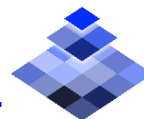


Intro to Computer Vision



Yoni Chechik

www.AliMath.com



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

References

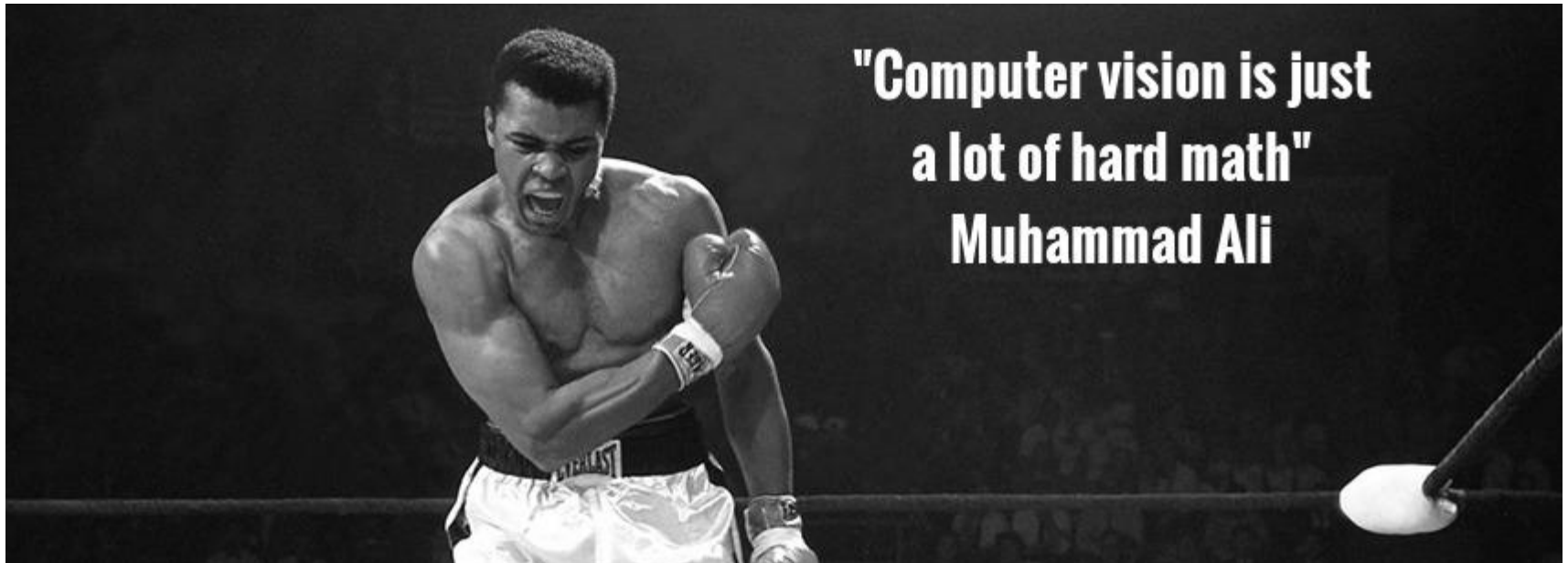
- Lectures Based on the book: **Computer Vision: Algorithms and Applications**, 2010, Richard Szeliski (<http://szeliski.org/Book/>)

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.**

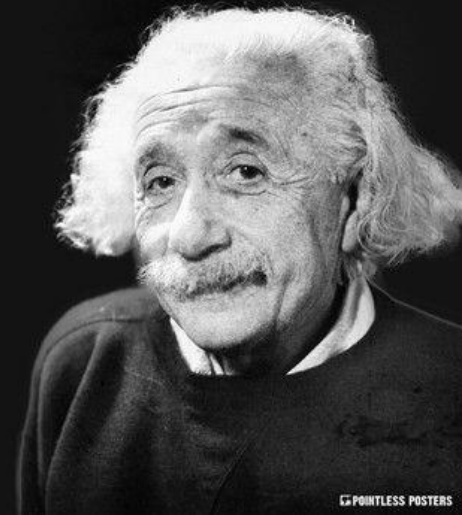


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Don't believe
everything you read
on the internet just
because there's a
picture with a quote
next to it.

