

# Intro to Computer Vision



Yoni Chechik  
Computer Vision course

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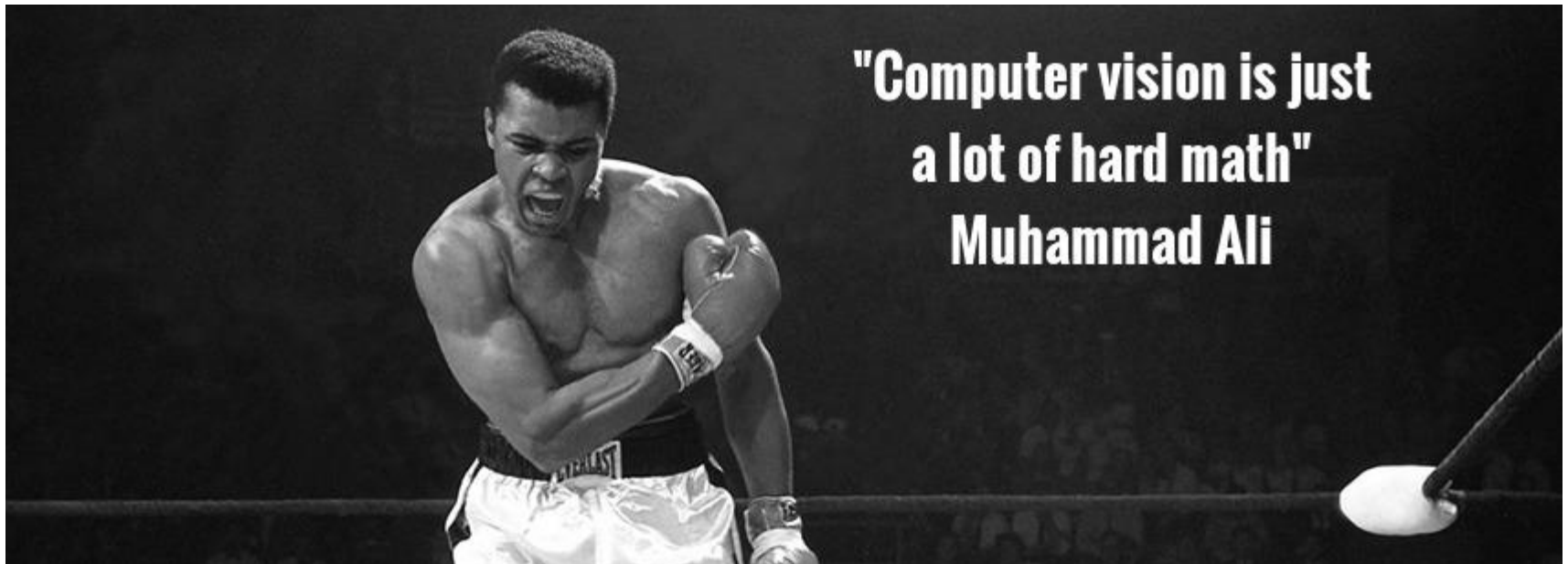
- **Course details**
- What is computer vision (CV)?
- Course outline
- Intro to Python

# 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.**

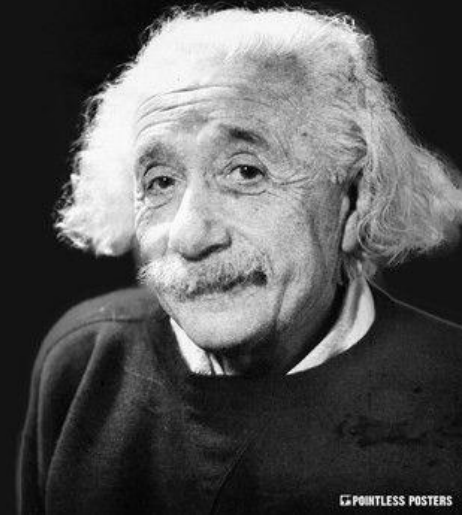


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- Course details
- **What is computer vision (CV)?**
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Don't believe  
everything you read  
on the internet just  
because there's a  
picture with a quote  
next to it.

