Intro to Computer Vision

Yoni Chechik

www.AlisMath.com

contents

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

References

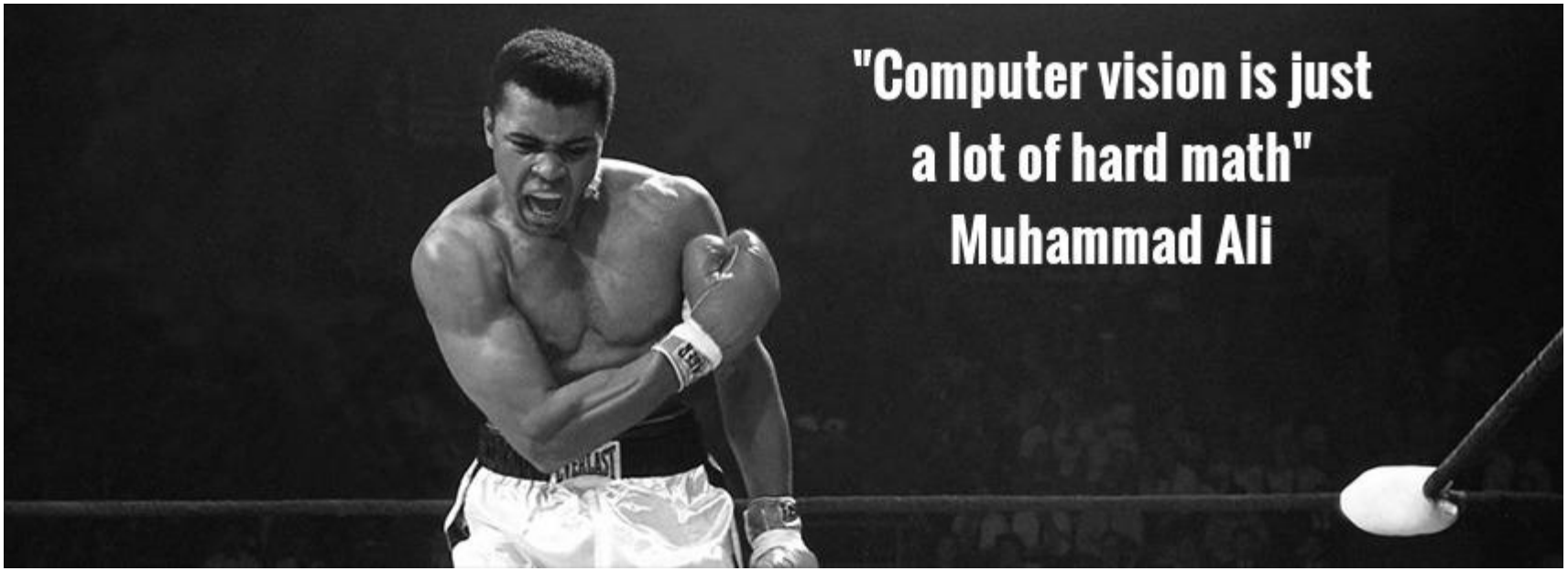
- Lectures Based on the book: **Computer Vision: Algorithms and Applications**, 2010, Richard Szeliski (http://szeliski.org/Book/)

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).