ALBERT EINSTEIN

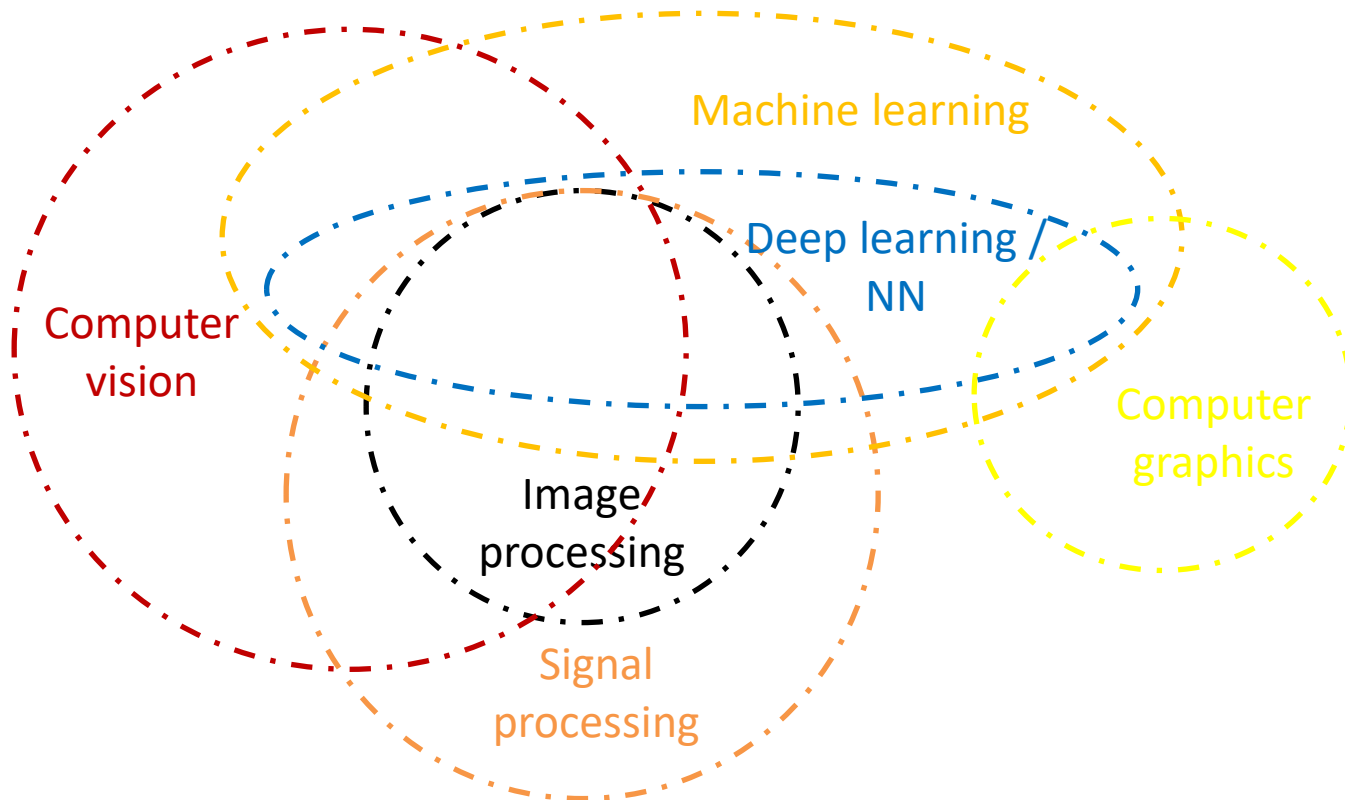


What is CV?

