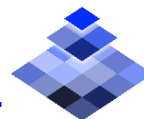


Intro to Computer Vision



Yoni Chechik

www.AliMath.com



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

References

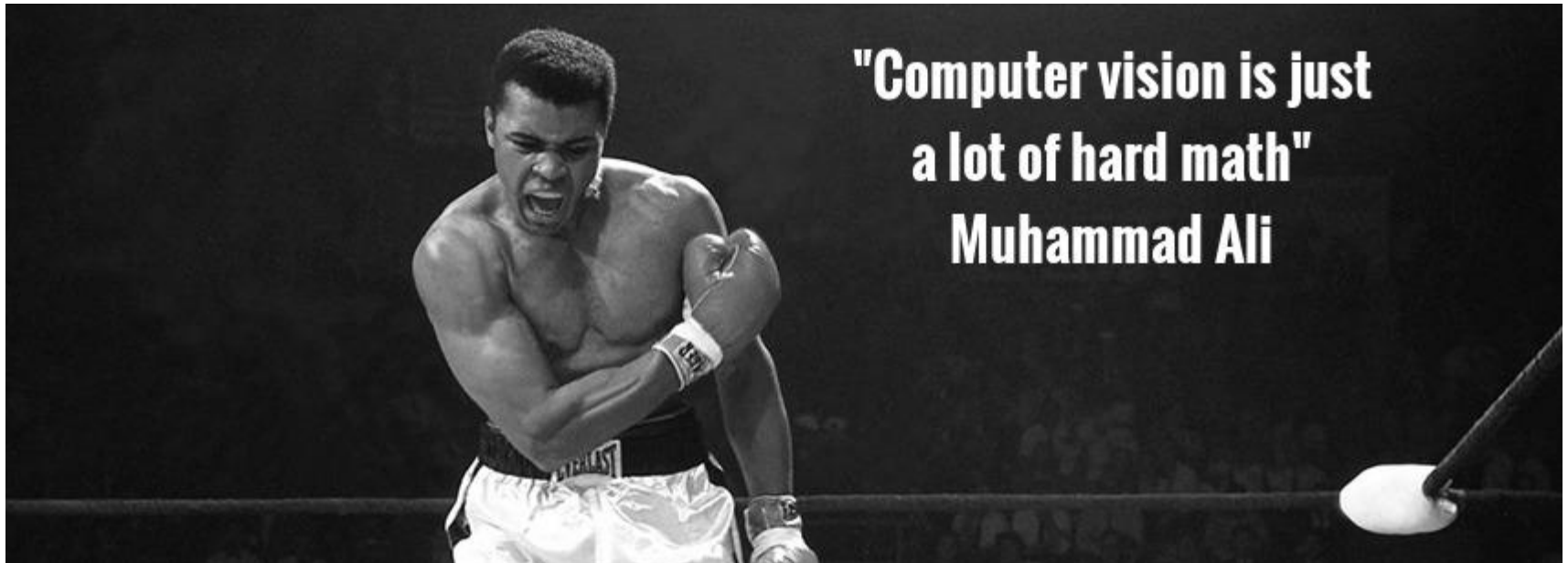
- Lectures Based on the book: **Computer Vision: Algorithms and Applications**, 2010, Richard Szeliski (<http://szeliski.org/Book/>)

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.**

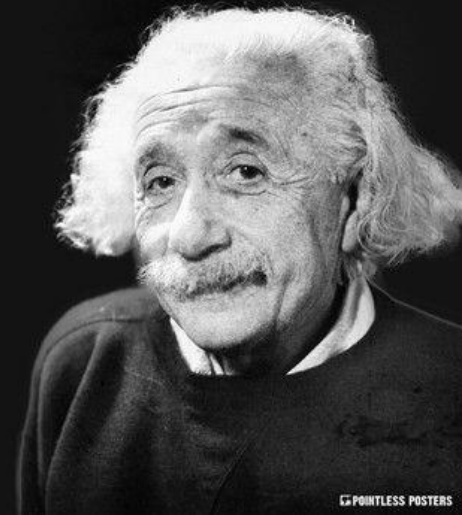


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- **What is computer vision (CV)?**
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Don't believe
everything you read
on the internet just
because there's a
picture with a quote
next to it.

