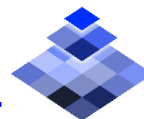


Intro to Computer Vision



Yoni Chechik

www.AliMath.com



contents

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

References

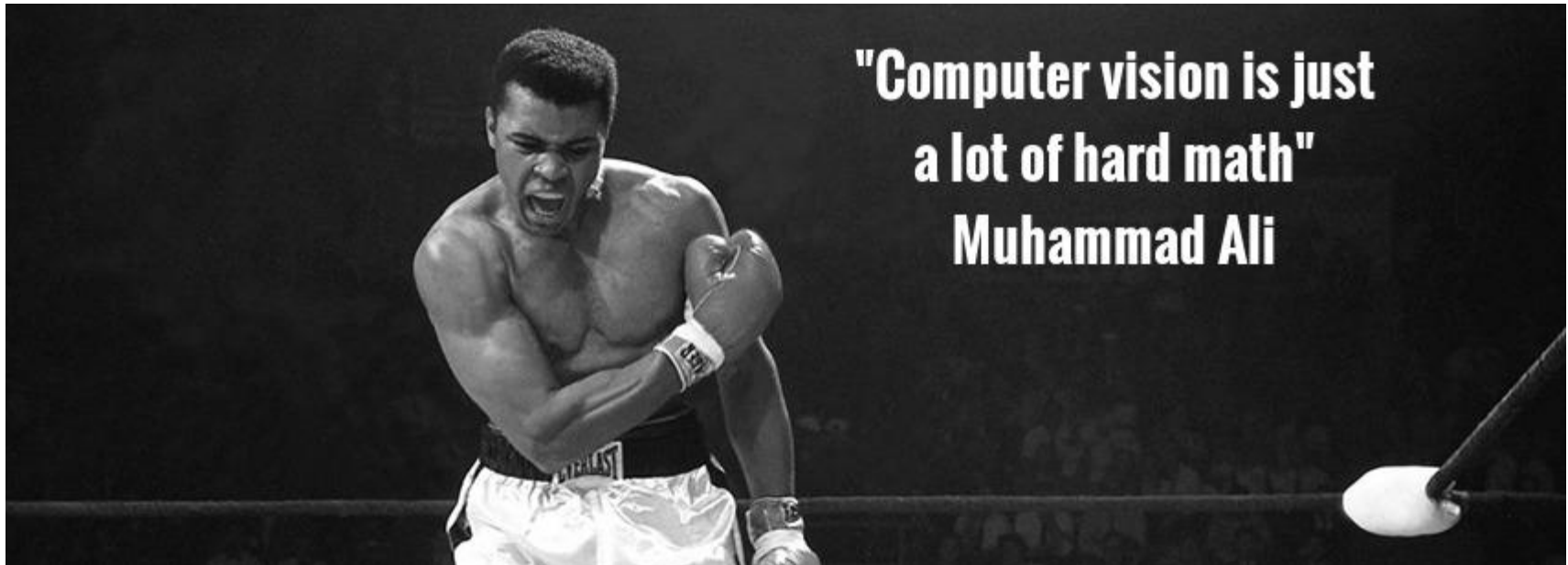
- Lectures Based on the book: **Computer Vision: Algorithms and Applications**, 2010, Richard Szeliski (<http://szeliski.org/Book/>)

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.**

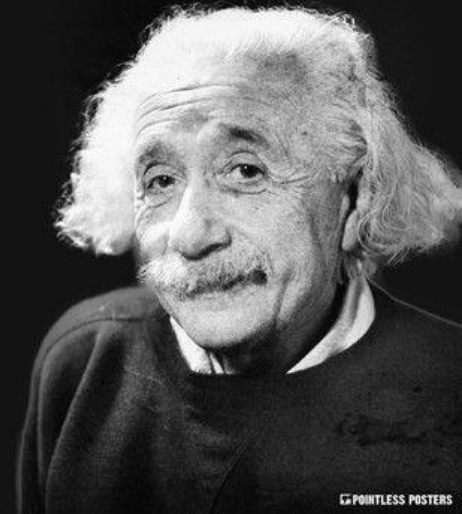


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- **What is computer vision (CV)?**
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Don't believe
everything you read
on the internet just
because there's a
picture with a quote
next to it.

