

Intro to Computer Vision



Yoni Chechik
Computer Vision course

contents

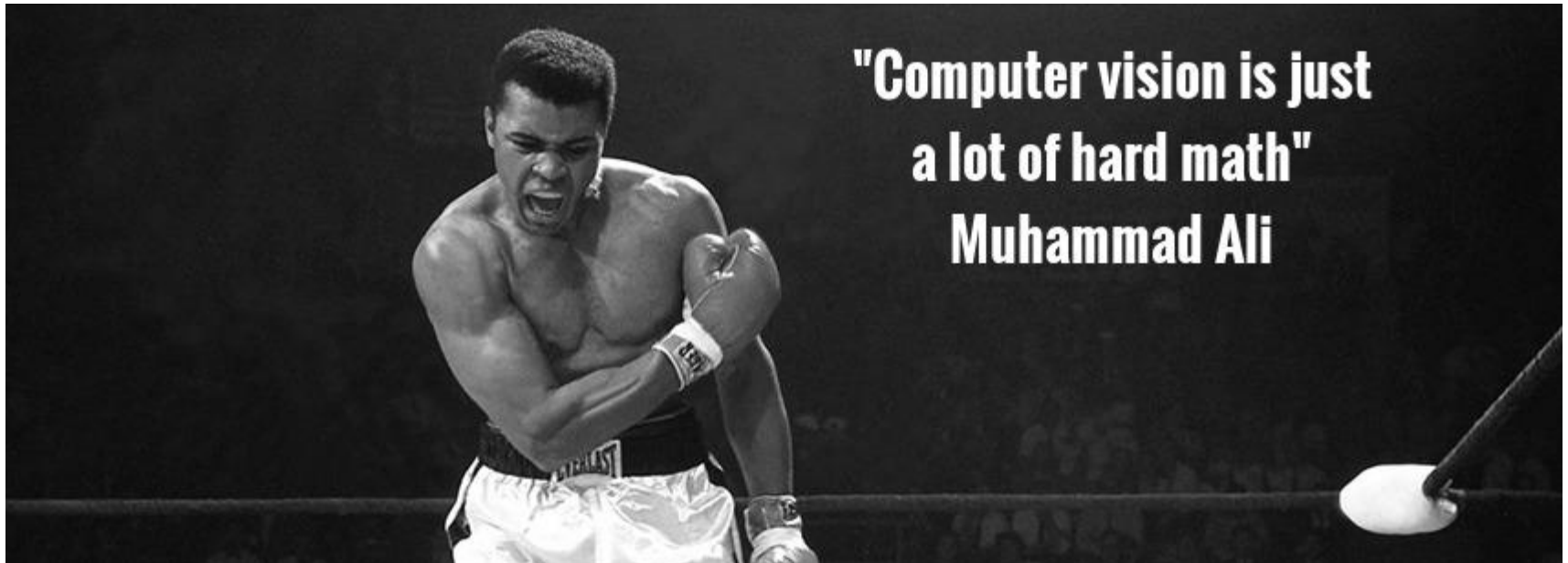
- **Course details**
- What is computer vision (CV)?
- Course outline
- Intro to Python

