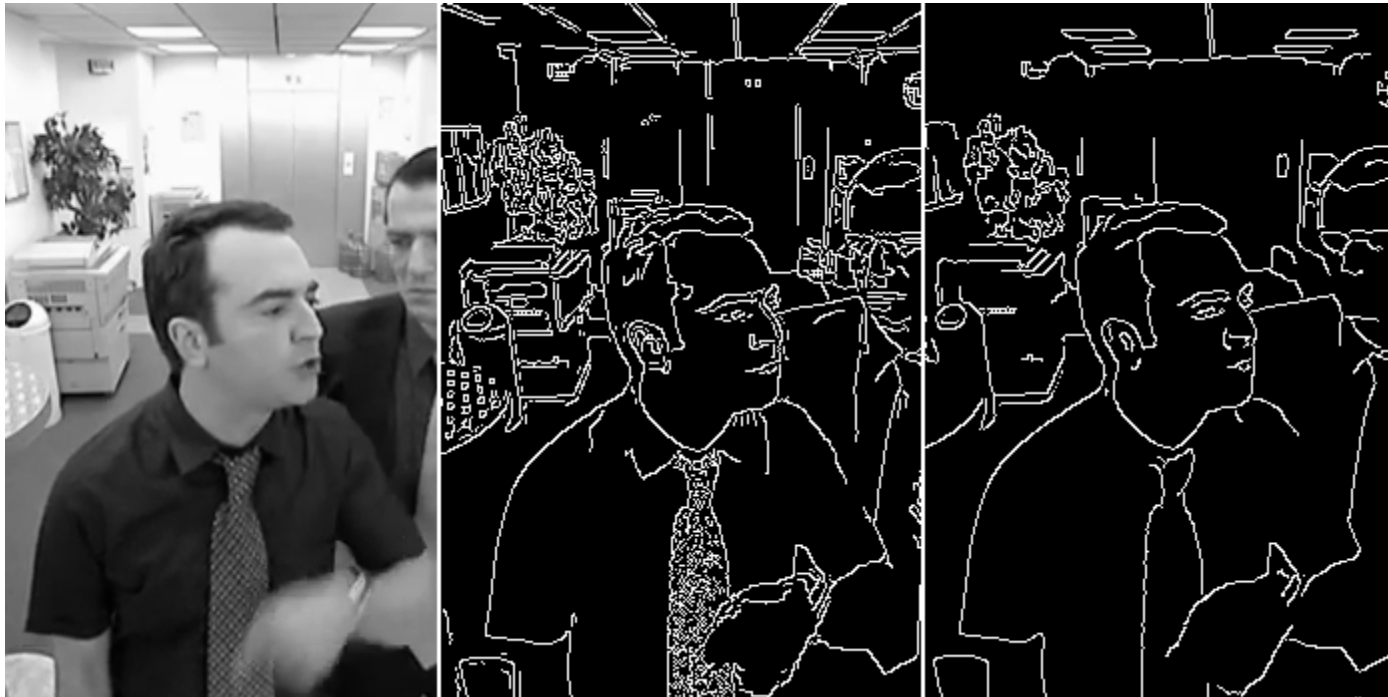| #	subject
1	**Introduction to CV + Python: NumPy, Matplotlib, OpenCV**
2	**Image processing recap: convolutions, LPF, HPF, morphology, connected components, gamma correction, decimation, interpolation.**
3	**Edge detection: gradient (roberts, prewitt, sobel), Laplacian, DoG (derivative of Gaussian), canny edge detector.**
4	**Curve fitting: least squares, total least squares, RANSAC, Hough transform.**
5	**Image formation: BRDF, pinhole camera, digital camera**
6	**Geometric transformation: 2d->2d, 3d->3d, 3d->2d (perspective and homographic projection)**
7	**Camera calibration: extrinsic, intrinsic, radial distortion.**
8	**Stereo vision: dual camera rectification, triangulation.**
9	**Features: feature detection, feature description, matching, SIFT, panoramas.**
10	**Stereo: SfM, Epipolar geometry, rectification, triangulation, matching.**
11	**Neural networks 1: intro, perceptron, dense layers, MNIST.**
12	**Neural Networks 2: CNN, back-propagation, tensorflow.**