- **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



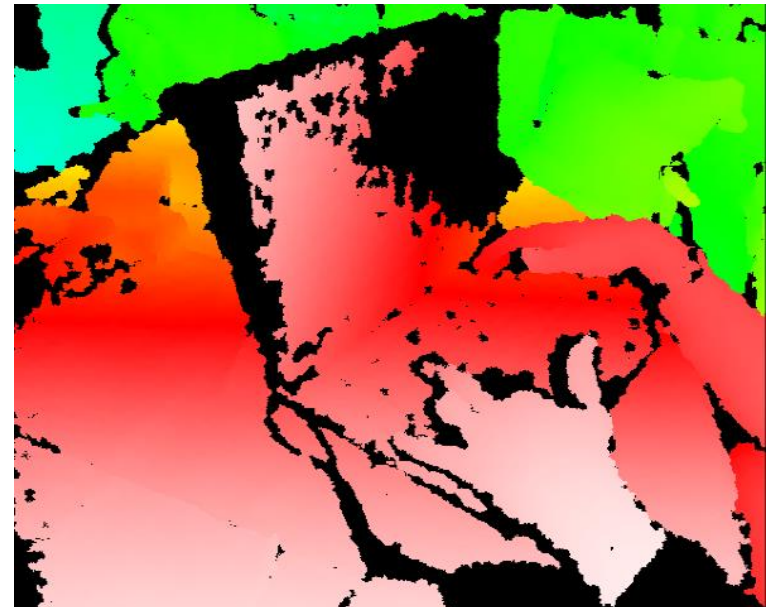
Why CV?

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>



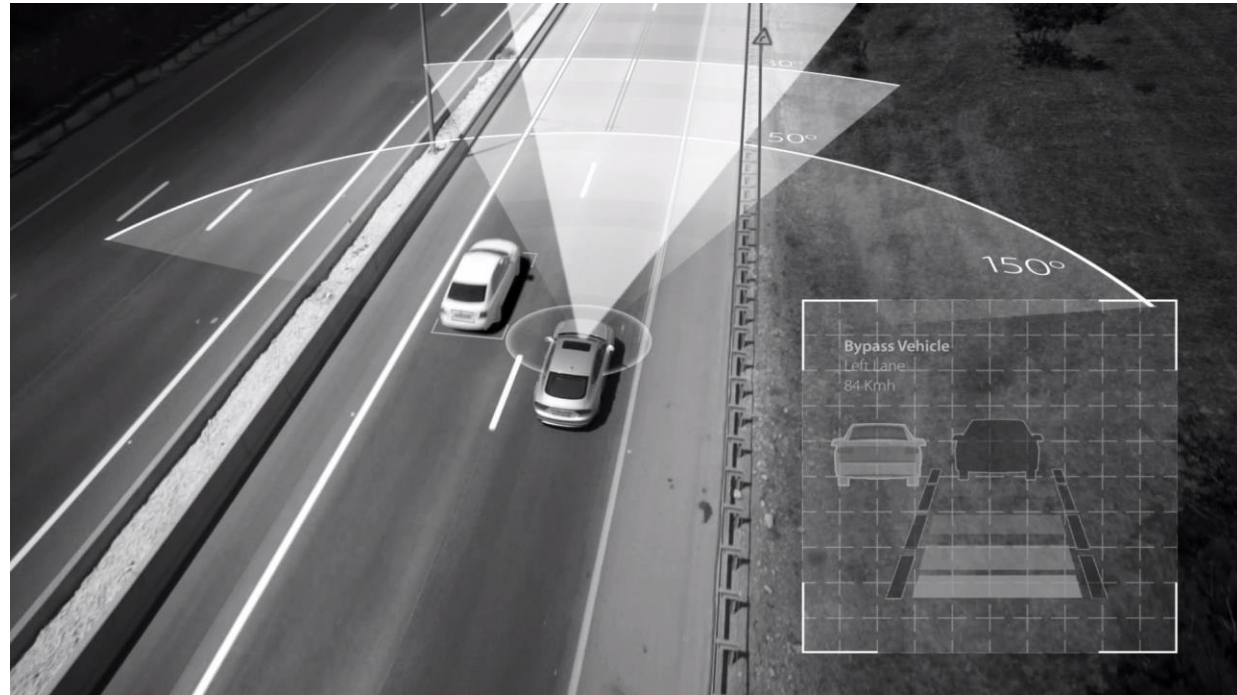
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Mobileye

- **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>
- <https://www.youtube.com/watch?v=fKXztwtXaGo> (Tesla-cooler!)