ALBERT EINSTEIN

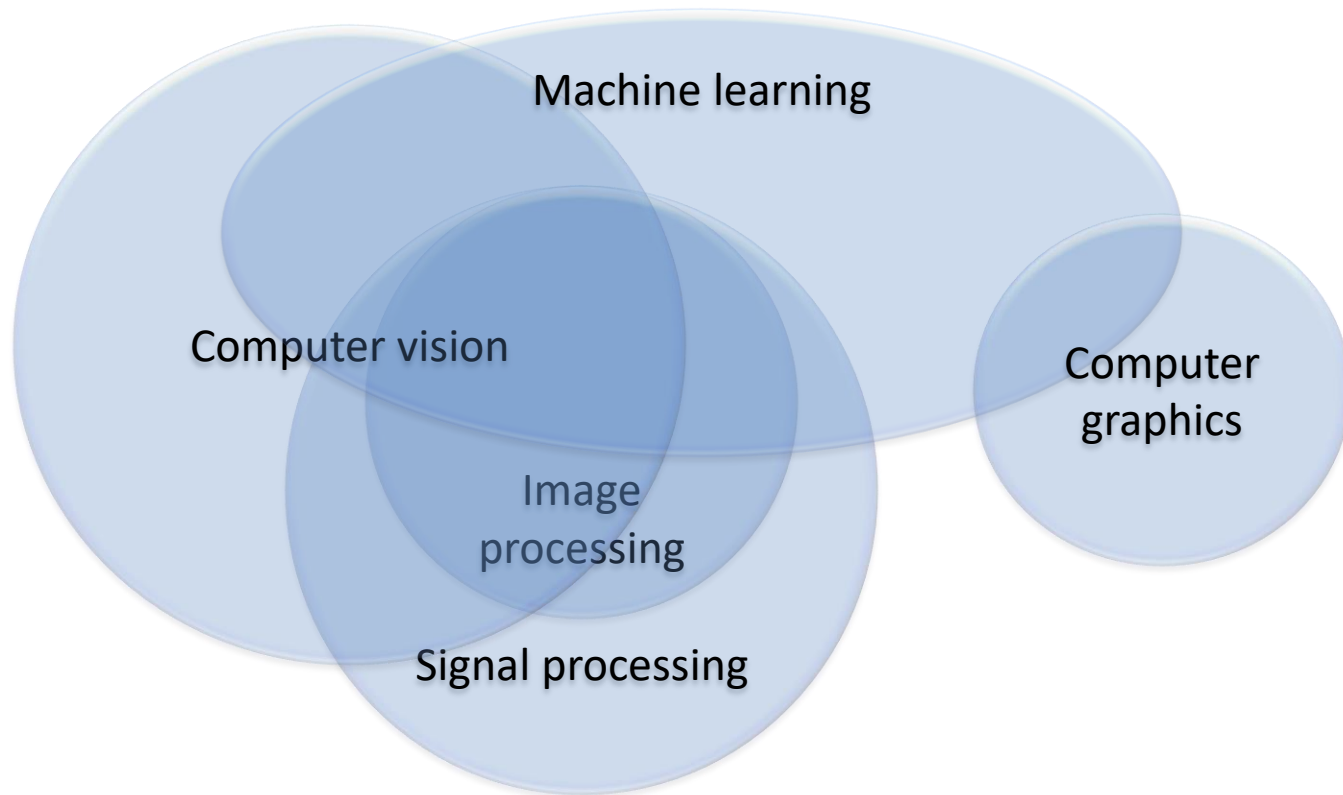


# What is CV?

- **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
	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>