References

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

Prerequisites

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

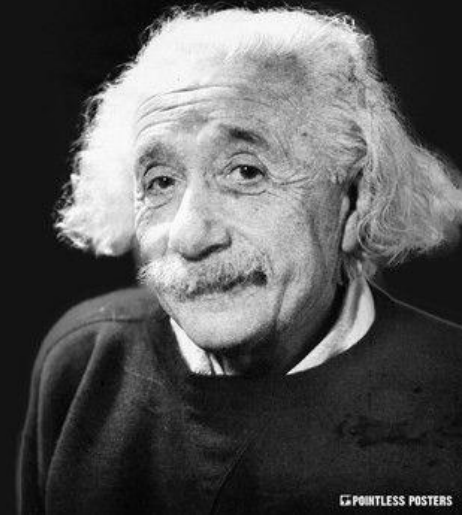


contents

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

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

ALBERT EINSTEIN

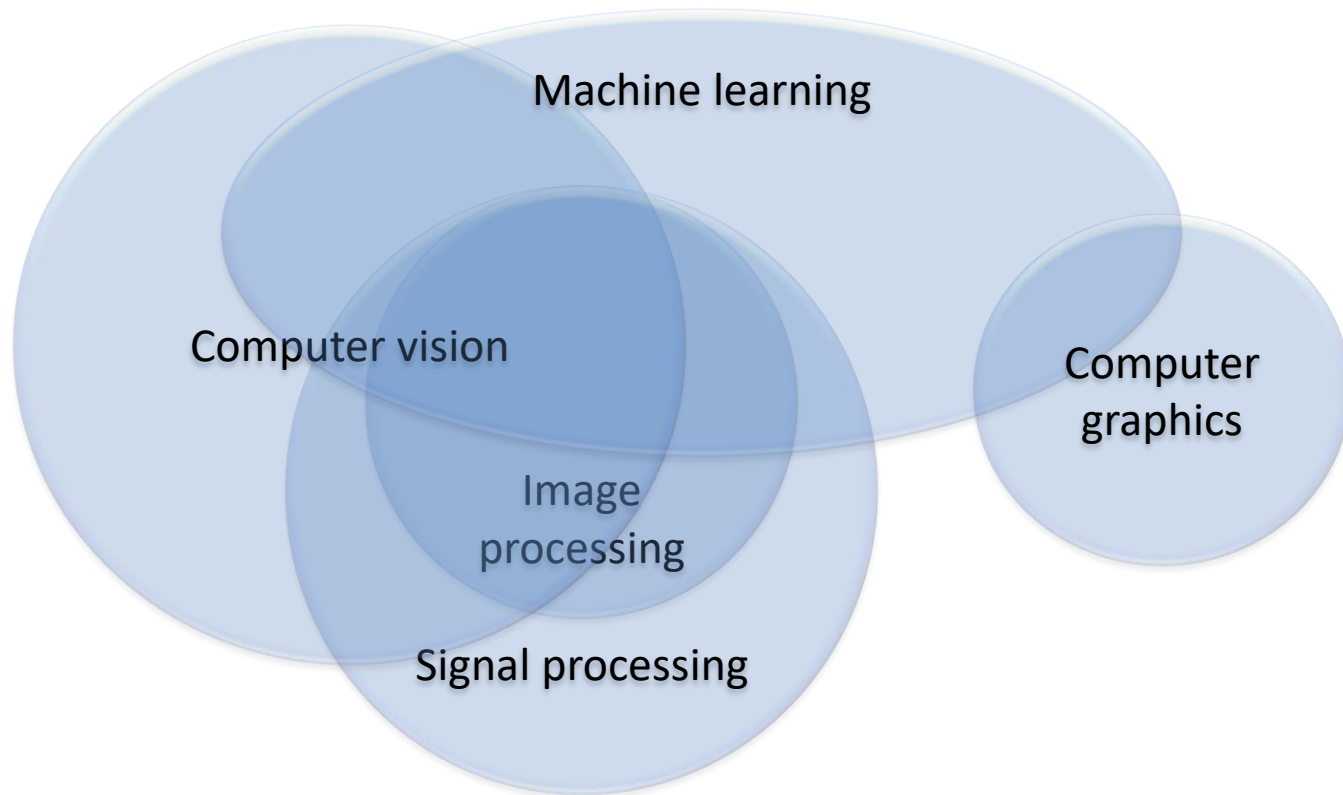


What is CV?

- **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
	Signal processing	Computer graphics
Data	Signal processing	Computer graphics
Image	Computer vision	Image processing



Why CV?