Why CV?

StartupHub.ai

ISRAEL'S COMPUTER VISION STARTUPS

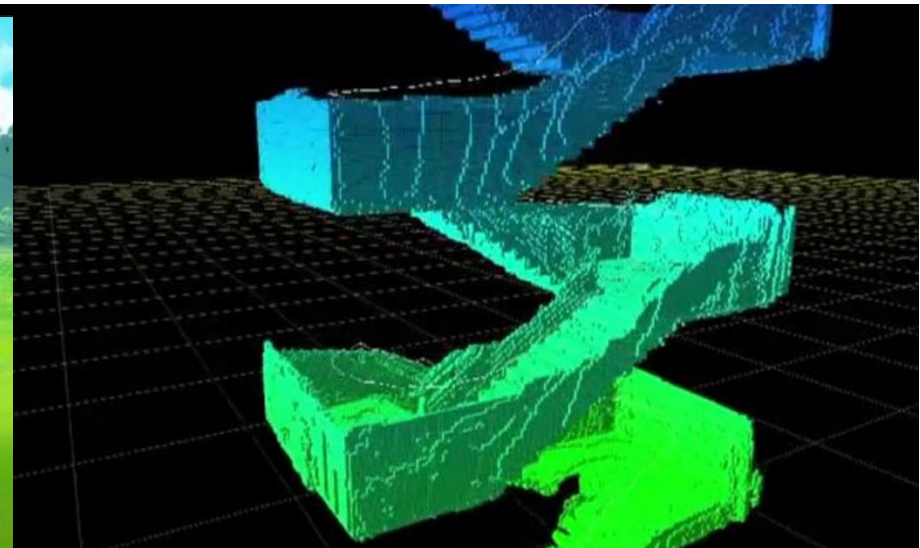
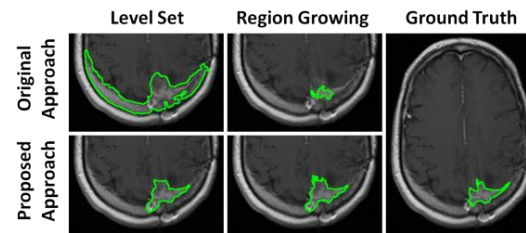


COMPUTER VISION TECHNOLOGY		HEALTHCARE	AUTOMOTIVE	AGRICULTURE	INDUSTRIAL	RETAIL	SECTORS
CHIPS	VIDEO INTELLIGENCE	MEDICAL IMAGING	AUTONOMOUS	CROP MANAGEMENT	ROBOTICS & UTILITIES	MONITORING & ANALYTICS	SMART CITY
Hailo Empowering Intelligence INTEL INTEL 	AGENT2 EyeSafe QUANTUM RGB D Vision viisights GETALERT 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 Imagray 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	HARVESTING	DRONES		FITNESS
missinglink.ai allegro.ai Clay Sciences			MDGO eyesight neteera CLAIR LABS GUARDIAN JUNGO SAVERONE CAARESYS	METOMOTION meshek (76);	XTEND AerialGuard AIROBOTICS skywatch.ai EDGY BEES		FITSCANNER MyselfFit
DATA CREATION			TRAFFIC & MOBILITY	NEW MEDIA	SURVEILLANCE & AUTONOMY	ENTERPRISE	REAL ESTATE
INNEREYE DataGen Technologies edgecase.ai			VALERANN NOTRAFFIC AGENT-TECH EyeWay	Lightricks Magisto Photomyne WIBBITZ tunity DEEPMEN	vhive PERCEPTO	intervyo minereye appliTools tuqqi INTELLIGO voca.ai ActiView TechSee	Leaperr Flatspace
PLATFORM			DEVELOPMENT	TELEOPERATION	CONSTRUCTION	MARKETING	FASHION
Voyager Labs cortica			cognata The Wholly Egg VR, SURGERY & MONITOR ContinUse Biometrics Augmedics VRHealth	Phantom Auto ottopia UVEYE NEOMATIX DASHCAM & ROUTING WHITE RAVEN VIA Parkam riexar	INTSITE astralink OKIBO Datamate CLONE Buildots LIGHTYX CONSTRU	Taboola anyclick BrandTotal AdVeriFai CHEQ TAILOR BRANDS minute cedate COMIGO	2 SIZER fitfully ZEEKIT
EYE TRACKING					INSPECTION	WATER VISION	EDUCATION, RAIL & TRAVEL
Blink					uv-eye NEOMATIX DASHCAM & ROUTING WHITE RAVEN VIA Parkam riexar	LYNXIGHT 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, 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>