ALBERT EINSTEIN

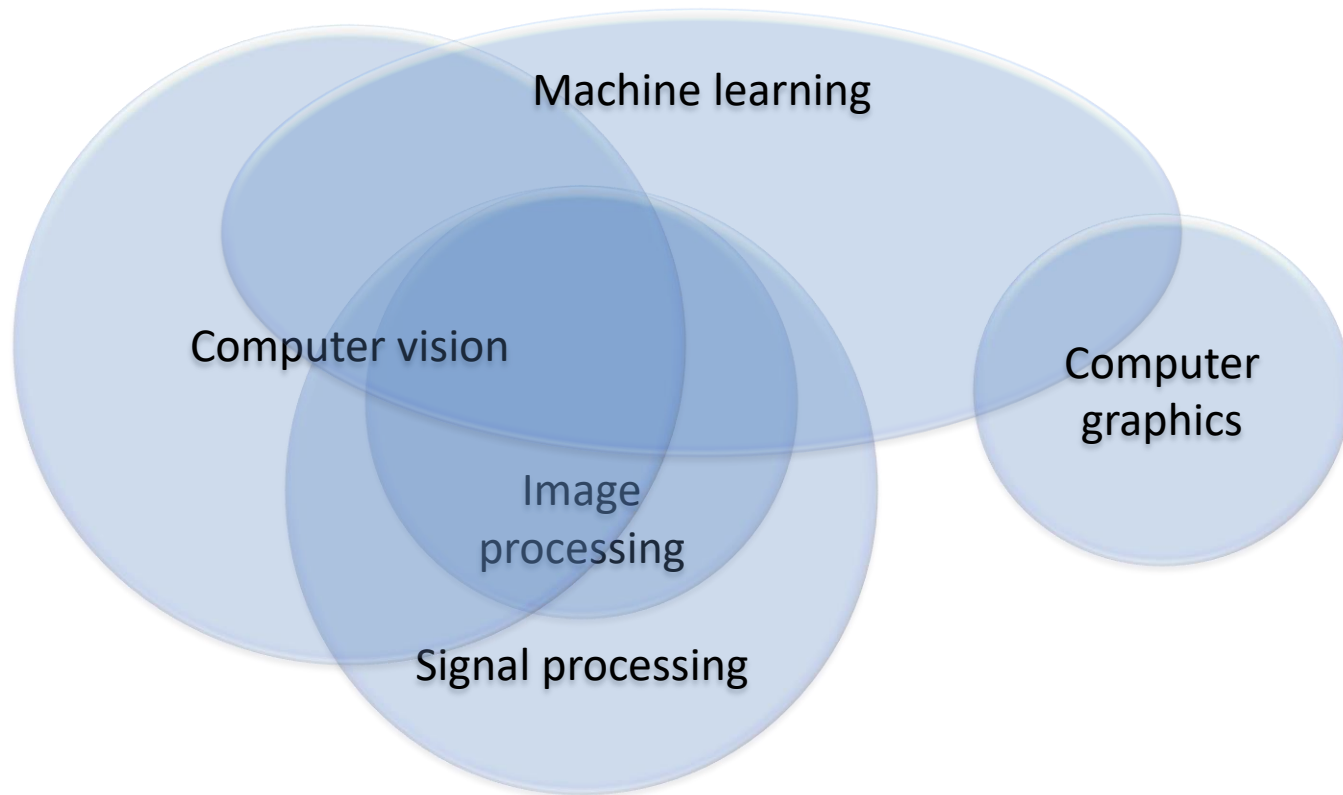


What is CV?

- **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?

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			
	 October – 2012 \$45.0M	 March – 2013 NA	 July – 2016 NA	 Undecidable! October – 2016 NA
	 November – 2013 \$360.0M	 January – 2016 NA	 January – 2016 NA	 REALFACE February – 2017 NA
	 May – 2005 \$115.0M	 July – 2008 \$3.0M	 August – 2016 \$2.4M	 November – 2016 \$4.7M
	 April – 2012 \$31.0M	 May – 2016 NA	 September – 2016 \$392.1M	 September – 2017 \$15,300.0M
	 January – 2014 NA	 September – 2014 NA	 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=KOUSSIKUJ-A>