ALBERT EINSTEIN

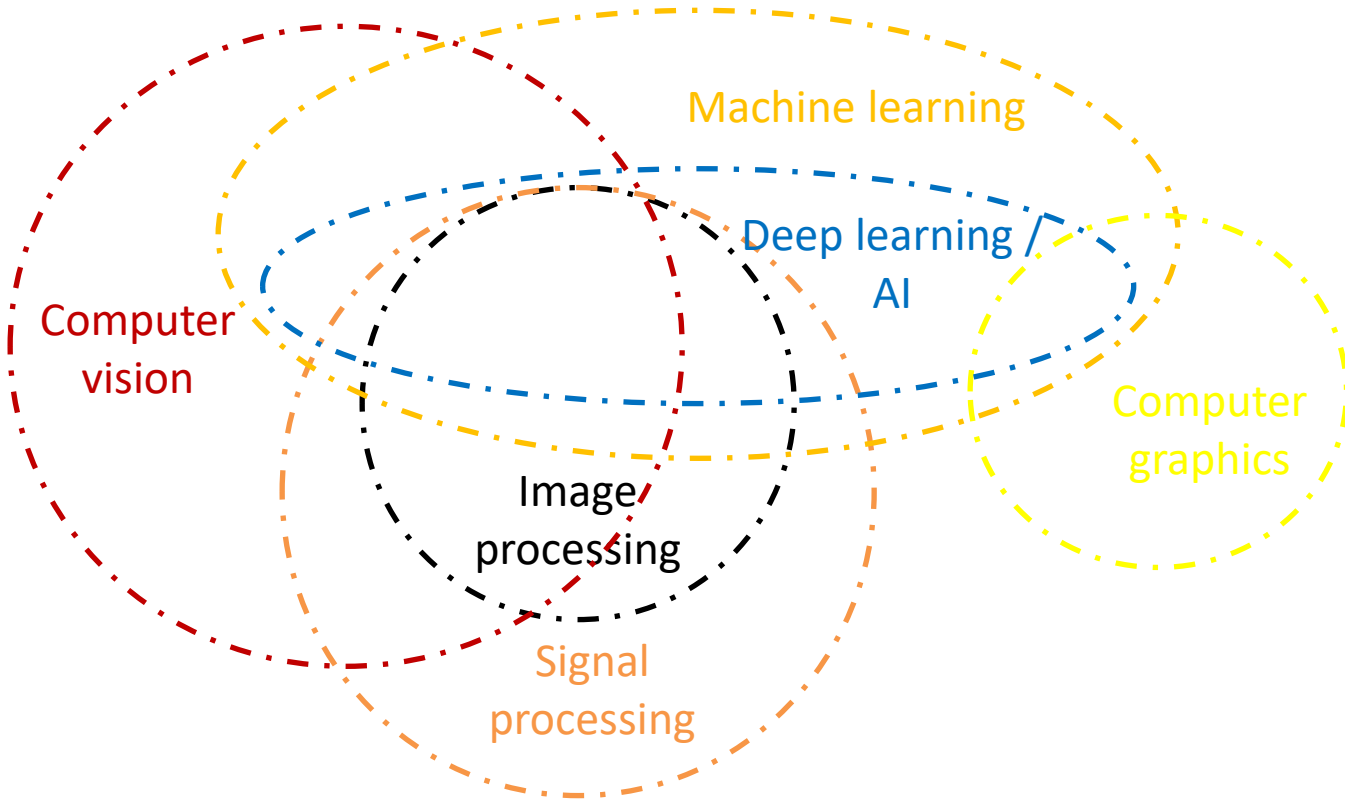


What is CV?

- **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



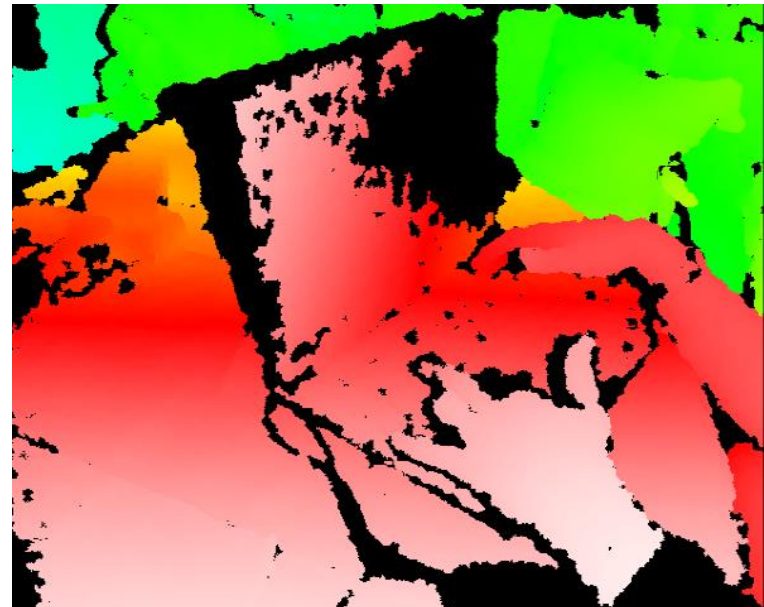
Why CV?

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>



Why CV?

