

# Intro to Computer Vision



Yoni Chechik  
Computer Vision course

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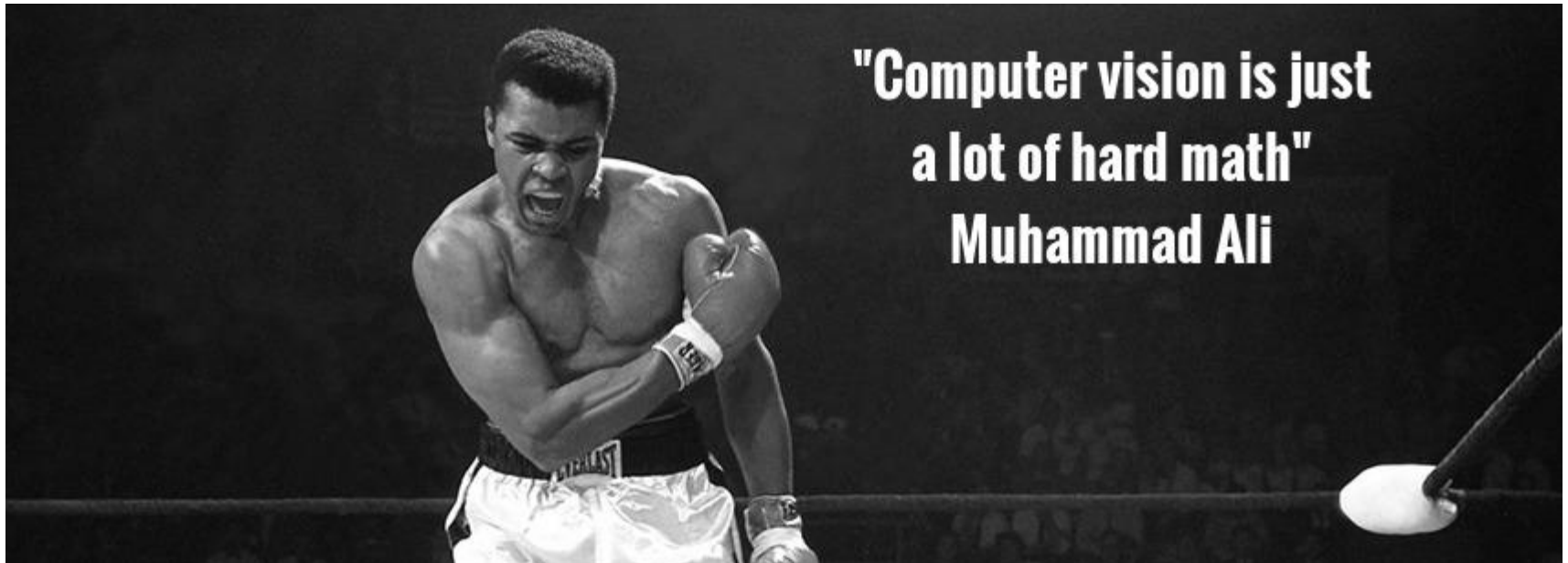
- **Course details**
- What is computer vision (CV)?
- Course outline
- Intro to Python

# References

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

# Prerequisites

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

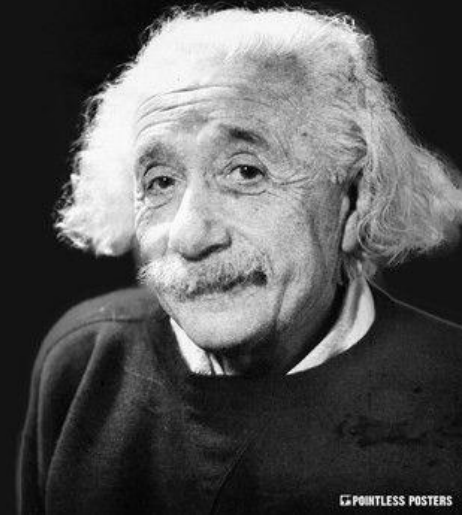


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Don't believe  
everything you read  
on the internet just  
because there's a  
picture with a quote  
next to it.