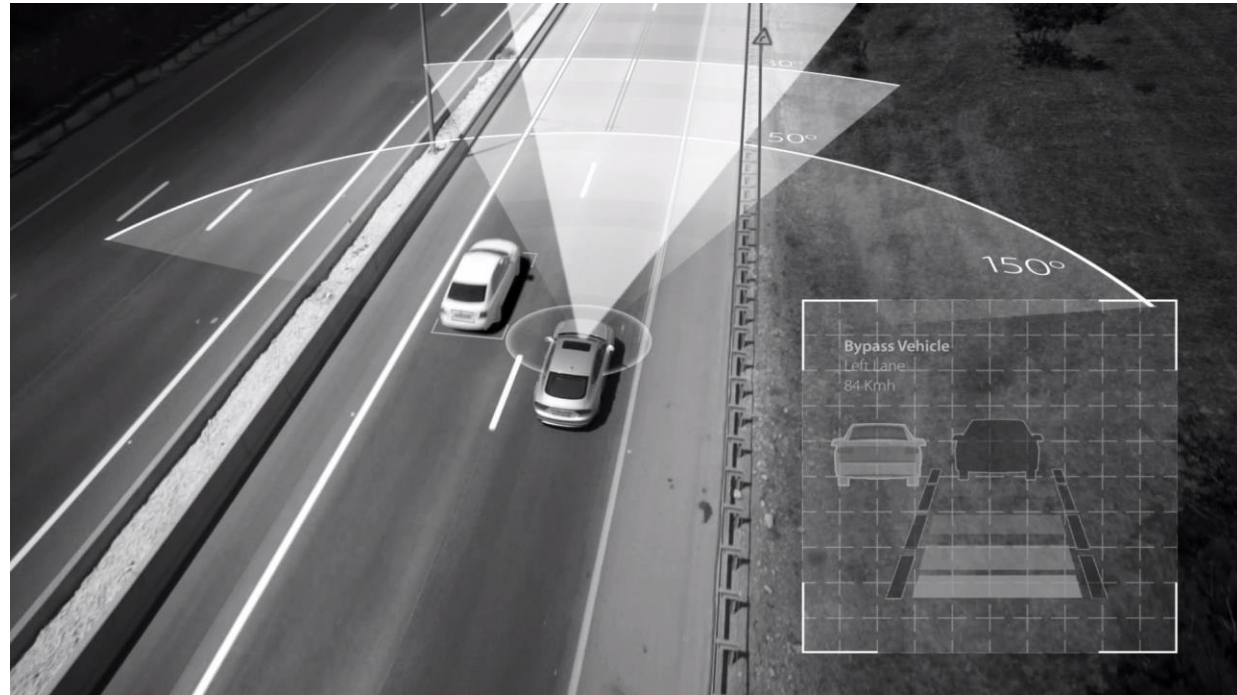
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	 January – 2014 NA	 September – 2014 NA	 August – 2017 NA	

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?