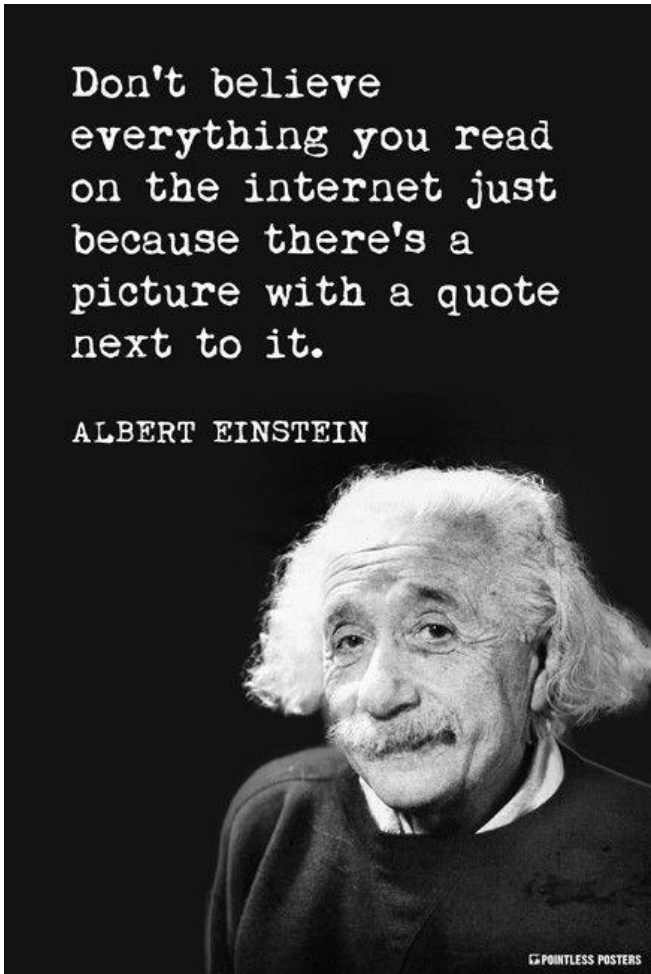
Prerequisites

- No prior knowledge in signal/image processing is assumed.
- Heavy use in algebra and calculus- mathematical maturity **is assumed.**