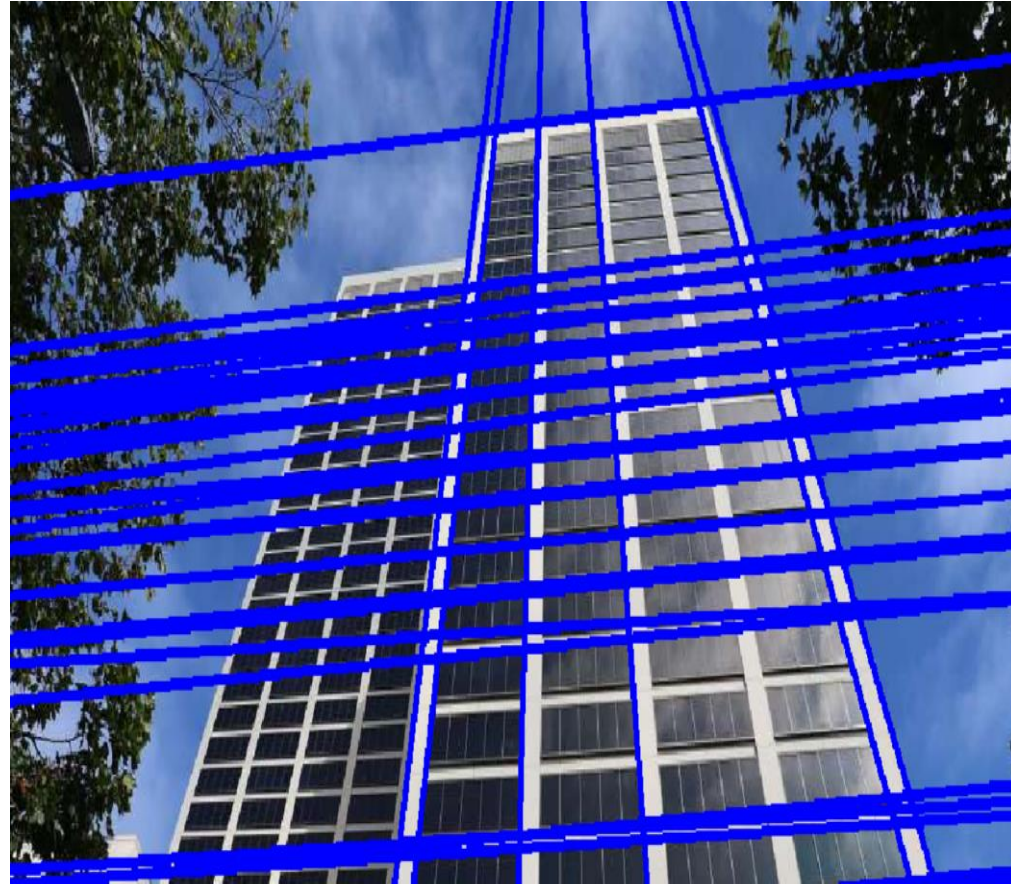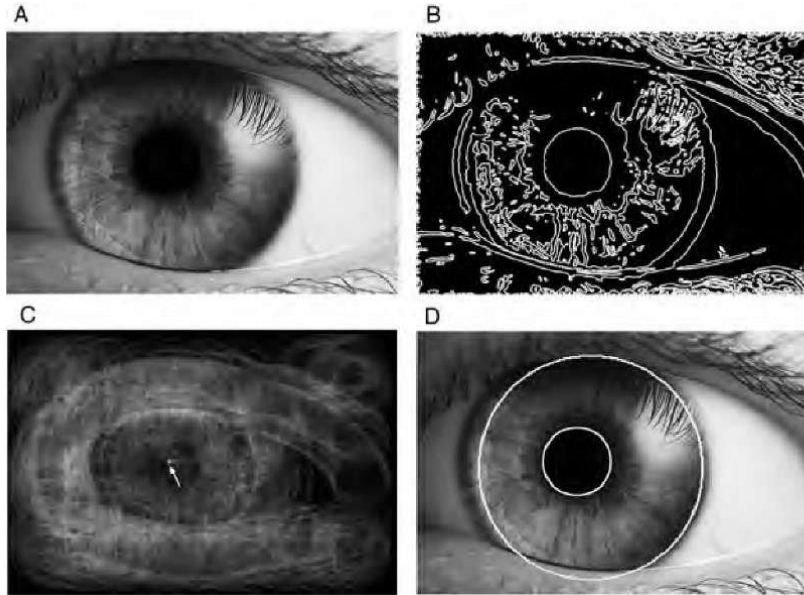# Image processing

- Read more about Lenna – the standard test image:
  https://en.wikipedia.org/wiki/Lenna

Edge Detection

- https://www.youtube.com/watch?v=hQ-bpfdWQh8
- https://pinetools.com/image-edge-detection