ALBERT EINSTEIN

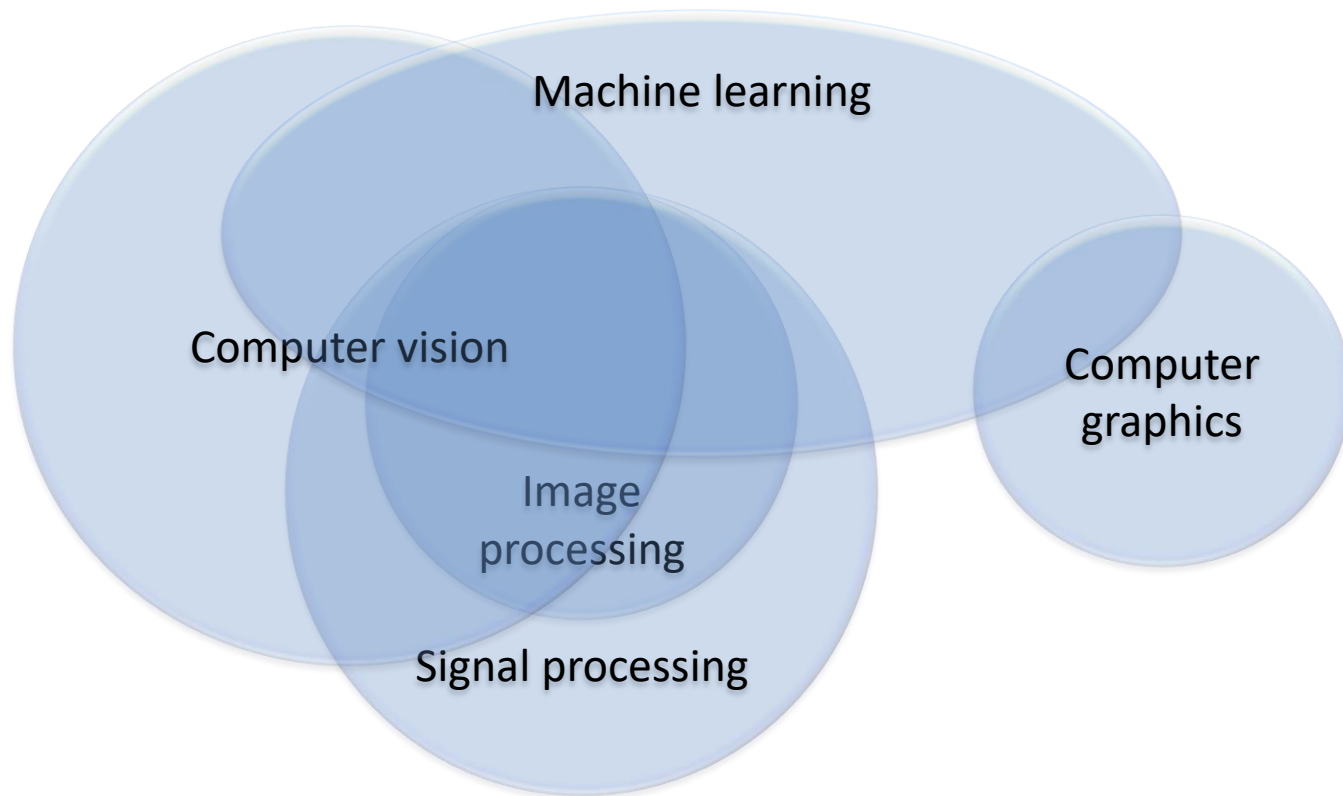


# What is CV?

- **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?