contents

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

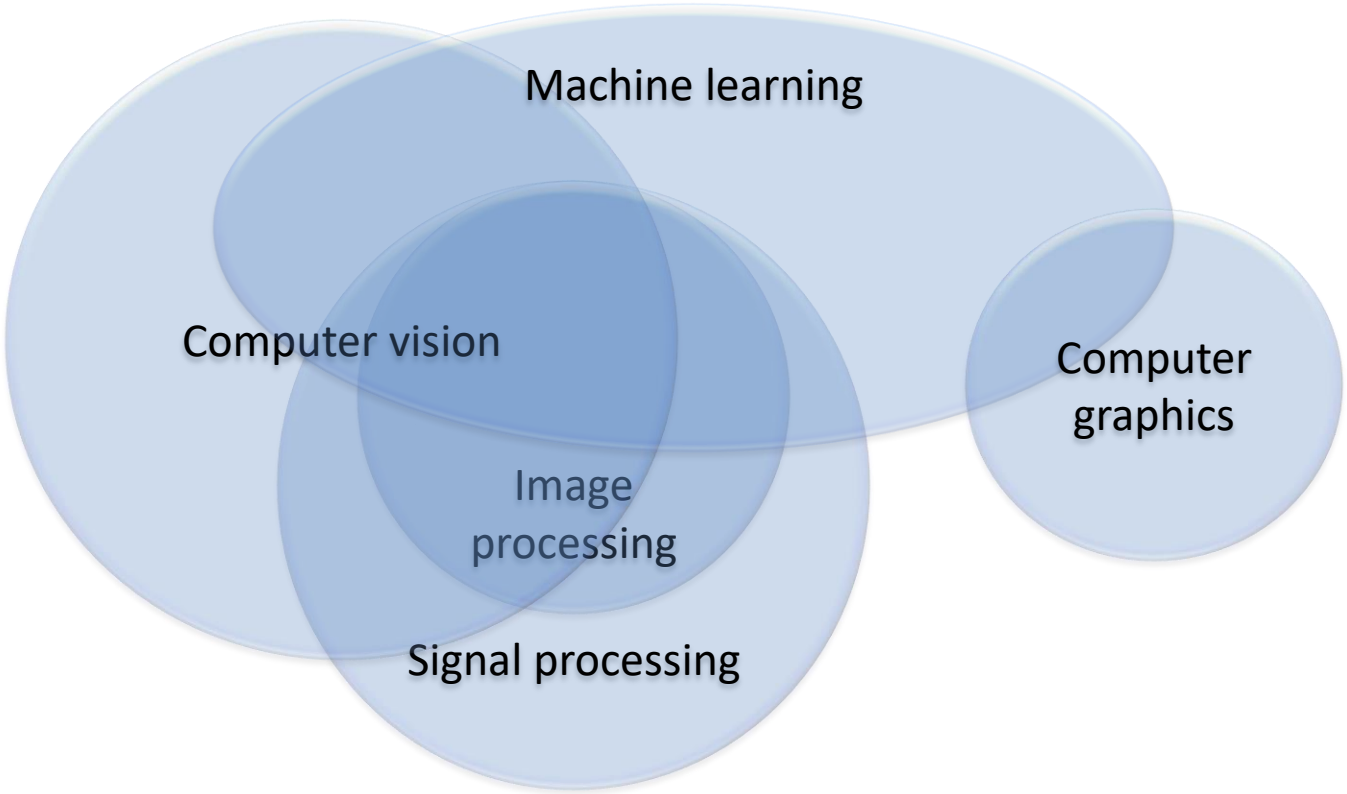


What is CV?

- **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?

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



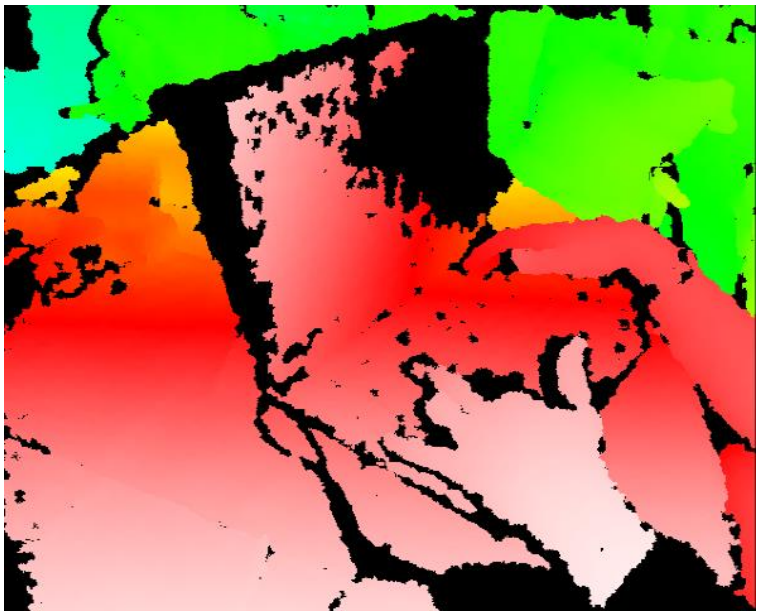