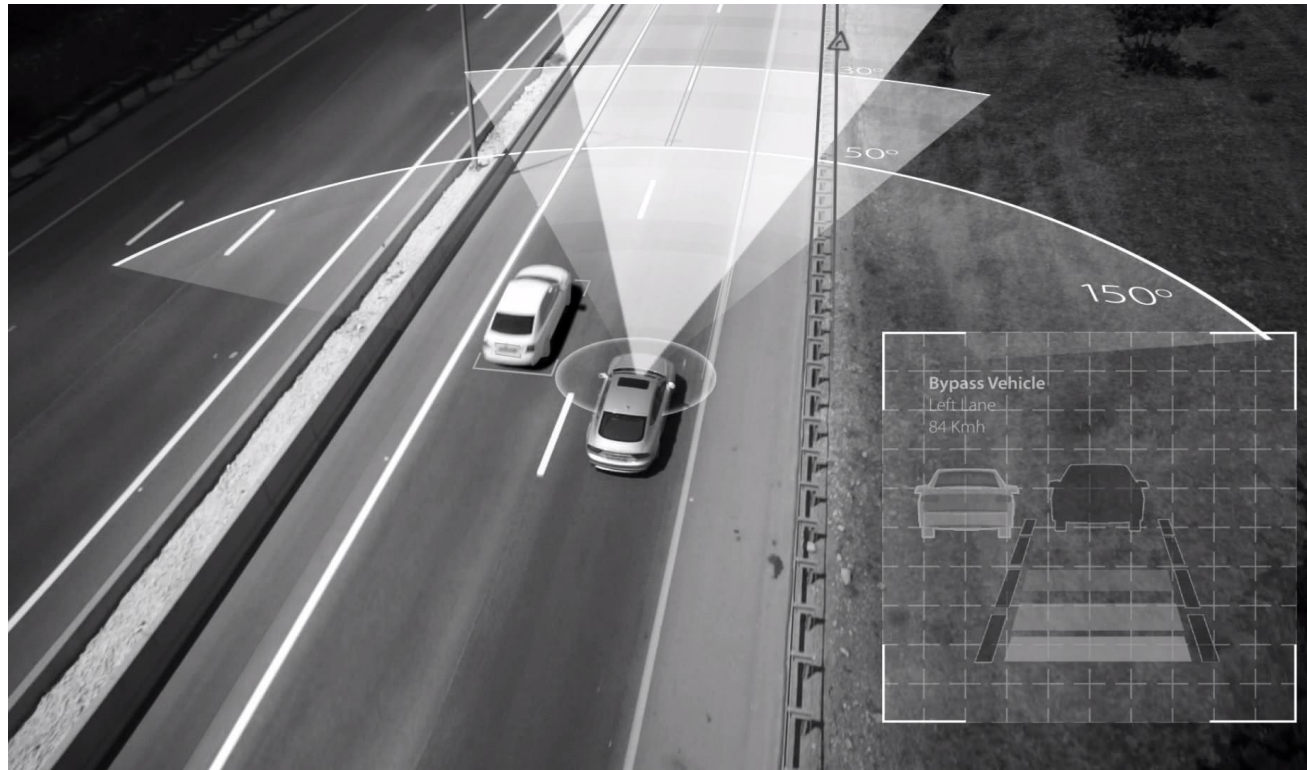
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# Mobileye

- **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

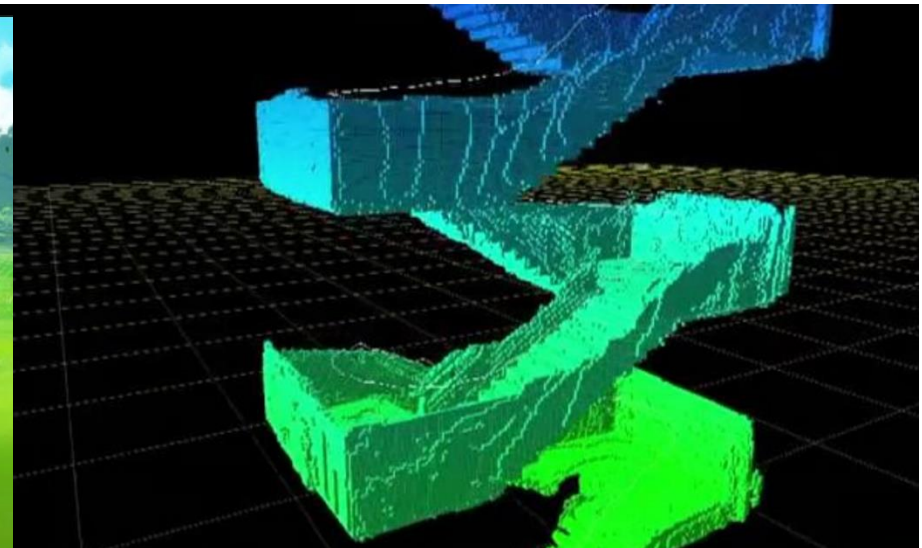
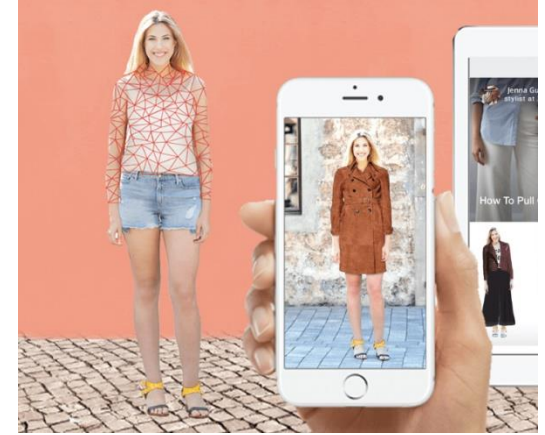