StartupHub.ai

ISRAEL'S COMPUTER VISION STARTUPS

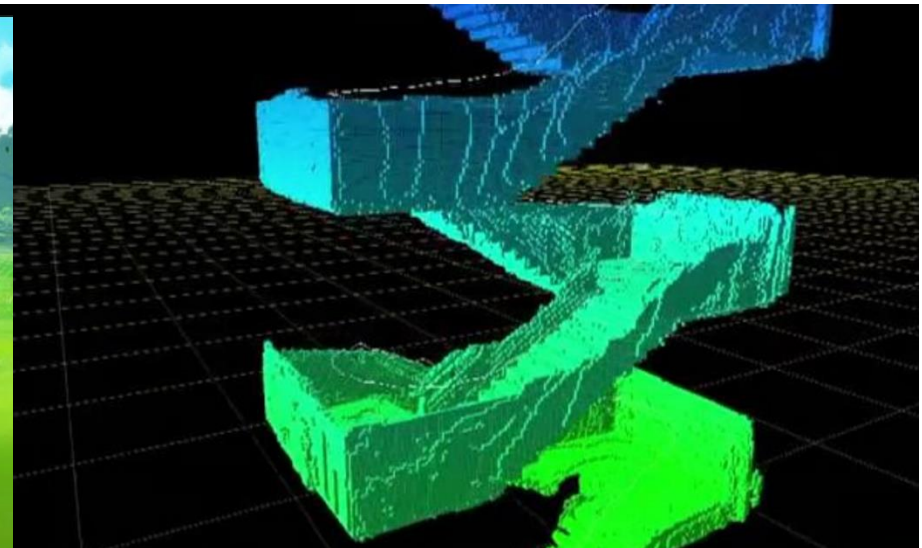


COMPUTER VISION TECHNOLOGY		HEALTHCARE	AUTOMOTIVE	AGRICULTURE	INDUSTRIAL	RETAIL	SECTORS
CHIPS	VIDEO INTELLIGENCE	MEDICAL IMAGING	AUTONOMOUS	CROP MANAGEMENT	ROBOTICS & UTILITIES	MONITORING & ANALYTICS	SMART CITY
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Blink							
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LYNXIGHT DEEP VISION CORAL DETECTION SYSTEMS							
EDUCATION, RAIL & TRAVEL							
RailVISION Anima SeeVoov							

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.