Why CV?

Top Public Company Acquirors

Company	Embedded Vision/Computer Vision M&A			
Alphabet	October – 2012 $45.0M	March – 2013 NA	July – 2016 NA	Undecidable! October – 2016 NA
	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



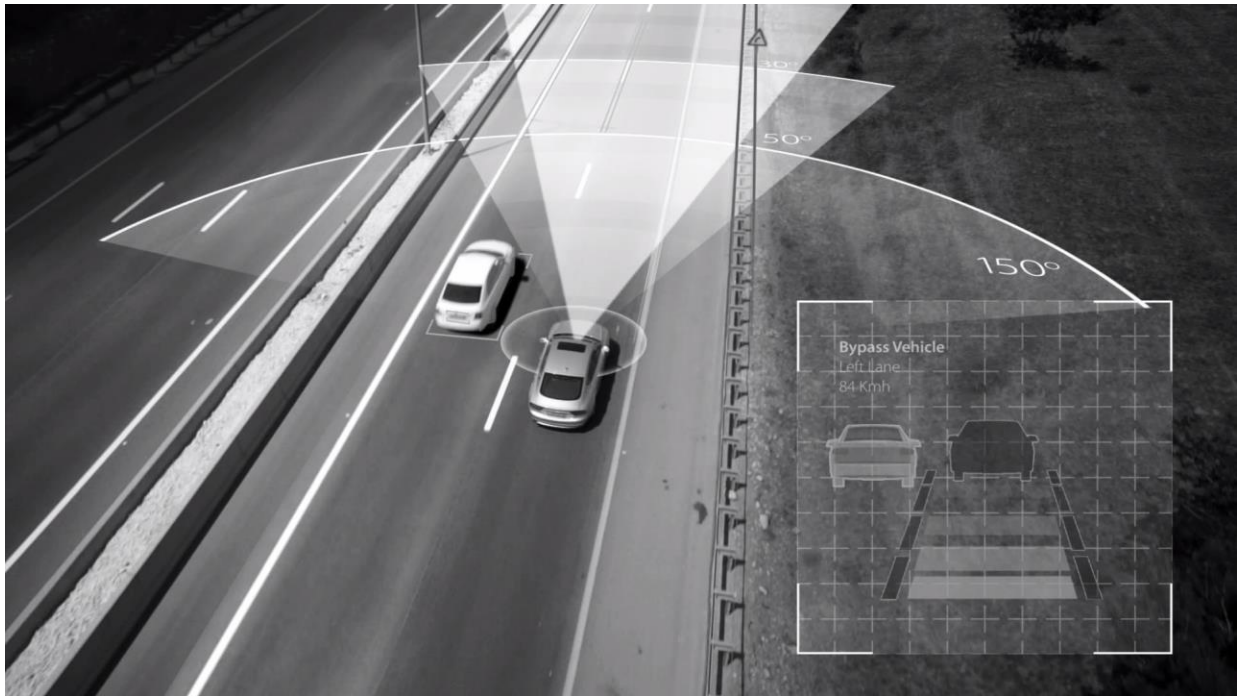
Why CV?