COMPUTER VISION TECHNOLOGY		HEALTHCARE	AUTOMOTIVE	AGRICULTURE	INDUSTRIAL	RETAIL	SECTORS
CHIPS	VIDEO INTELLIGENCE	MEDICAL IMAGING	AUTONOMOUS	CROP MANAGEMENT	ROBOTICS & UTILITIES	MONITORING & ANALYTICS	SMART CITY
Hailo Empowering Intelligence INTEL INTEL	AGENT EyeSafe QUANTUM RGB D Vision viisights GETALERT 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 PerSimoO RADLogics TECHMED 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 MOVIX SKYLINE ROBOTICS IPV ORCA AI pzartech BladeRanger	trax trigo eyezon WISE SHELF memomi MYSTOR-E SPATIAL LOGIC UTILIS syte clonde	ZENCITY SPATIAL LOGIC UTILIS syte clonde
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	HARVESTING	DRONES		FITNESS
missinglink.ai allegro.ai dataloop Clay Sciences			MDGO eyesight neteera CLAIR LABS GUARDIAN JUNGO SAVERONE CAARESYS	METOMOTION meshek (76)	XTEND AerialGuard AIROBOTICS skywatch.ai EDGY BEES ClearVuze Sightec HIGH LANDER Sightec CIVDRONE vHive PERCEPTO		FITSCANNER MyselfFit
DATA CREATION			TRAFFIC & MOBILITY	NEW MEDIA		ENTERPRISE	REAL ESTATE
INNEREYE DataGen Technologies edgecase.ai			VALERANN NOTRAFFIC AGENT-TECH EyeWay	Lightricks Magisto Photomyne WIBBITZ tunity DEEPNEN	skywatch.ai EDGY BEES ClearVuze Sightec HIGH LANDER Sightec CIVDRONE vHive PERCEPTO	intervyo minereye appliTools tuqqi INTELLIGO voca.ai ActiView TechSee	Leaperr Flatspace
PLATFORM			DEVELOPMENT	TELEOPERATION	CONSTRUCTION		FASHION
Voyager Labs cortica			cognata The Wholly AI	Phantom Auto ottopia	INSITE astralink OKIBO Datamate CLONE Buildots LIGHTYX CONSTRU	SIZER ZEEKIT	
EYE TRACKING			VR, SURGERY & MONITOR	INSPECTION		MARKETING	WATER VISION
Blink			ContinUse Biometrics Augmedics VRHealth	UVEYE NEOMATIX WHITE RAVEN VIA Parkam riexar	Taboola anysclip BrandTotal AdVeriFai CHEQ TAILOR BRANDS minute cedate COMIGO	LYNXNIGHT DEEP VISION CORAL 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.
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