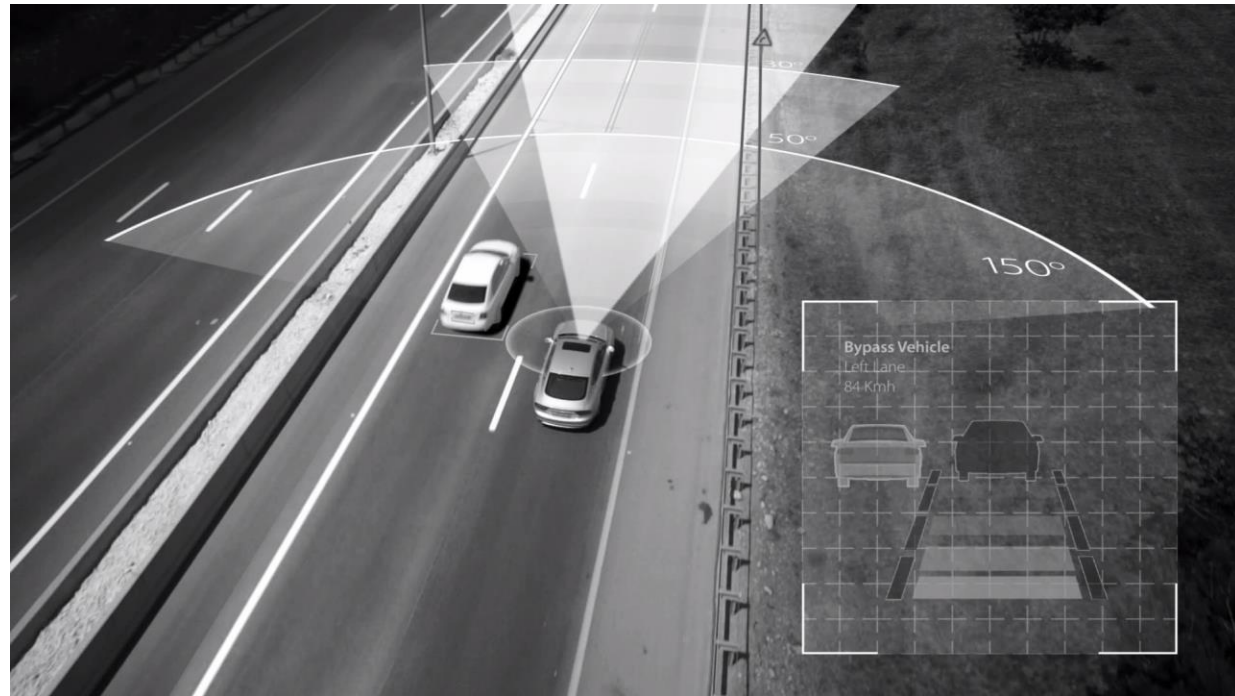
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	 January – 2014 NA	 September – 2014 NA	 August – 2017 NA	



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=fKXzttwtXaGo> (Tesla-cooler!)



Why CV?

StartupHub.ai

ISRAEL'S COMPUTER VISION STARTUPS



COMPUTER VISION TECHNOLOGY	
CHIPS	VIDEO INTELLIGENCE
Hailo Inuitive	Agent2 EyeSafe Quantum RGB D Vision
PROCESSING Brodmann Edgify Redfalcon	Viisights GETALERT VIDEOInForm SENSORITY vidocites ZyroBot XRvision anyvision 1702ai
OPTICAL & SENSOR vayyar KAYA INSTRUMENTS TRIEYE NEWSIGHT IMAGING unispectral	FACIAL RECOGNITION FACEPTION D-ID VIKI SENSE TECHNOLOGIES verifyoo Facetrom F2B6 BrighterAI IDENTITYTECH
DEVELOPMENT missinglink.ai allegro.ai dataLoop Clay Sciences	AUGMENTED REALITY zsens Resonai AUGMIND hexa ADSHIR Reality human-eyes RESTAR SUPERB REALITY MANTIS VISION SPECTALIX
DATA CREATION INNEREYE DataGen Technologies edgecase.ai	IMPAIRMENT AID NOVASIGHT 6 over 6 RetiSpec SESAME ENABLE ORCAM ICI VISION eyecontrol RenewSenses
PLATFORM Voyager Labs cortica	VR, SURGERY & MONITOR ContinUse Biometrics Augmedics VRHealth
EYE TRACKING Blink	

HEALTHCARE	
MEDICAL IMAGING	
zebra Healthy.io BODY VISION MobileODT sight FDNA HT DeePathology.ai ORCA DENTAL AI PerSimoO RADLogics TECHSO MED IBEX XPRINT XRAY MEDICAL VISION MAGENTIQ IMedias Deep Oncology nucleai SCOPIO @ MedHub-AI	iz.ai aidoc DIA maxQ Biomedical innogy DeePathology.ai PerSimoO TECHSO MED XPRINT XRAY MEDICAL VISION MAGENTIQ IMedias nucleai @ MedHub-AI
OPTICAL camerEyes BIO EYE	