Top Public Company Acquirors

Company	Embedded Vision/Computer Vision M&A			
Alphabet	October – 2012 $45.0M	March – 2013 NA	July – 2016 NA	Undecidable! October – 2016 NA
	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	

Mobileye

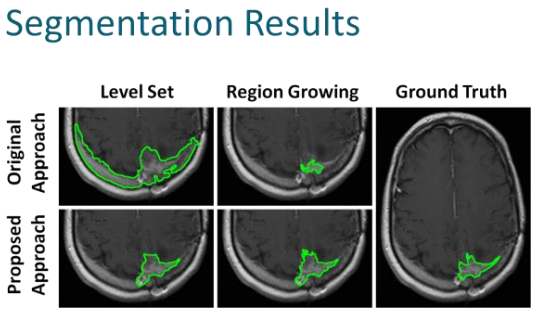
- **Mobileye** is an Israeli subsidiary of Intel corporation that develops vision-based advanced driver-assistance systems (ADAS) providing warnings for collision prevention and mitigation. [Wikipedia]
- https://www.youtube.com/watch?v=JDUb6CurYJM
- https://www.youtube.com/watch?v=fKXztwtXaGo (Tesla-cooler!)

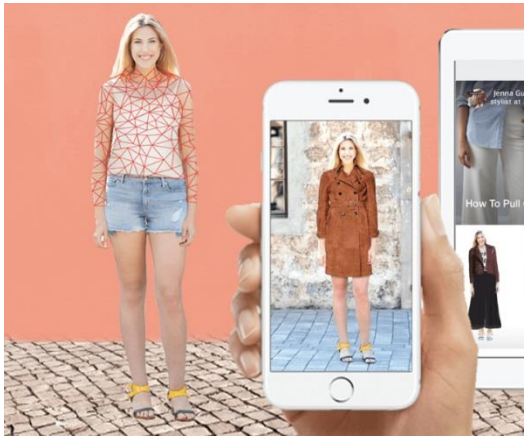


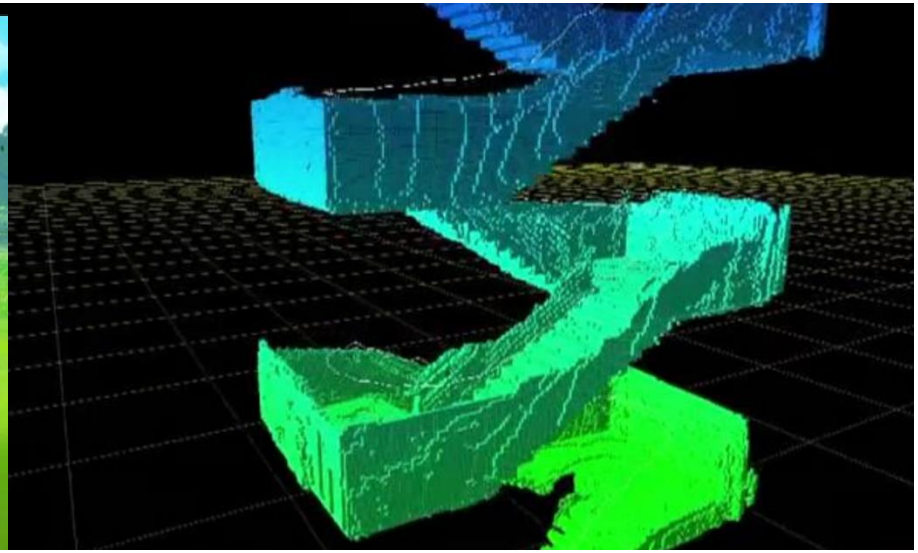
Why CV?