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>



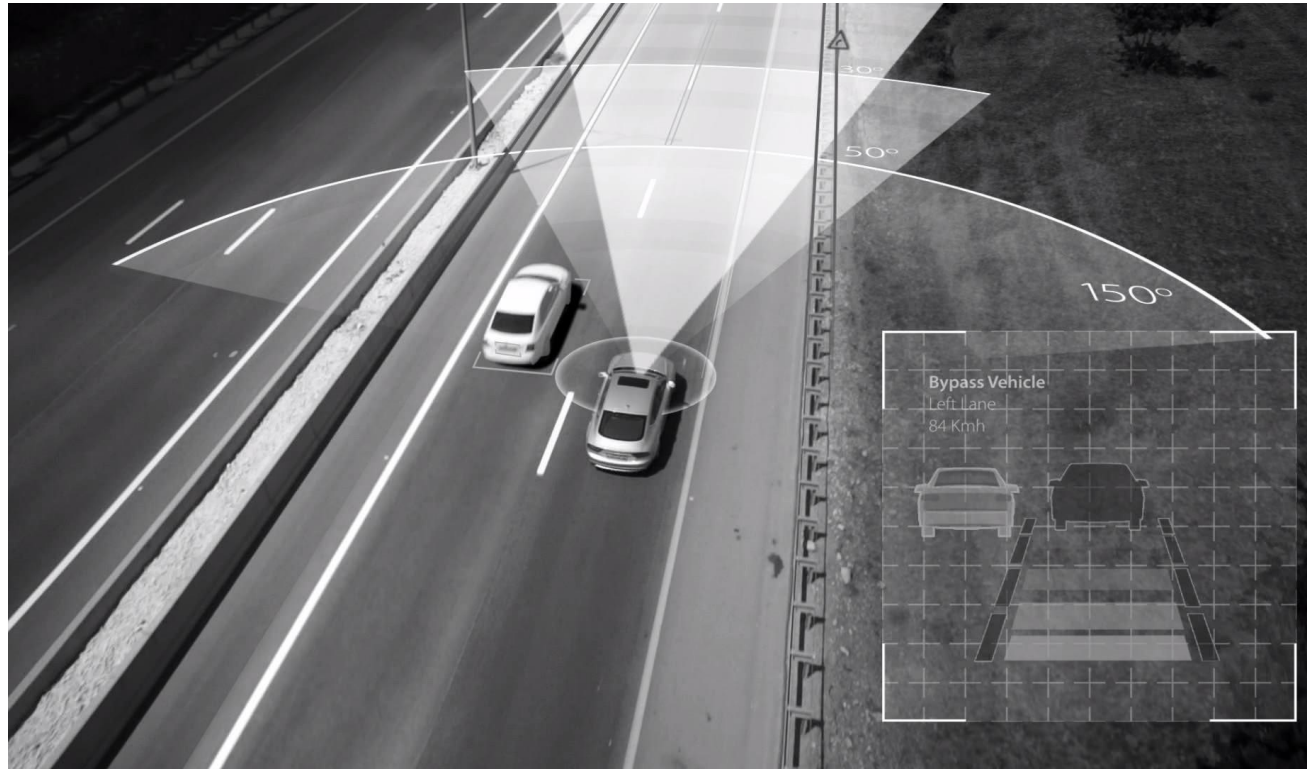
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# Mobileye