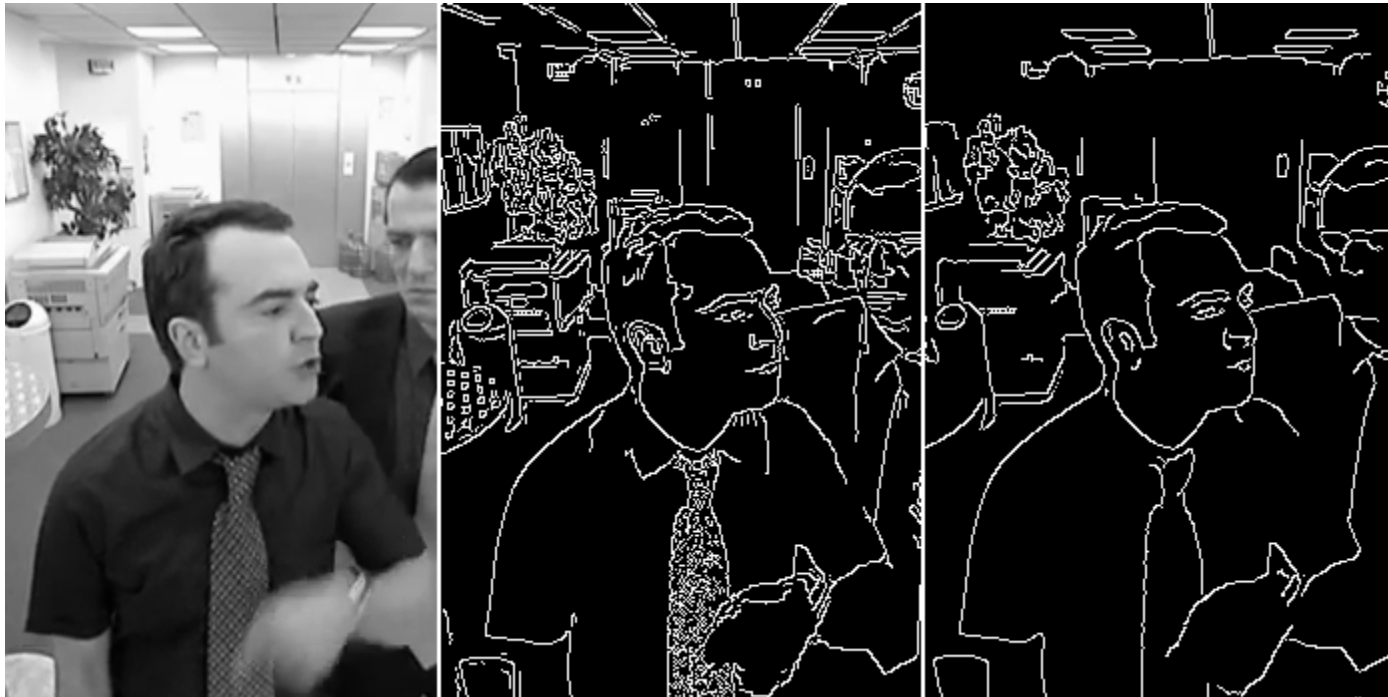
Image processing

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

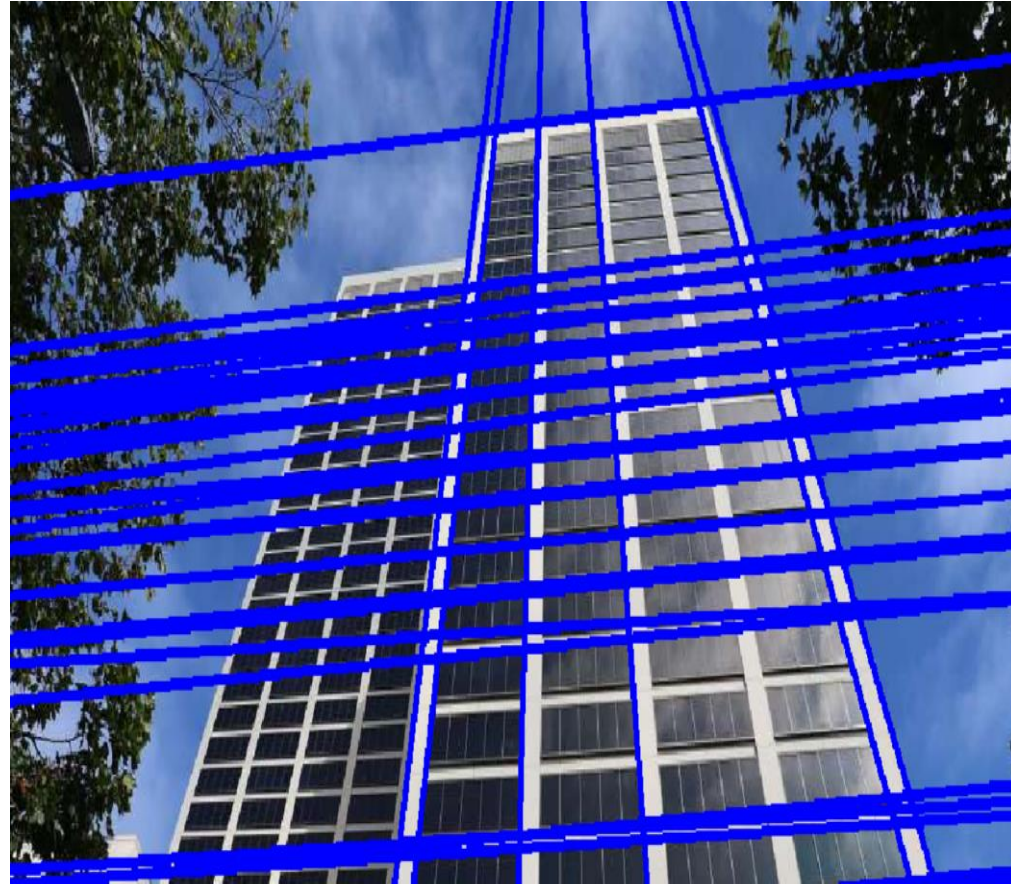
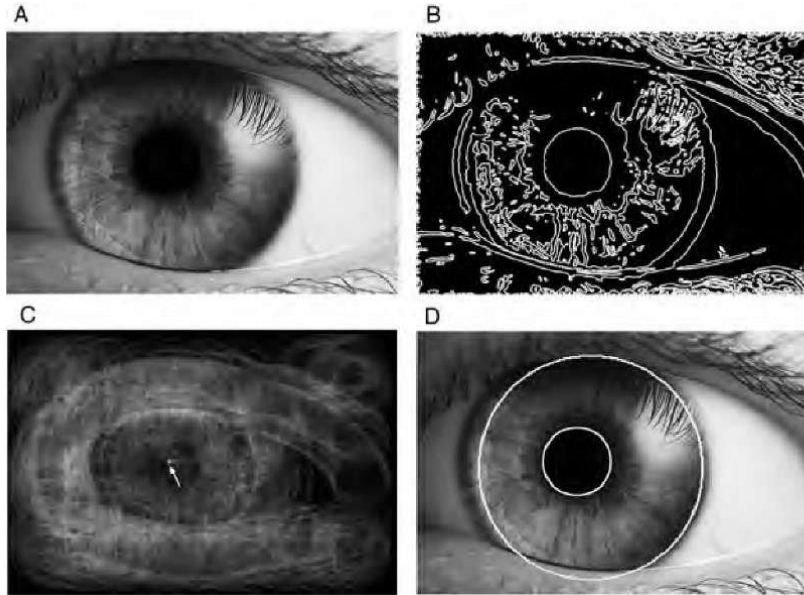


Edge Detection

- <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.