IT'S
F***ING
COOL

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>



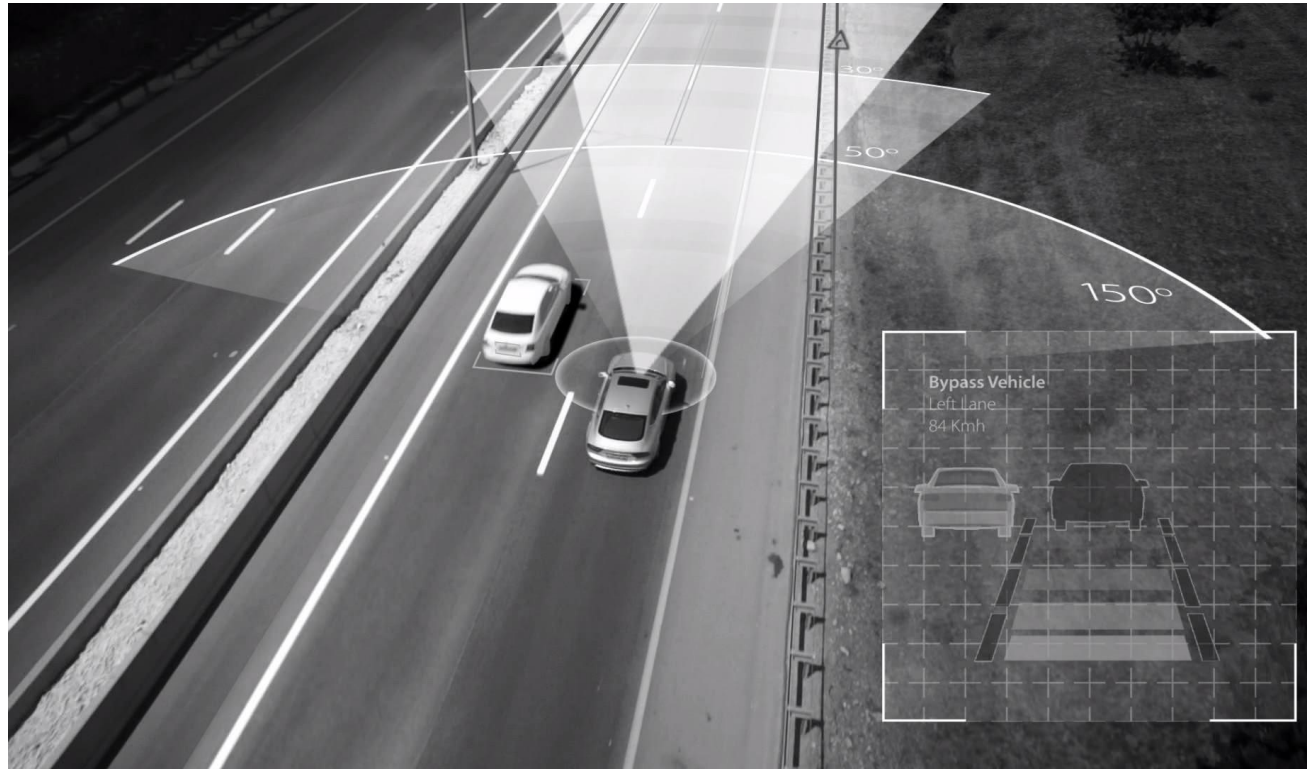
Why CV?

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	

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=39QMYkx89j0>



Why CV?