More CV related topics

- Virtual/augmented reality
- navigation
- Gaming
- medicine
- And much more…







contents

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

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.

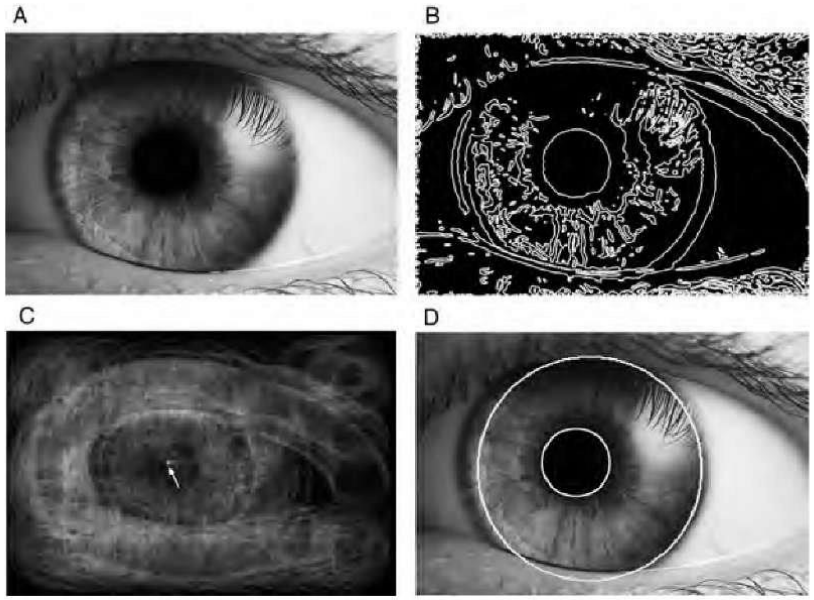
Image processing

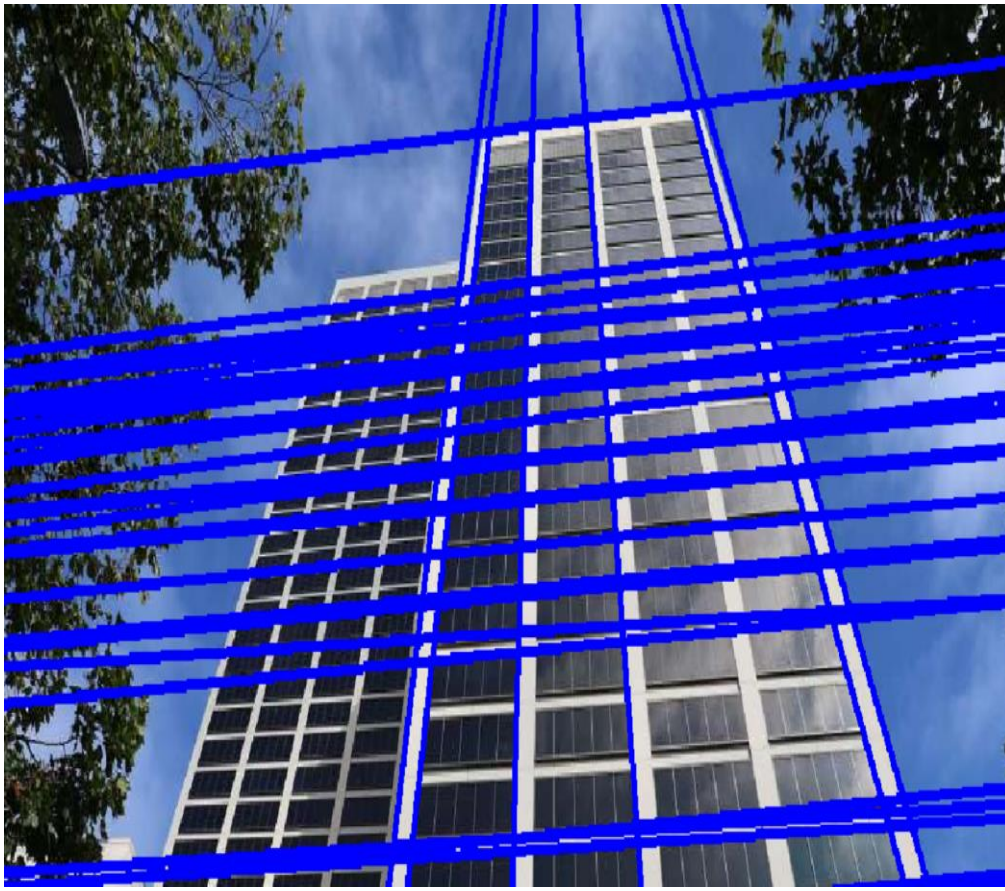
- Read more about Lenna – the standard test image: https://en.wikipedia.org/wiki/Lenna