- **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>





# Why CV?

StartupHub.ai

## ISRAEL'S COMPUTER VISION STARTUPS

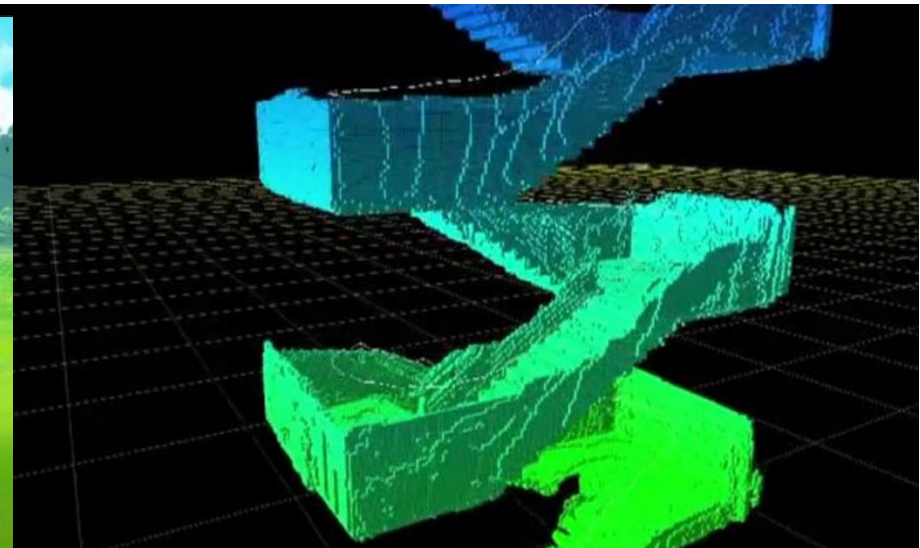


COMPUTER VISION TECHNOLOGY		HEALTHCARE	AUTOMOTIVE	AGRICULTURE	INDUSTRIAL	RETAIL	SECTORS
CHIPS	VIDEO INTELLIGENCE	MEDICAL IMAGING	AUTONOMOUS	CROP MANAGEMENT	ROBOTICS & UTILITIES	MONITORING & ANALYTICS	SMART CITY
Hailo INTEL Brodmann Edgify REDFALCON Vayyar KAYA INSTRUMENTS TRIEYE unispectral missinglink.ai allegro.ai Clay Sciences INNEREYE DataGen Technologies edgecase.ai Voyager Labs cortica Blink	AGENT2 EyeSafe QUANTUM RGB Dvision viisights GETALERT VIDEOInform SENSORITY videocites ZyroBot XRvision anyvision 1702ai FACEPTION D-ID VIKI SENSE TECHNOLOGIES verifyoo IS IT YOU ONLINE Facetrom FAB BrighterAI IDENTITYTECH zsens Resonai ADSHIR Reality human-eyes RESTAR SUPERB REALITY MANTIS VISION SPECTALIX	zebra iz.ai aidoc BODY VISION DIA maxQ MobileODT sight FDNA innaging HT DeePathology.ai ORCA DENTAL AI PerSimo RADLogics TECHSOMED IBEX X-PRINT X-RAY MEDICAL VISION MAGENTIQ IMedis Deep Oncology nucleai SCOPIO @ MedHub-AI	arbe Imagray INNOVIZ TECHNOLOGIES Kodiak ADASXY i4drive oryx Vectoraic RIDEVISION RAM StreetLight.ai CRadar.AI BWV RFISSE IONTERRA VAYAVISION VOYAGE 81	TARANIS prospera See Tree SKYX fieldin AgroScout saillog arugga GemmaCert SeedX VIBBE HiGrade	Planet Watchers KITOV SYSTEMS DLR COGNITEAM MOVI SKYLINE ROBOTICS IPV ORCA AI pzartech BladeRanger	trax trigo eyezon WISE SHELF memomi MYSTOR-E SPORTS ANALYTICS & CONTENT playsight TRACK160 WSC Sports PhysiMax Pixellot SenSwim Zone7 LVISION Baseline	SPATIAL LOGIC UTILIS syte clonde nanit robotics intuition robotics t e m i robotics RES scio FITSCANNER MyselfFit Leaperr Flatspace SIZER fitfully ZEEKIT LYNXIGHT DEEP VISION CORAL DETECTION SYSTEM RailVISION Anima SeeVoov
PROCESSING							
OPTICAL & SENSOR							
DEVELOPMENT							
DATA CREATION							
PLATFORM							
EYE TRACKING							
		OPTICAL	TRAFFIC & MOBILITY	TELEOPERATION	CONSTRUCTION	MARKETING	
		camereyes BIO EYE NOVASIGHT 6 over 6 RetiSpec	VALERANN NOTRAFFIC AGENT-TECH EyeWay cognata The Wholly Egg VR, SURGERY & MONITOR ContinUse Biometrics Augmedics VRHealth	tunity DEEPNEN Phantom Auto ottopia UVEYE NEOMATRIX Visual Intelligence DASHCAM & ROUTING WHITE RAVEN VIA Parkam flexar	XTEND AerialGuard AIROBOTICS skywatch.ai EDGYBEES ClearVuze Sightec HIGH LANDER Chirdeye CIVDRONE vHive PERCEPTO INTSITE astralink OKIBO Datamate CLONE ARCadio Buildots LIGHTYX CONSTRU	intervyo minereye appltools tuqqi INTELLIGO voca.ai ActiView TechSee Taboola anyclip BrandTotal AdVeri.ai CHEQ TAILOR BRANDS minute cedato COMIGO	VISUAL SEARCH CONSUMER ROBOTICS & TECH FITNESS REAL ESTATE FASHION WATER VISION EDUCATION, RAIL & TRAVEL