StartupHub.ai

ISRAEL'S COMPUTER VISION STARTUPS

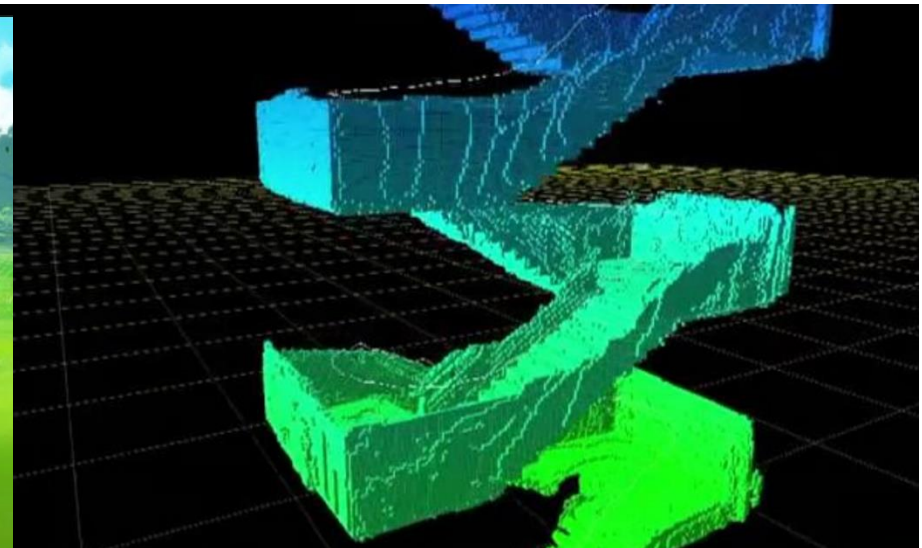


COMPUTER VISION TECHNOLOGY		HEALTHCARE	AUTOMOTIVE	AGRICULTURE	INDUSTRIAL	RETAIL	SECTORS
CHIPS	VIDEO INTELLIGENCE	MEDICAL IMAGING	AUTONOMOUS	CROP MANAGEMENT	ROBOTICS & UTILITIES	MONITORING & ANALYTICS	SMART CITY
Hailo Empowering Intelligence INTEL INTEL 	AGENT EyeSafe QUANTUM RGB D Vision viisights GETALERT VIDEOinFORM SENSORITY videocites ZyroBot XR Vision anyvision 1702ai	zebra iz.ai Healthy.io aidoc Body Vision DIA MobileODT maxQ sight Biomedical FDNA innoging HT DeePathology.ai ORCA DENTAL AI PerSimo RADLogics TECHSOMED IBEX XPRINT XRAY MAGENTIQ IMedis Deep Oncology nucleai SCOPIO MedHub-AI	arbe Imagry INNOVIZ TECHNOLOGIES Kodiak i4drive ADASKY oryx Vectoraic RIDEVISION RAM StreetLight.ai CRadar.AI BWV RFISSE IONTERRA VAYAVISION VOYAGE 81	TARANIS prospera See Tree SKYX fieldin AgroScout arugga GemmaCert SeedX VIBBE HiGrade	Planet Watchers KITOV SYSTEMS DLR COGNITEAM MOWI SKYLINE ROBOTICS IPV ORCA AI pzartech BladeRanger	trax trigo eyezon WISE SHELF memomi MYSTOR-E	SPATIAL LOGIC UTILIS syte donde
PROCESSING							VISUAL SEARCH
Brodmann Edgify REDFALCON							
OPTICAL & SENSOR							CONSUMER ROBOTICS & TECH
vayyar KAYA INSTRUMENTS TRIEYE NEWSIGHT IMAGING unispectral							nanit intuition robotics temi RES SCIO
DEVELOPMENT			IN-CAR MONITORING				FITNESS
missinglink.ai allegro.ai Clay Sciences			MDGO eyesight neteera CLAIR LABS GUARDIAN JUNGO SAVERONE CAARESYS				FITSCANNER MyselfFit
DATA CREATION			TRAFFIC & MOBILITY				REAL ESTATE
INNEREYE DataGen Technologies edgecase.ai			VALERANN NOTRAFFIC AGENT-TECH EyeWay				Leapers Flatspace
PLATFORM			DEVELOPMENT				FASHION
Voyager Labs cortica			cognata The Wholly Egg				sizer fitfully ZEEKIT
EYE TRACKING			VR, SURGERY & MONITOR				WATER VISION
Blink			ContinUse Biometrics Augmedics VRHealth				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



contents

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

Course outline

#	subject
1	Introduction to CV + Python: numpy, matplotlib.
2	Image processing recap: convolutions, LPF, HPF, morphology, connected components, gamma correction, histogram equalization.
3	Edge detection: gradient (roberts, prewitt, sobel), Laplacian, DoG (derivative of Gaussian), canny edge detector.
4	Shape detection: template matching, Hough transform.
5	Digital cameras: image formation, transformation, interpolation.
6	Camera calibration: extrinsic, intrinsic, radial distortion.
7	Stereo vision :dual camera rectification, triangulation.
8	3D cameras: LIDAR, KINECT, structured light, planoptic
9	Line fit: least squares, total least squares, RANSAC,
10	Feature extraction: SIFT, image stitching (scale space).
11	Neural networks: intro, CNN, MNIST, Alexnet.
12	Final project 1
13	Final project 2