AUTOMOTIVE	
AUTONOMOUS	
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IN-CAR MONITORING MDGO eyesight neteera CLAIR LABS GUARDIAN JUNGGO SAVERONE CAARESYS	
TRAFFIC & MOBILITY VALERANN NOTRAFFIC AIGENT-TECH EyeWay	
DEVELOPMENT cognata The Wholly Egg	
VR, SURGERY & MONITOR ContinUse Biometrics Augmedics VRHealth	

AGRICULTURE	
CROP MANAGEMENT	
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NEW MEDIA PHOTO & VIDEO CREATION Lightricks Magisto Photomyne WIBBITZ tunity DEEPNEN	
TELEOPERATION Phantom Auto ottopia	
INSPECTION UVEYE NEOMATIX Visual Intelligence	
DASHCAM & ROUTING WHITE RAVEN VIA Parkam flexar.	

INDUSTRIAL	
ROBOTICS & UTILITIES	
Planet Watchers KITOV SYSTEMS DLR COGNITEAM MOVI SKYLINE ROBOTICS IPV ORCA AI pzartech BladeRanger	KITOV SYSTEMS COGNITEAM SKYLINE ROBOTICS ORCA AI BladeRanger
DRONES SURVEILLANCE & AUTONOMY XTEND AerialGuard AIROBOTICS skywatch.ai EDGY BEES ClearVuze Sightec HIGH LANDER Chirdeye CIVDRONE vHive PERCEPTO	AerialGuard EDGY BEES HIGH LANDER CIVDRONE PERCEPTO
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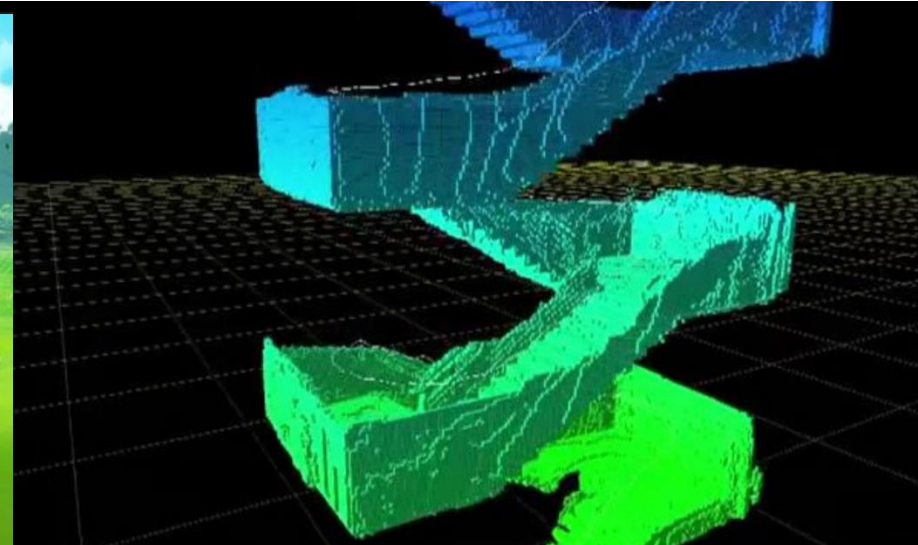
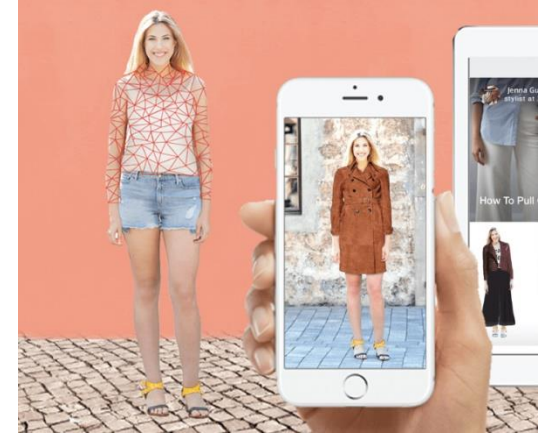
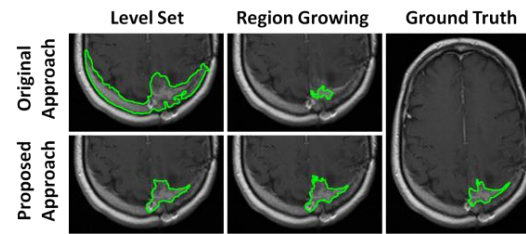
RETAIL	
MONITORING & ANALYTICS	
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SECTORS	
SMART CITY	
SPATIAL LOGIC ZENCITY UTILIS	ZENCITY UTILIS
VISUAL SEARCH syte donde	donde
CONSUMER ROBOTICS & TECH nanit intuition robotics temi RES SCIO	intuition robotics temi SCIO
FITNESS FITSCANNER MyselfFit	MyselfFit
REAL ESTATE Loop Leaperr Flatspace	Flatspace
FASHION SIZER fitfully ZEEKIT	fitfully ZEEKIT
WATER VISION LYNXIGHT DEEP VISION CORAL DETECTION SYSTEM	LYNXIGHT DEEP VISION CORAL DETECTION SYSTEM
EDUCATION, RAIL & TRAVEL RailVISION Anima SeeVooV	RailVISION SeeVooV