Edge Detection

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

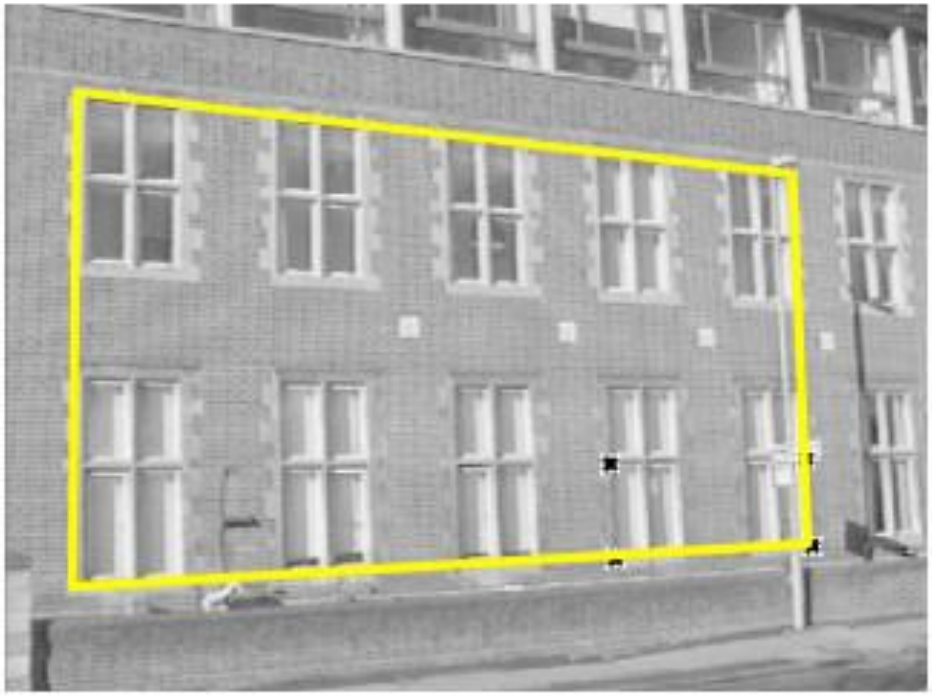
Curve fitting & Hough transform

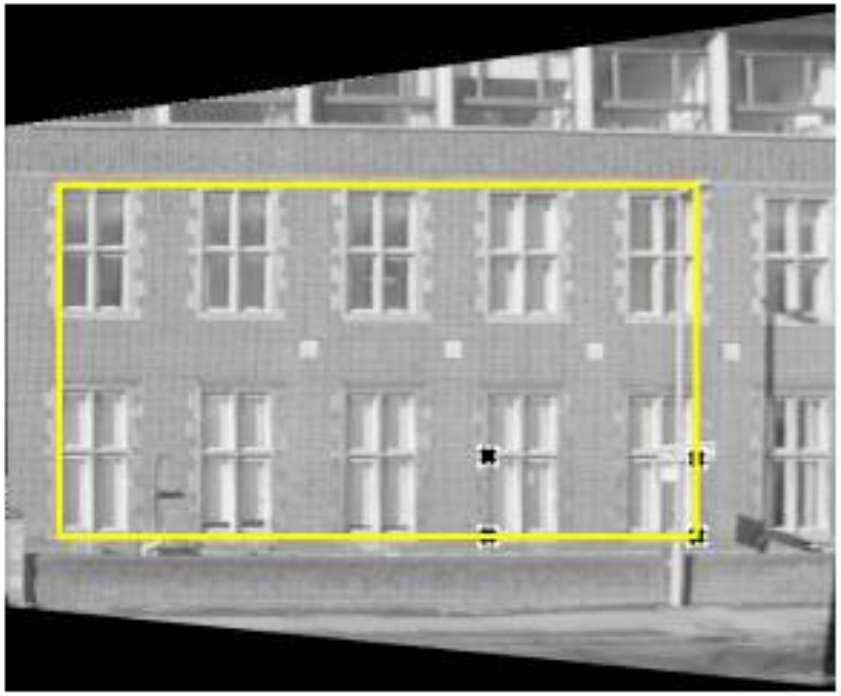




Digital cameras

- Image formation: https://www.youtube.com/watch?v=dY0K65eXhkA
- 2D & 3D transformation.





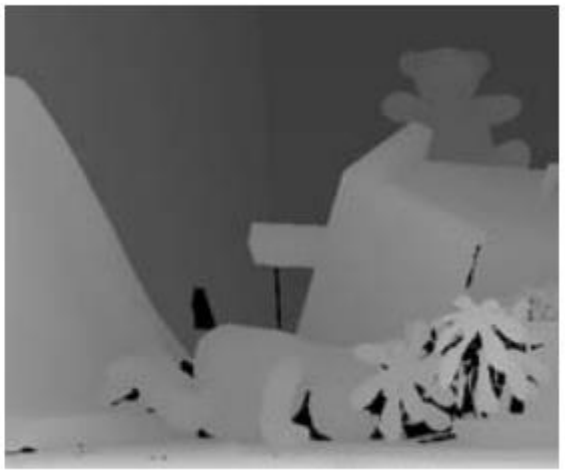
from Hartley & Zisserman

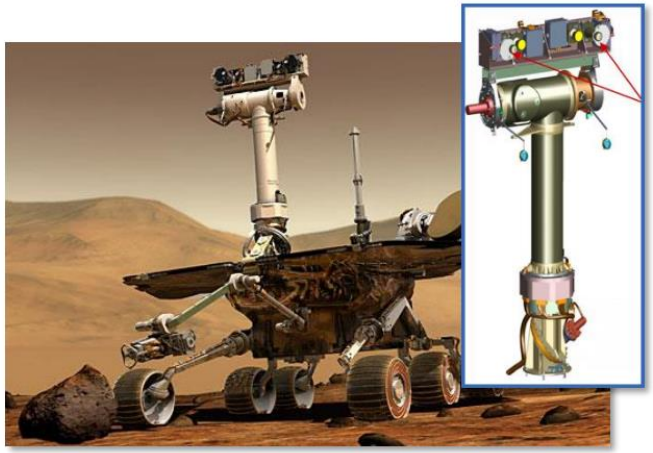
Image calibration

- Fisheye correction from go-pro for example

Stereo & 3d cameras

- https://www.youtube.com/watch?v=PySBQ8Q_R8k



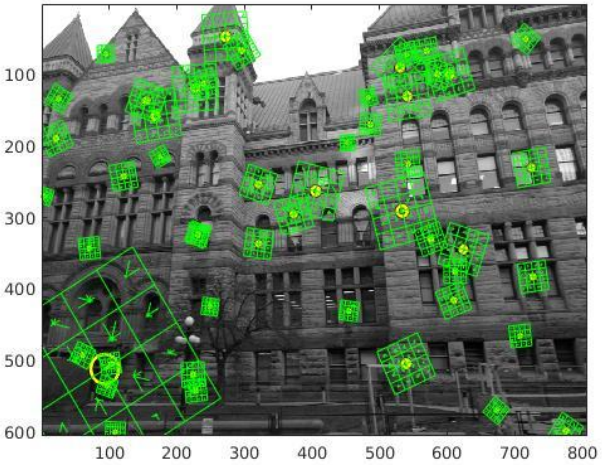


(a)