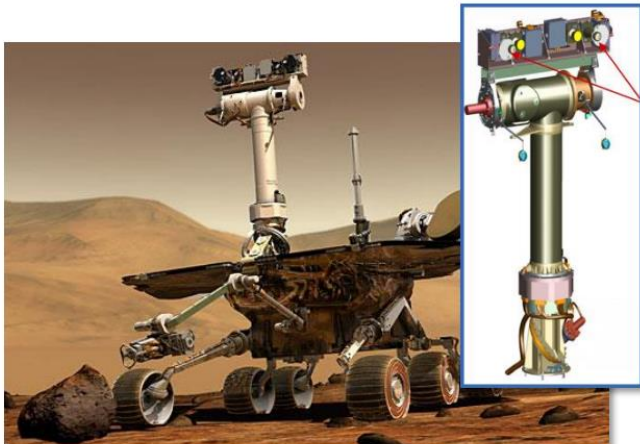
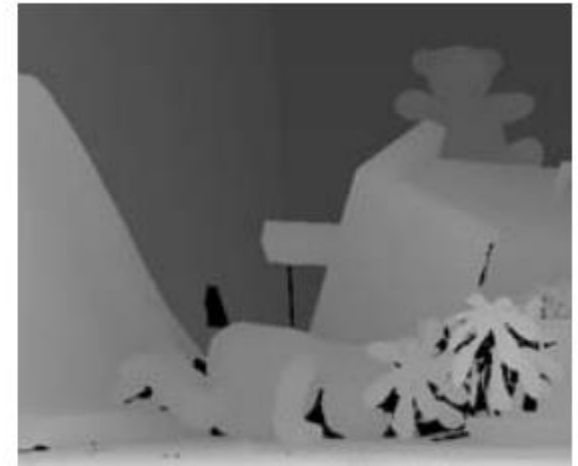
Image calibration

- Fisheye correction from go-pro for example



Stereo & 3d cameras

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



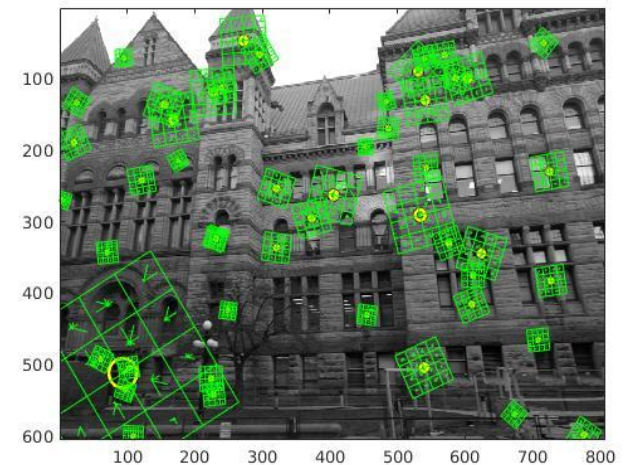
(a)



(b)

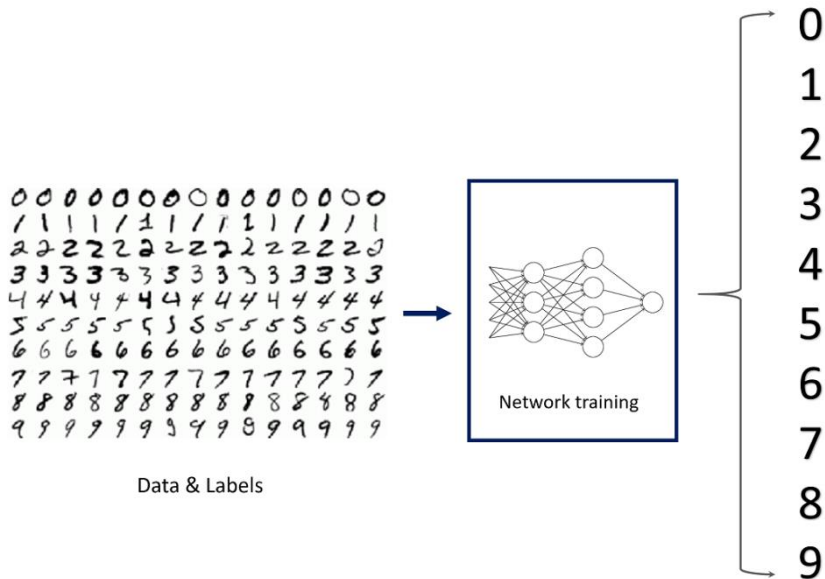
Features

- 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>

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