More CV related topics

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

Segmentation Results



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- **Course outline**
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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.

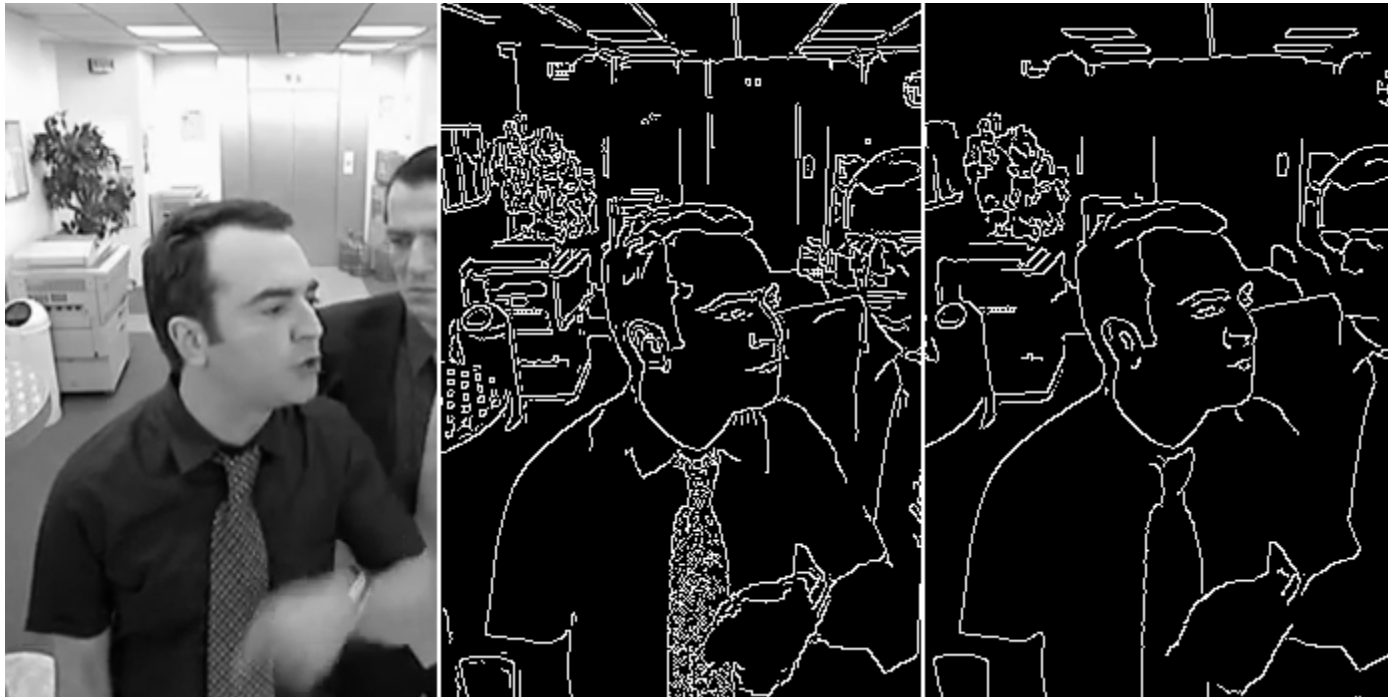
Image processing

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

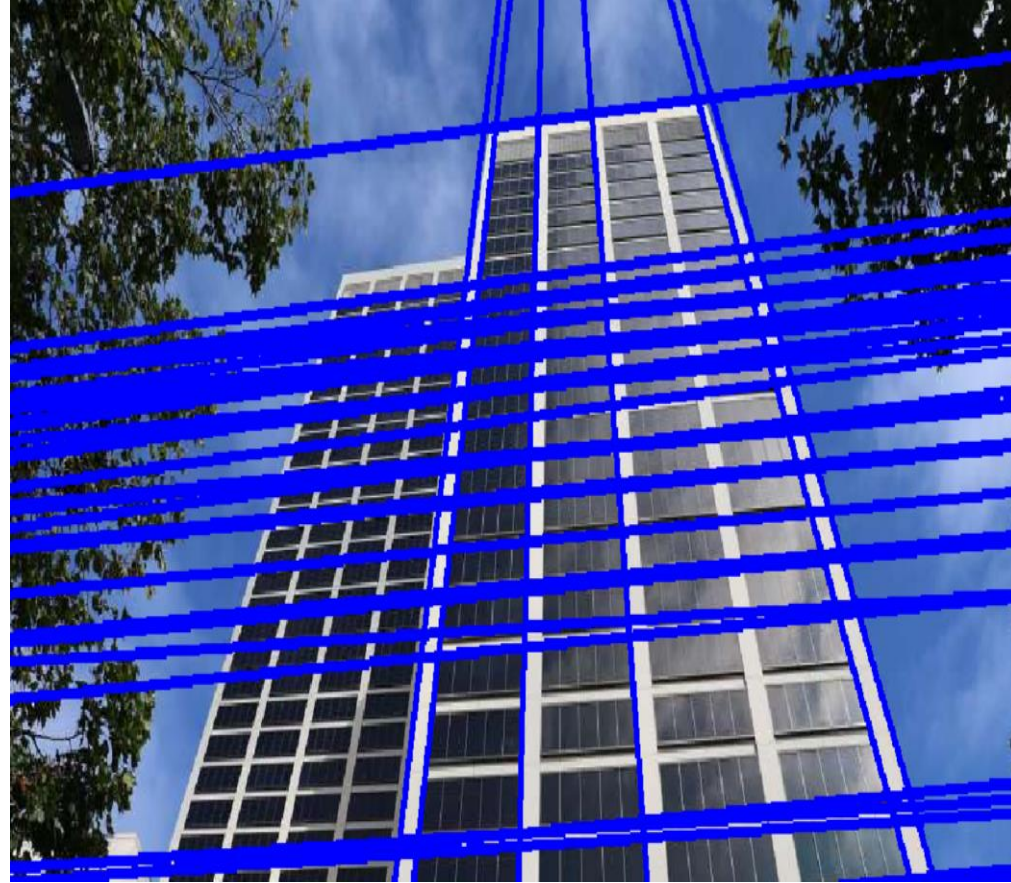
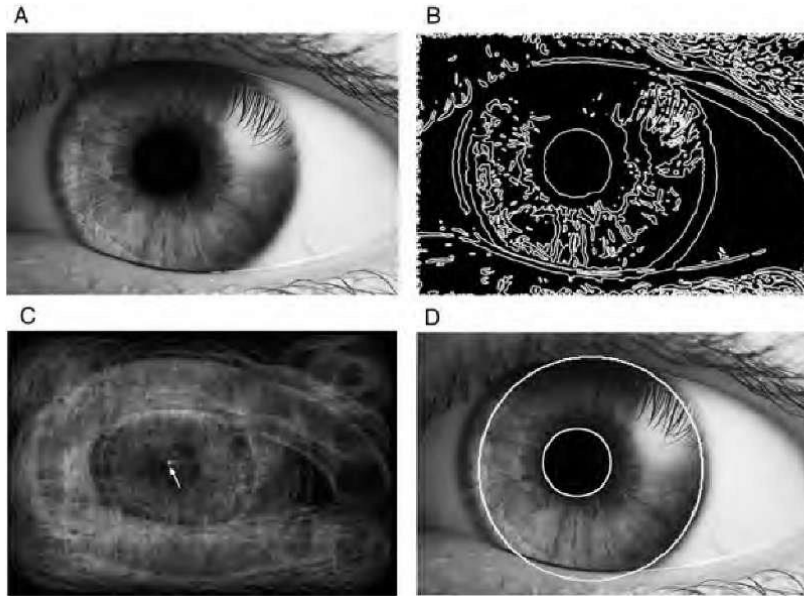


Edge Detection

- <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.