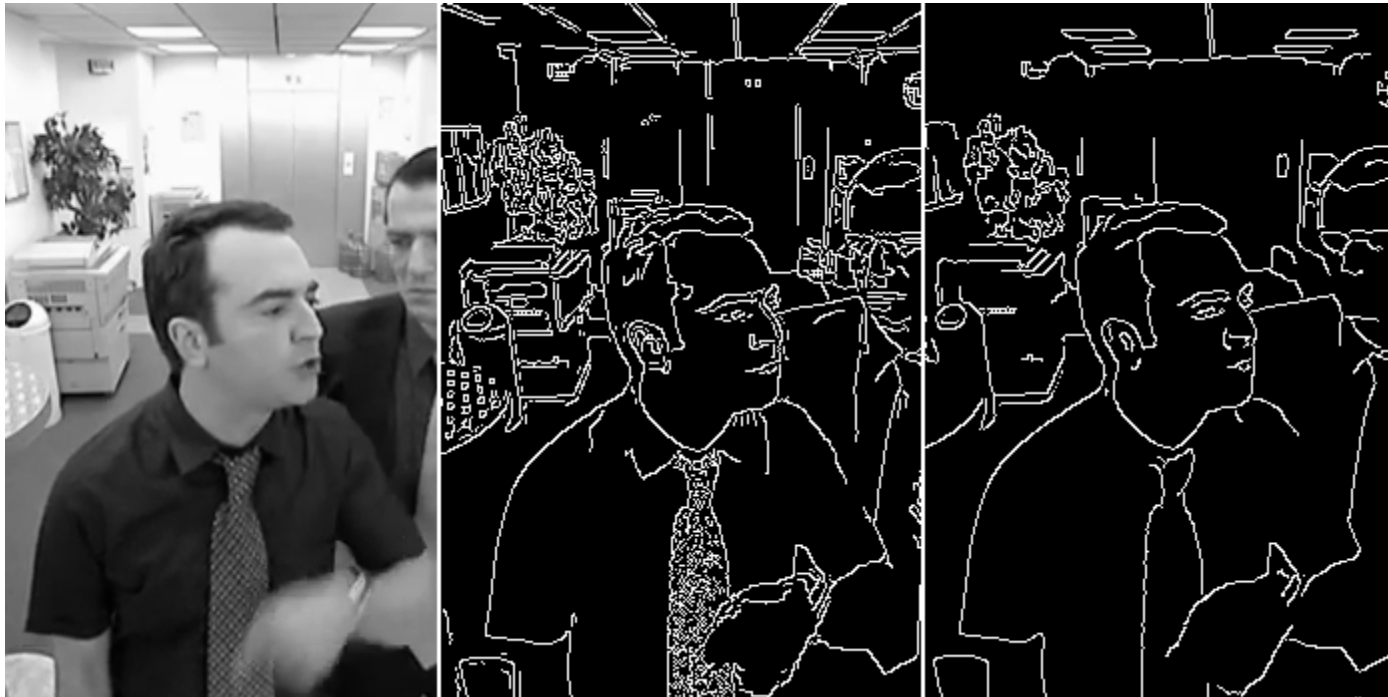
Image processing

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

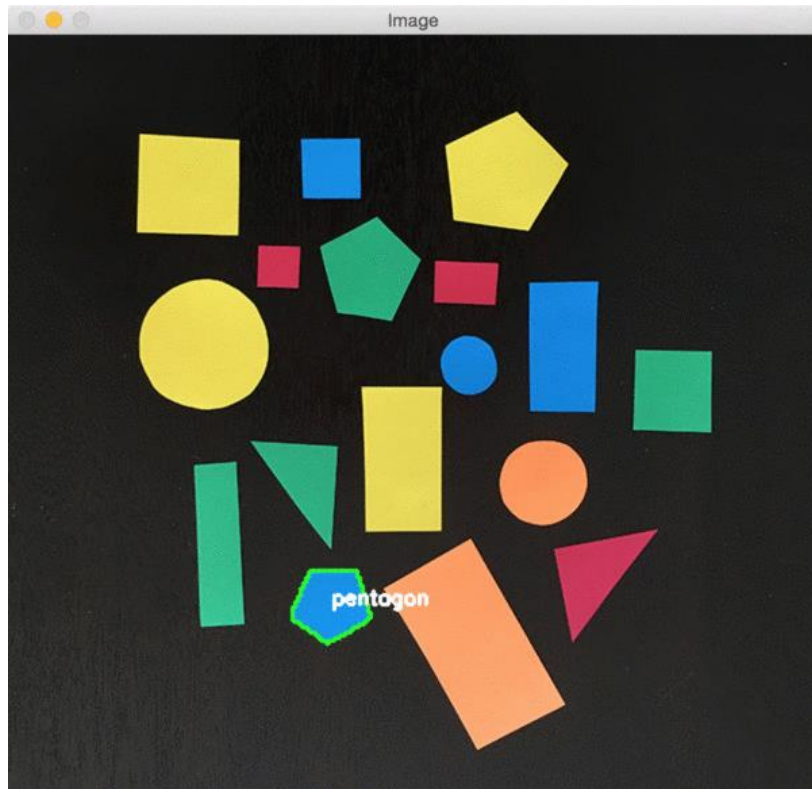


Edge Detection

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



Shape detection



Digital cameras

- Image formation:
<https://www.youtube.com/watch?v=dY0K65eXhkA>
- Transformation and interpolation.