# 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.
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



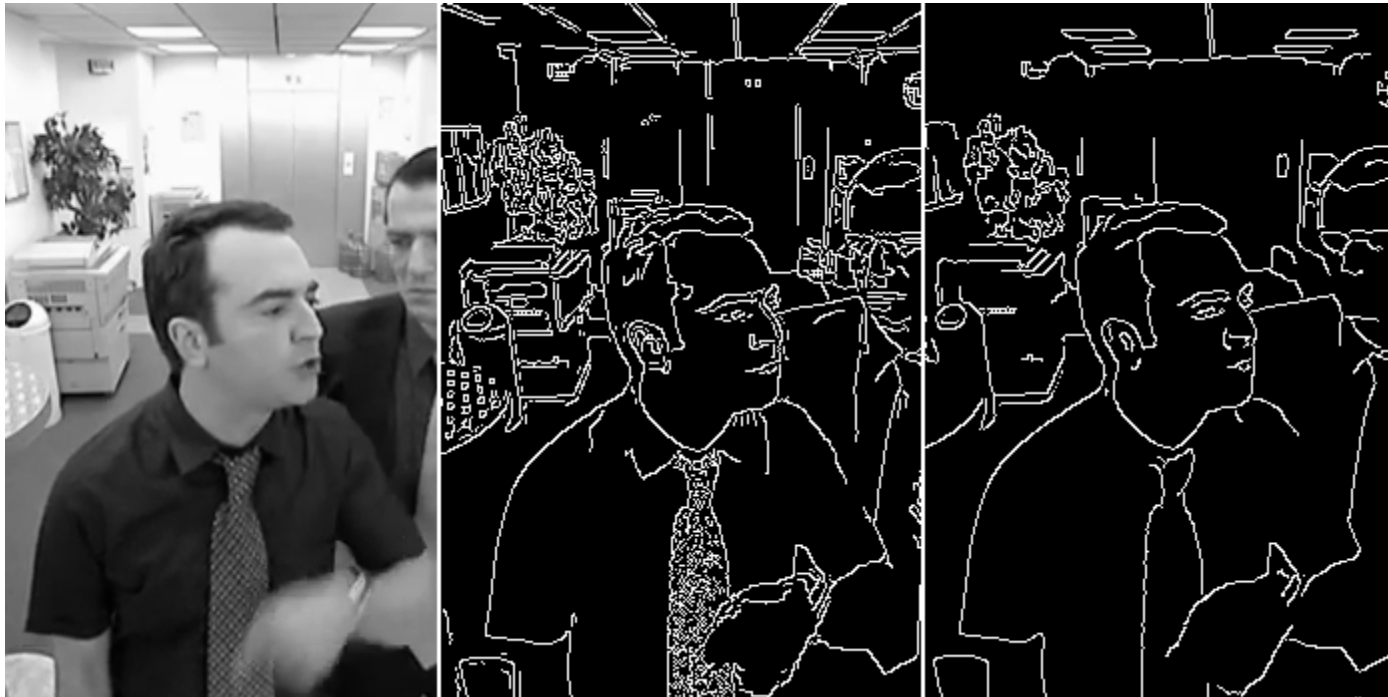
# Image processing

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

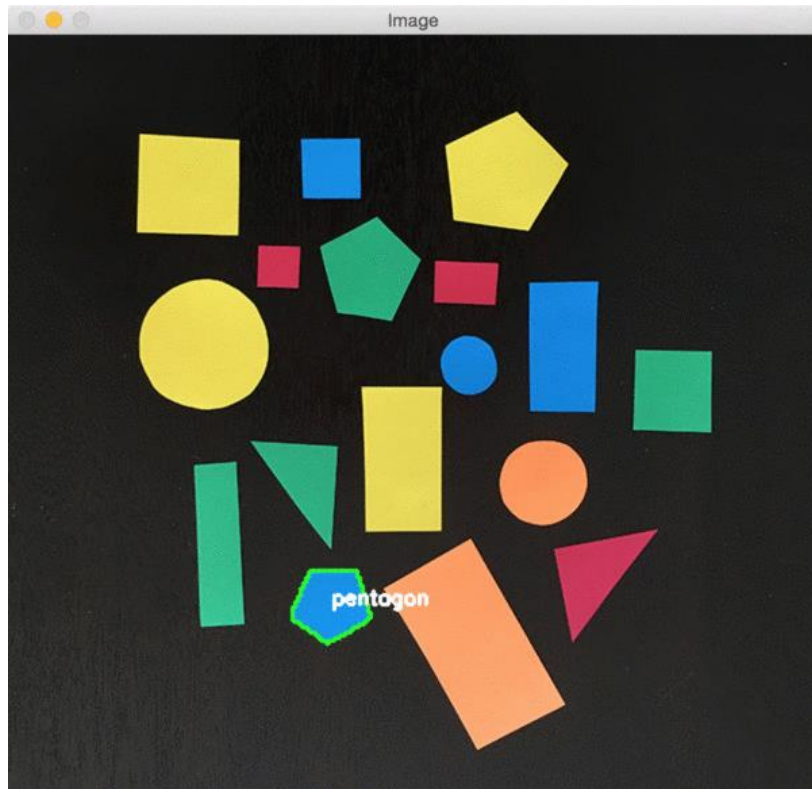


# Edge Detection

- <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.