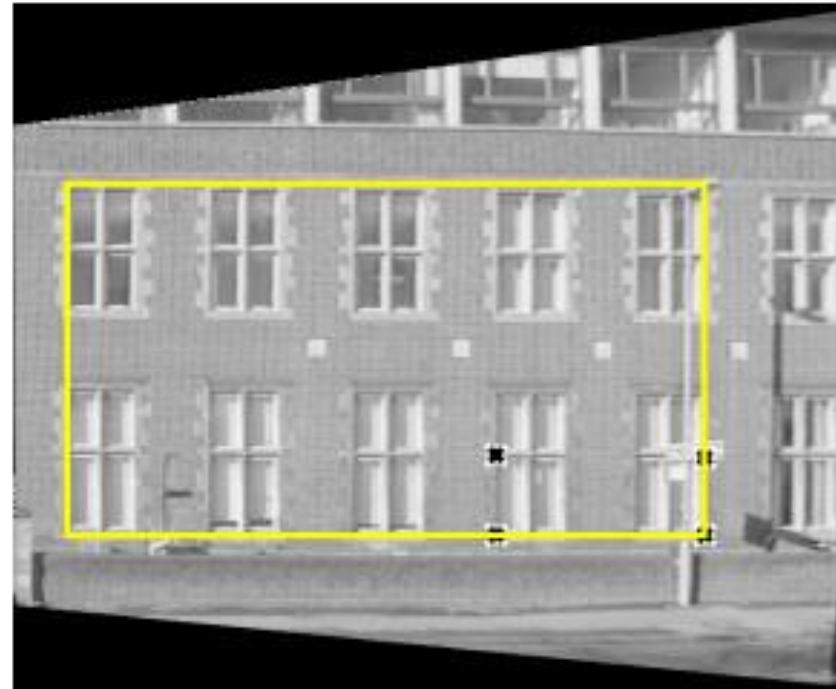
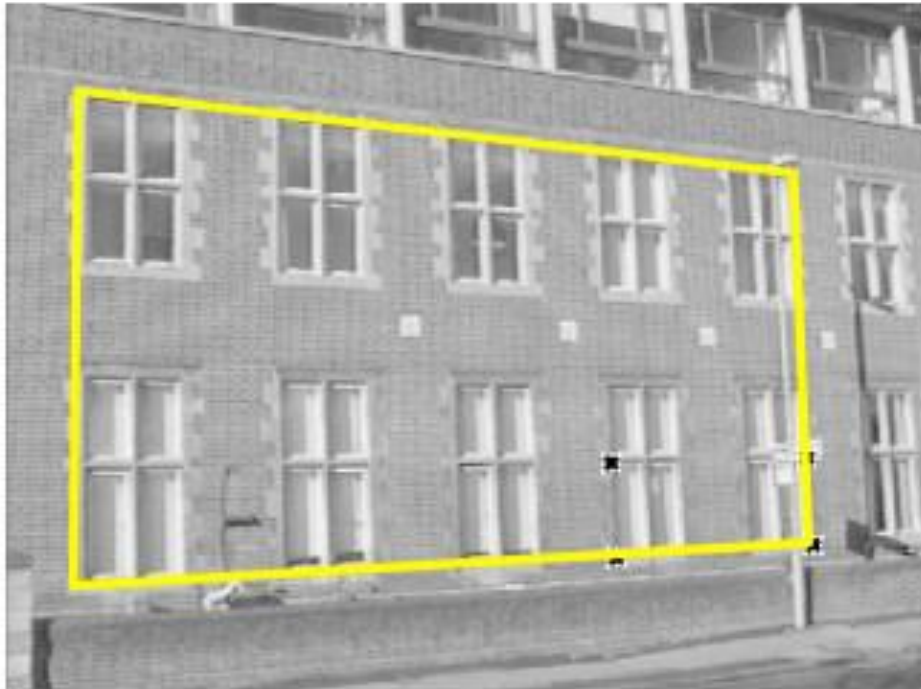


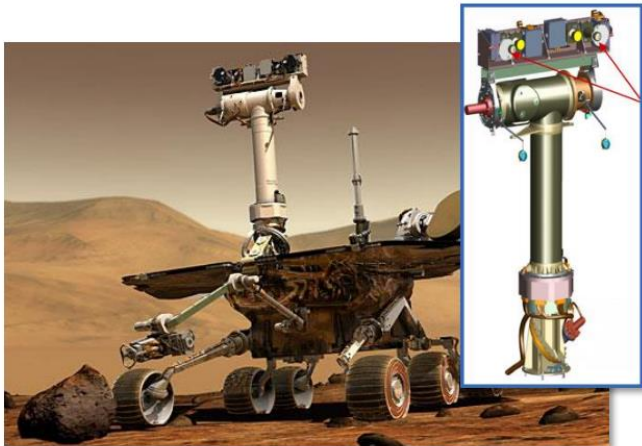
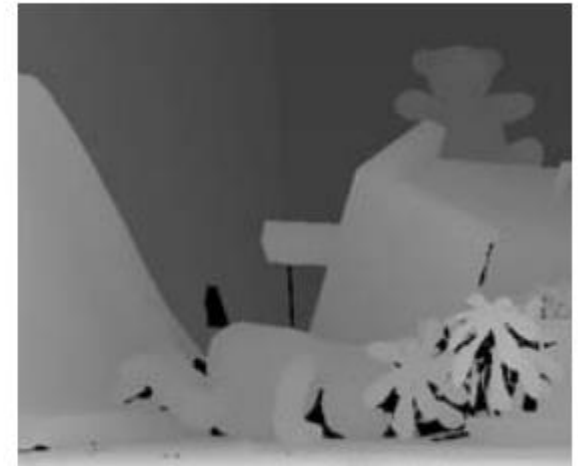
Image calibration