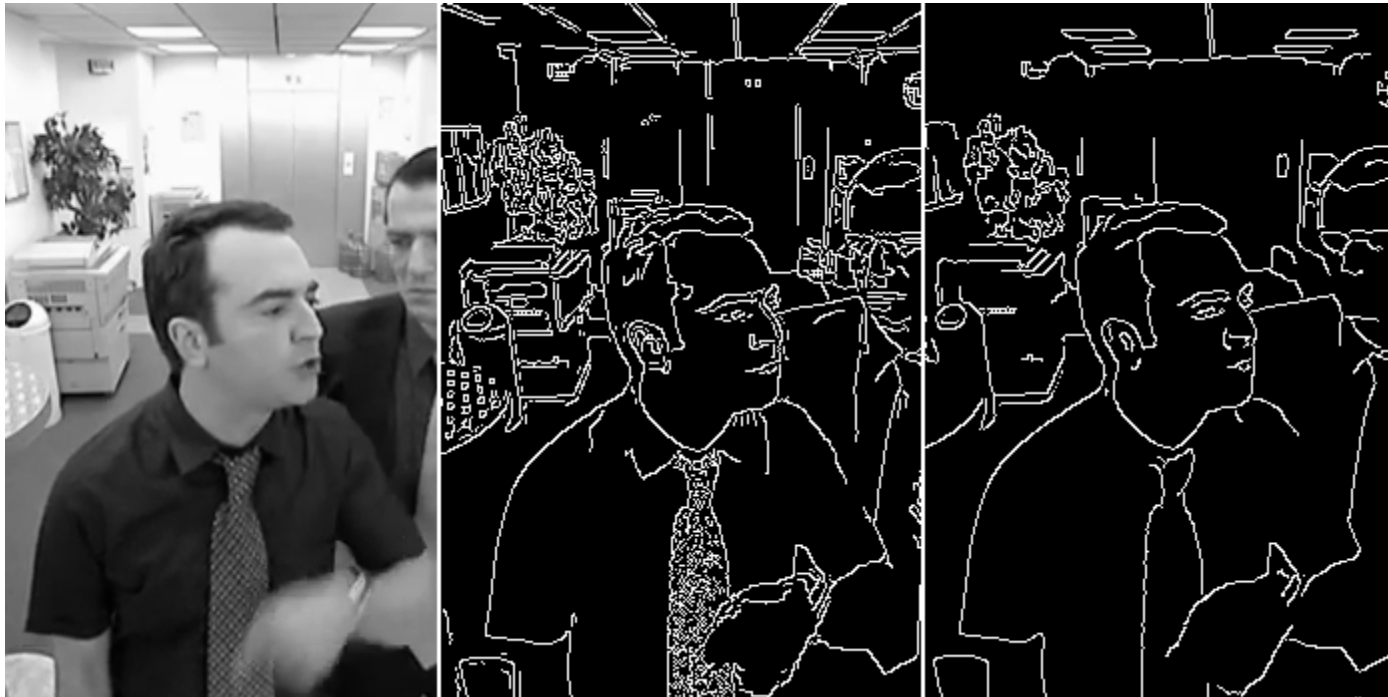
# Image processing

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

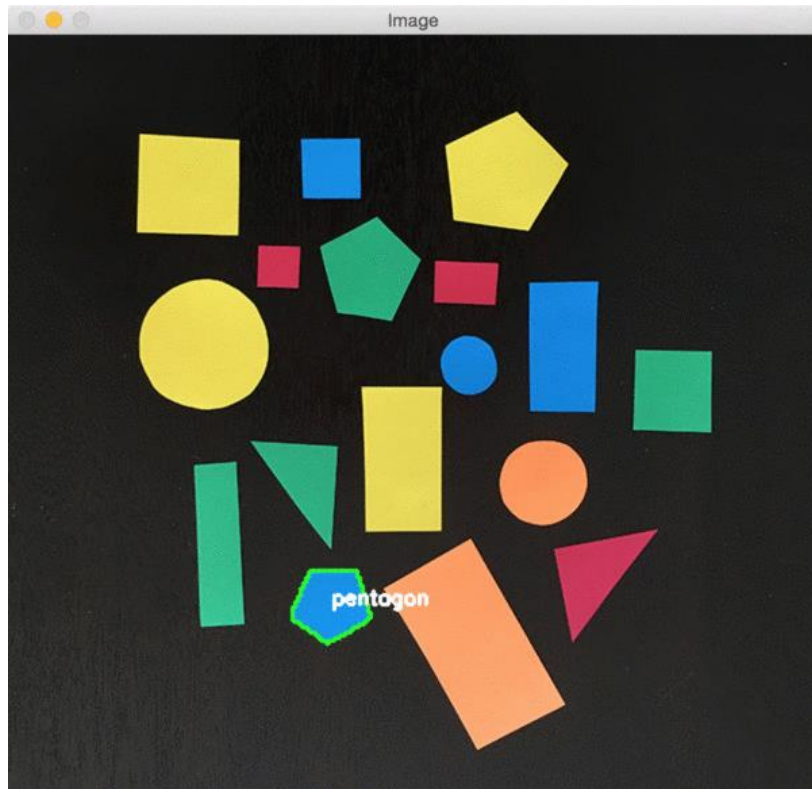


# Edge Detection

- <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.