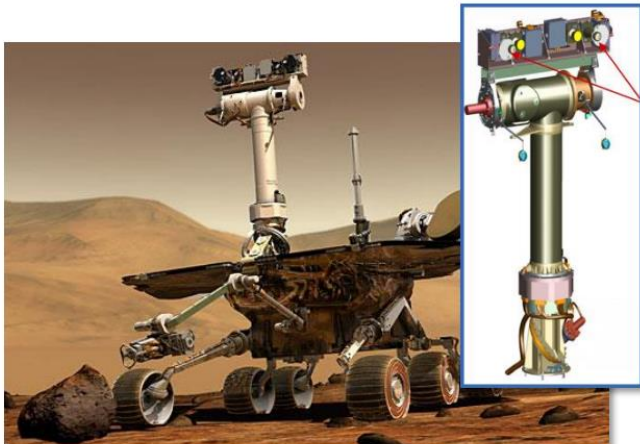
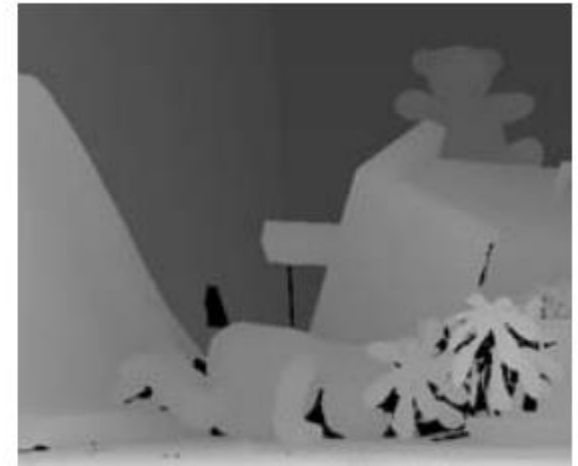
# Image calibration

- Fisheye correction from go-pro for example



# Stereo & 3d cameras

- [https://www.youtube.com/watch?v=PySBQ8Q\\_R8k](https://www.youtube.com/watch?v=PySBQ8Q_R8k)



(a)