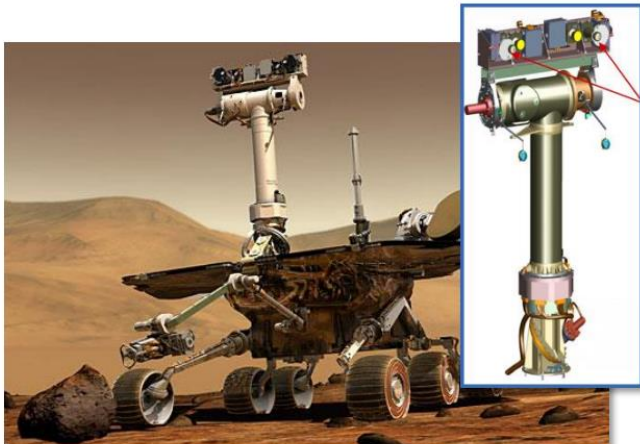
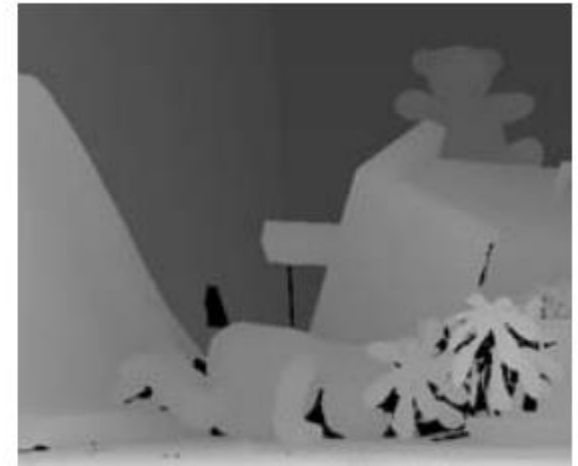
Image calibration

- Fisheye correction from go-pro for example



Stereo & 3d cameras

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



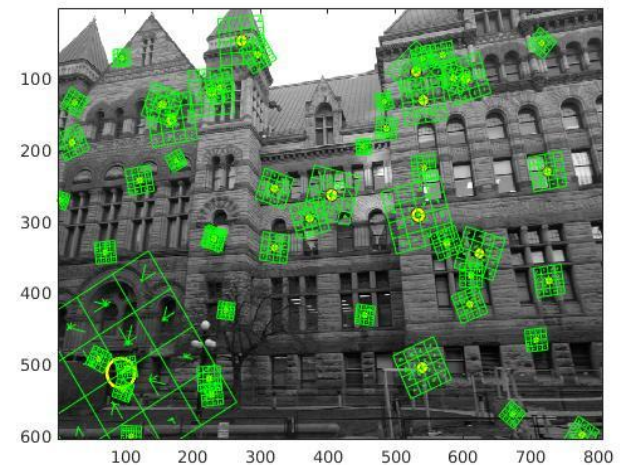
(a)



(b)

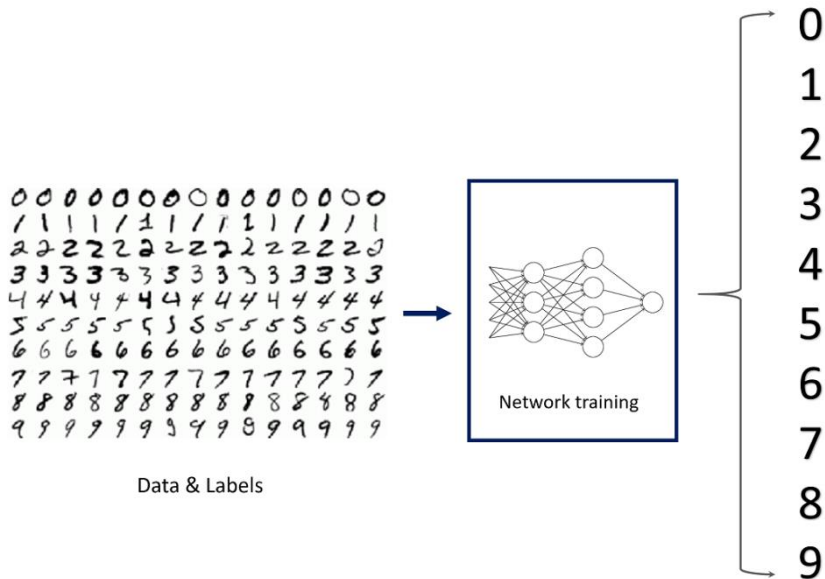
Fitting & Feature extraction

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



Neural networks

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



contents

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