Curve fitting & Hough transform

Digital cameras

- Image formation:
  https://www.youtube.com/watch?v=dY0K65eXhkA

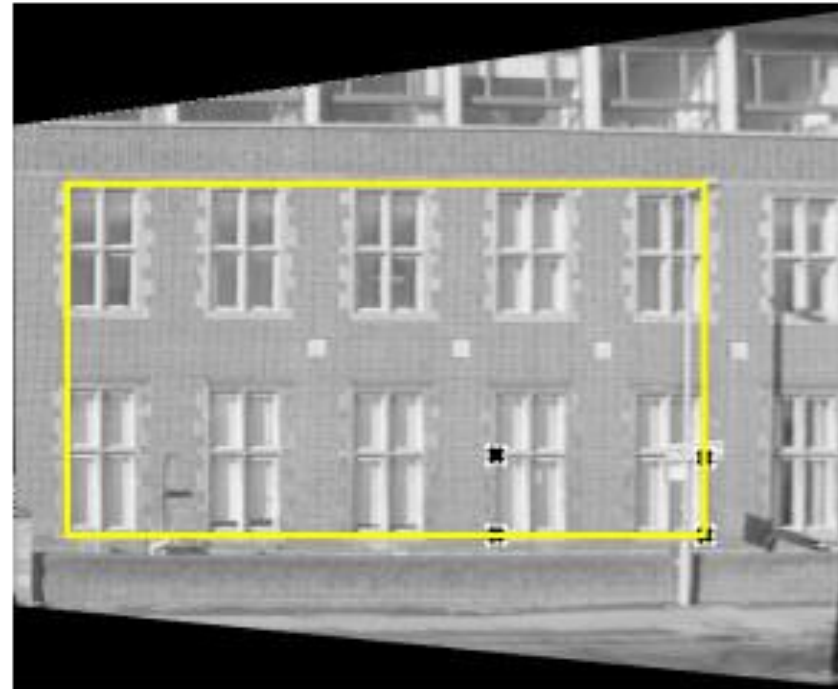- 2D & 3D transformation.

from Hartley & Zisserman

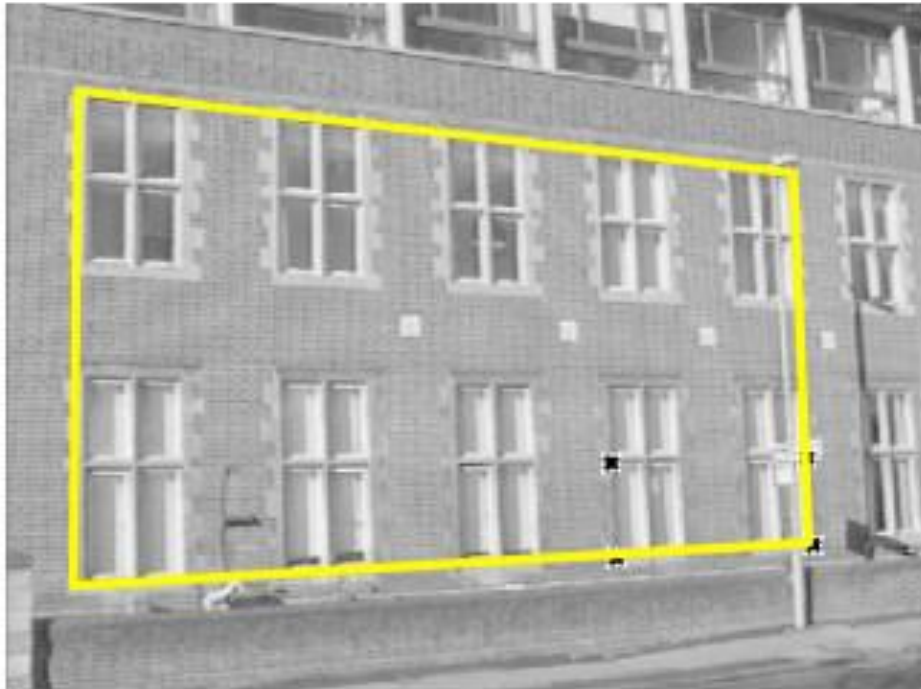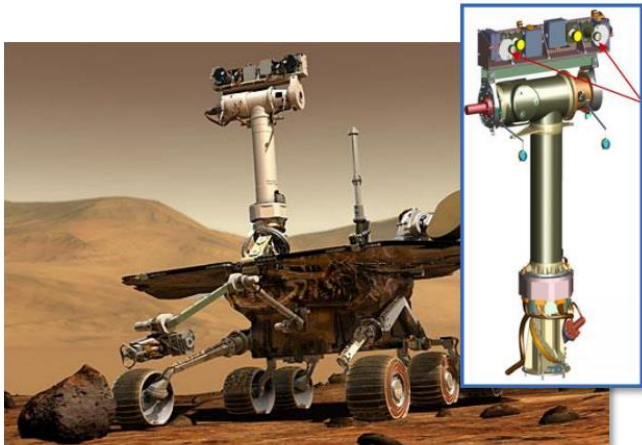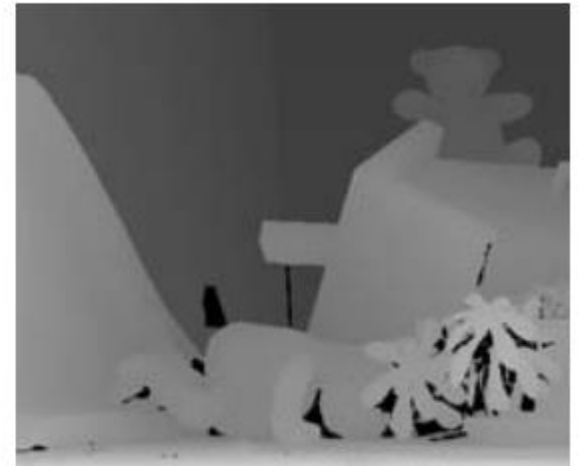# Image calibration