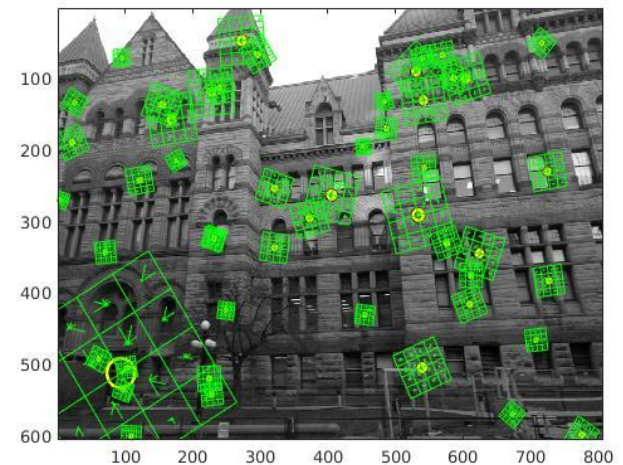


(b)



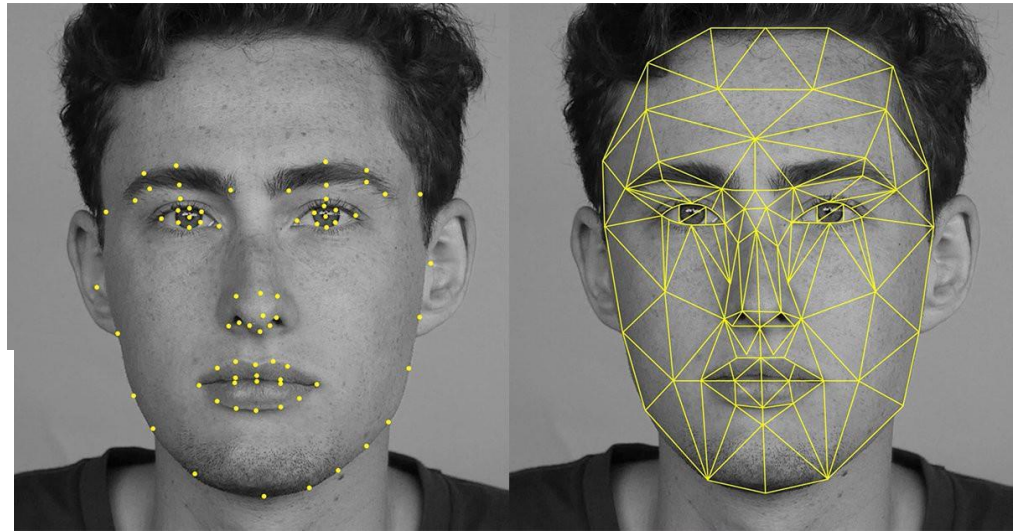
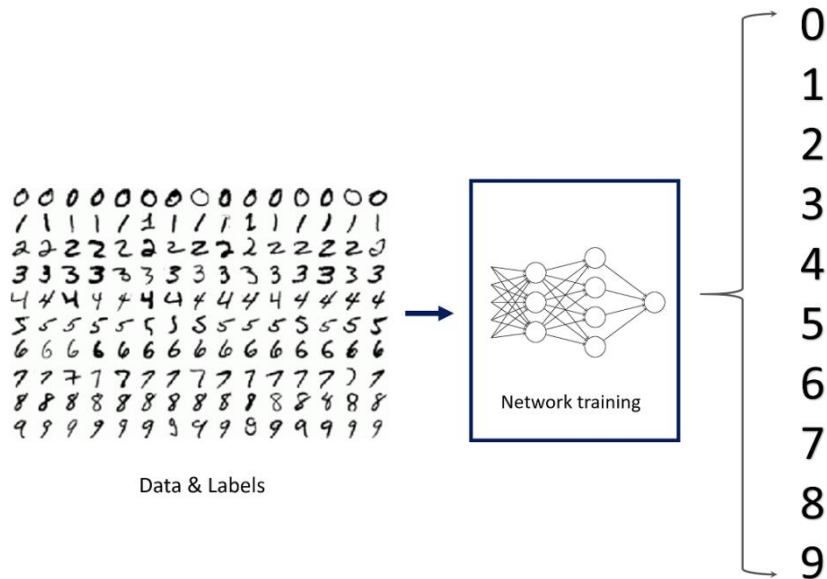
# Fitting & Feature extraction

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



# Neural networks

- <https://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&t=40s>
  - <http://nvidia-research-mingyuliu.com/gaugan>

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