(b)

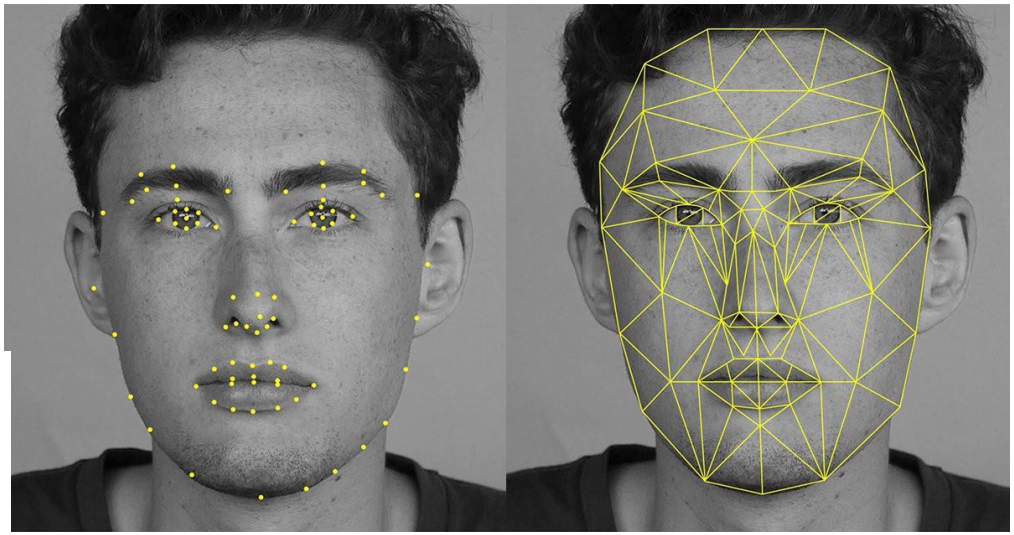
Features

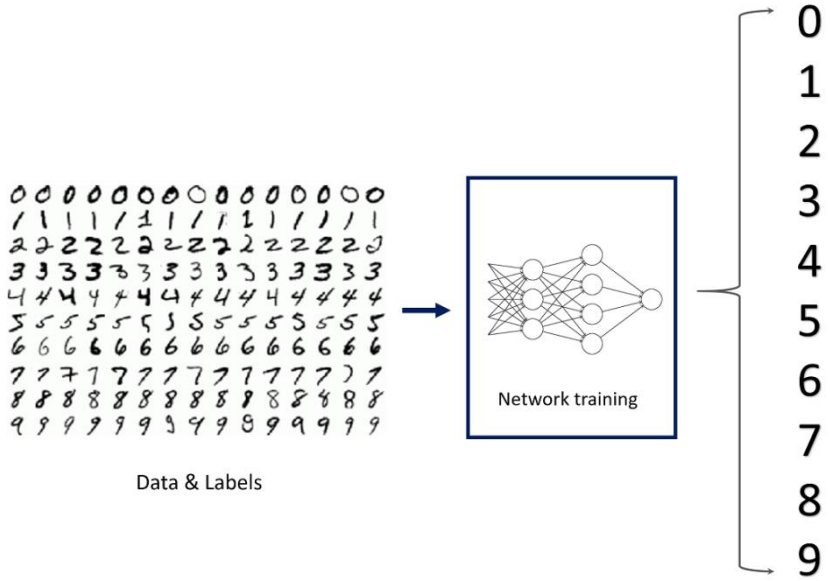
- Extract interesting points from image for later recognition, stitching, learning and more.
- http://www.in2white.com/



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

contents

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