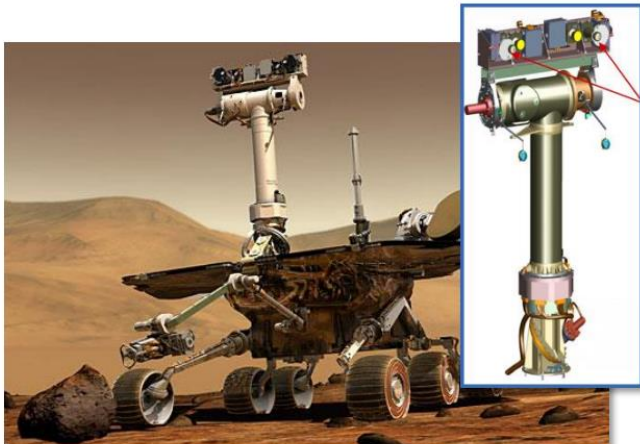
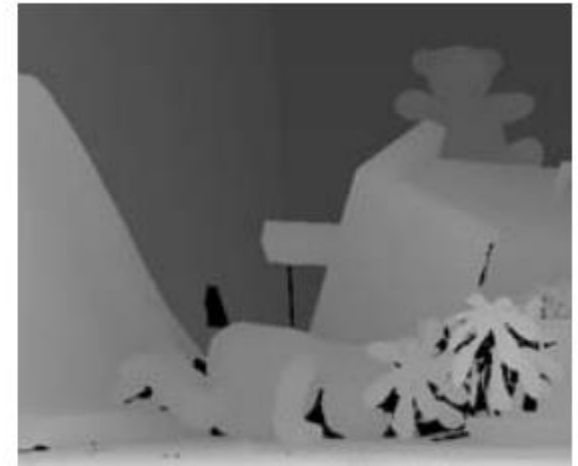
# Image calibration

- 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)

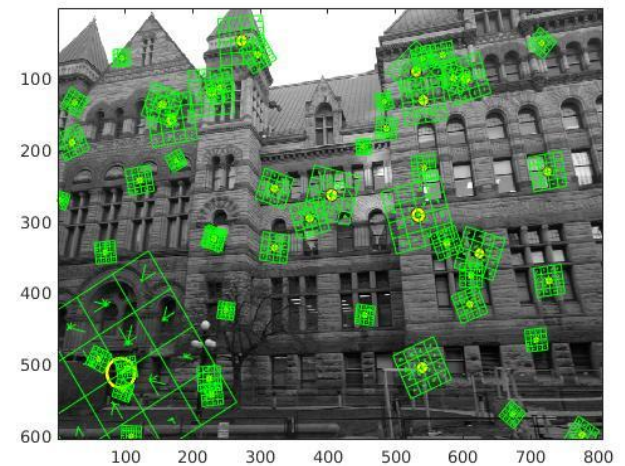


(b)



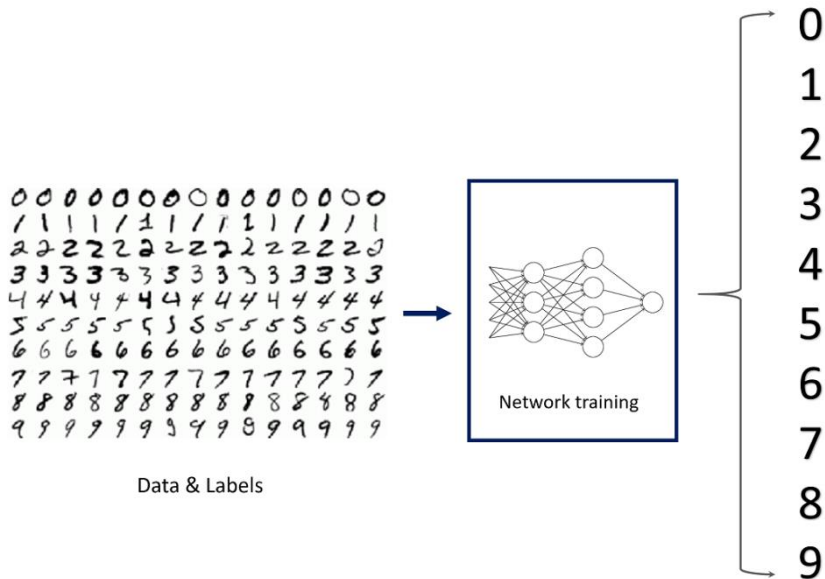
# Fitting & Feature extraction

- 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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