- Fisheye correction from go-pro for example



Stereo & 3d cameras

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



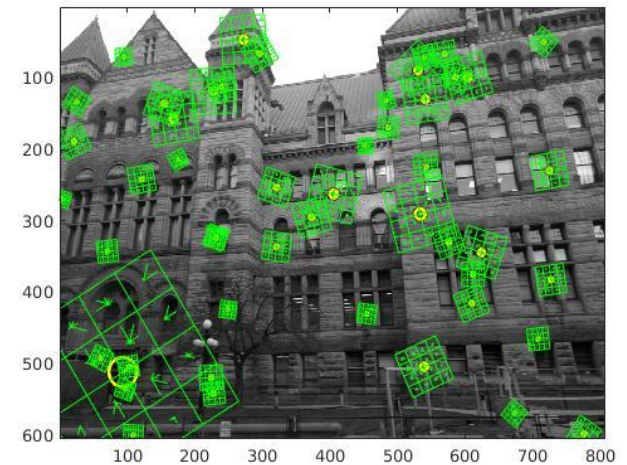
(a)



(b)

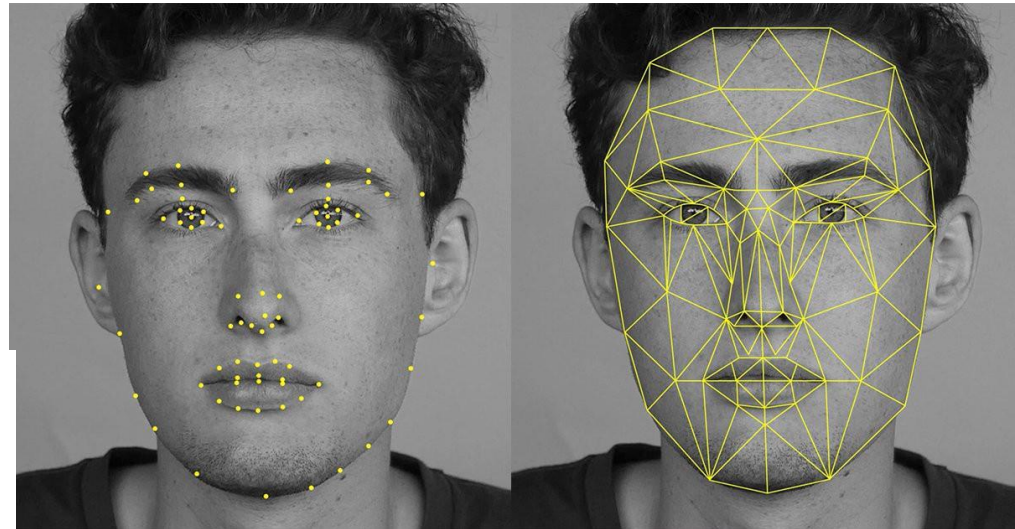
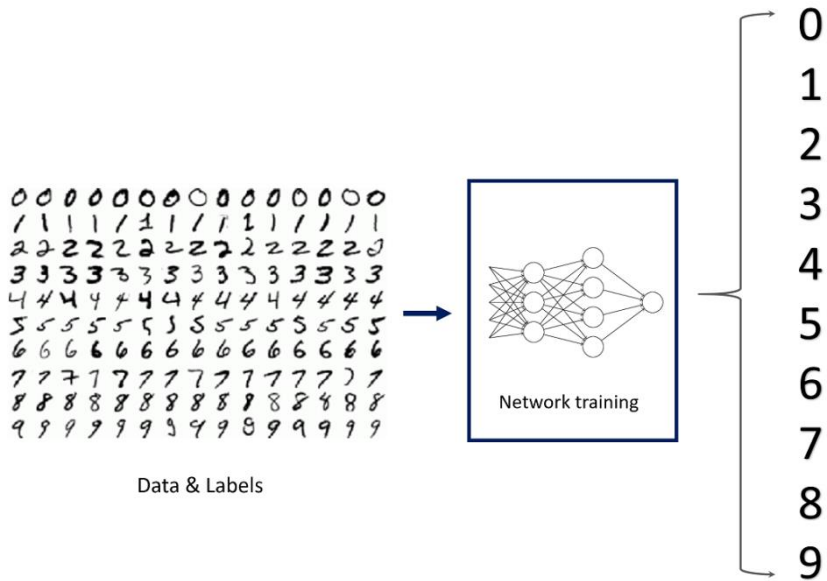
Features

- 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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