- Fisheye correction from go-pro for example

Stereo & 3d cameras

-

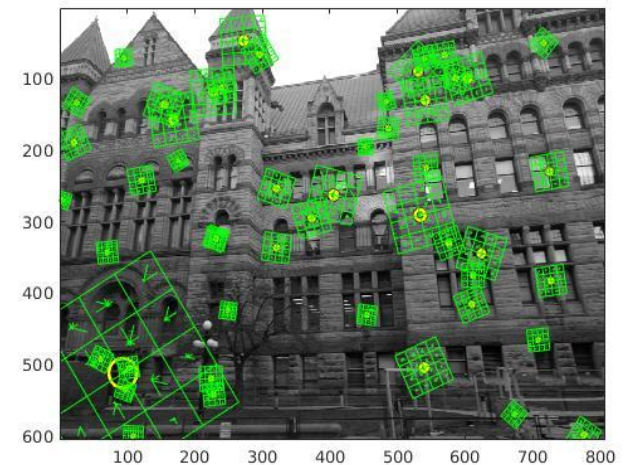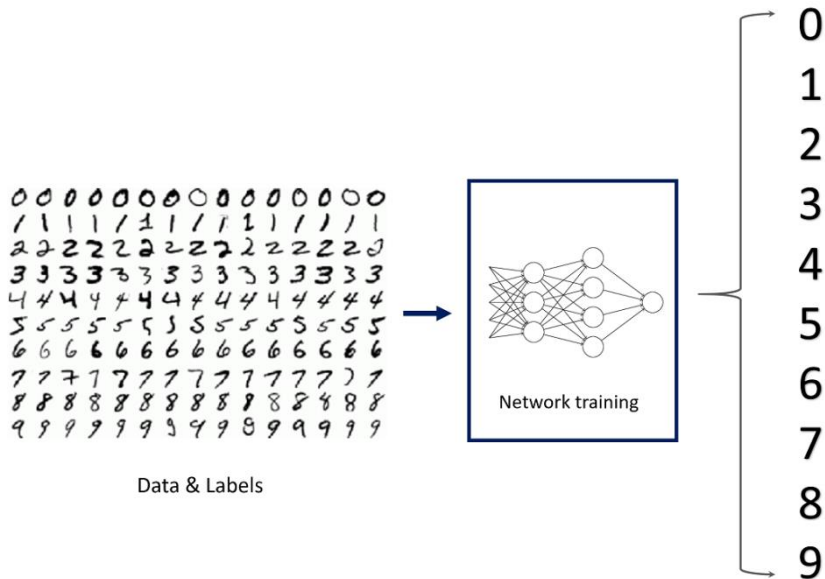(a)   (b)

Features

- Extract interesting points from image for later recognition, stitching, learning and more.
- http://www.in2white.com/

Neural networks

- https://deepdreamgenerator.com/generator
- https://quickdraw.withgoogle.com

Dream generator- style transfer

Dream generator- style transfer

And some more AI stuff

- Deep fake
  - https://www.youtube.com/watch?v=cQ54GDm1eL0
  - https://www.youtube.com/watch?v=-QvIX3cY4lc
- Nvidia GauGAN
  - https://www.youtube.com/watch?v=p5U4NgVGAwg
  - http://nvidia-research-mingyuliu.com/gaugan

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