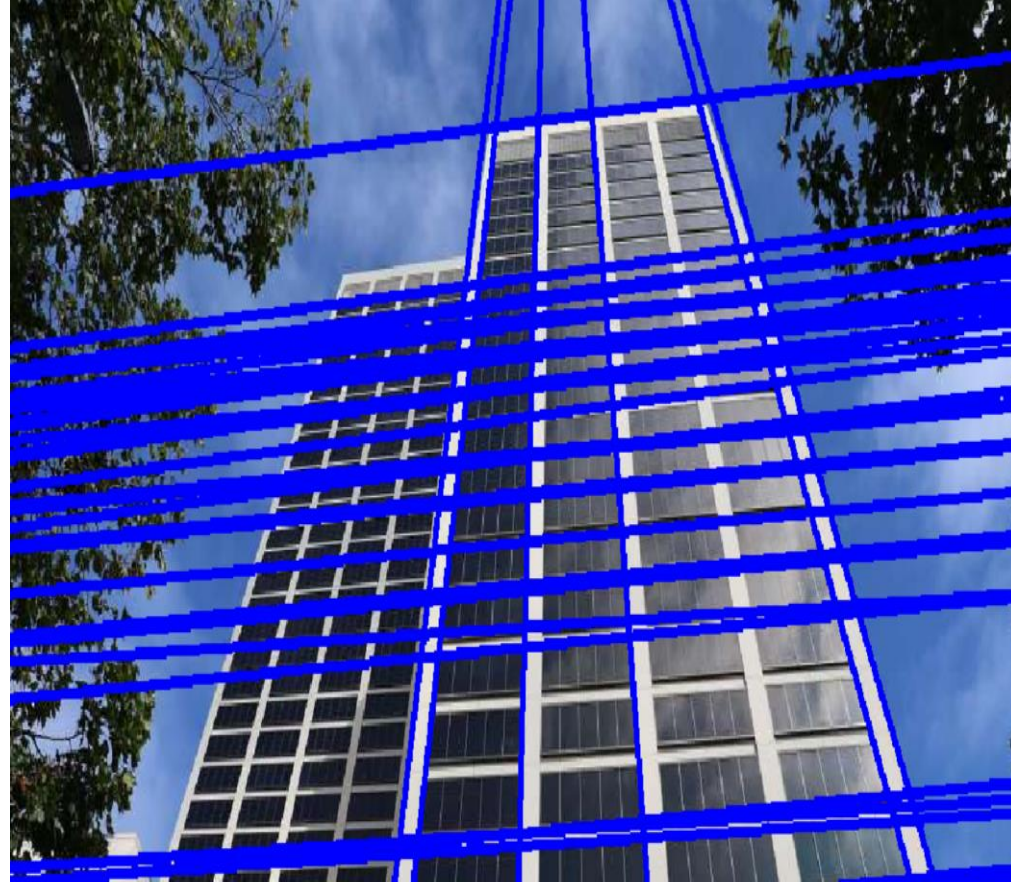
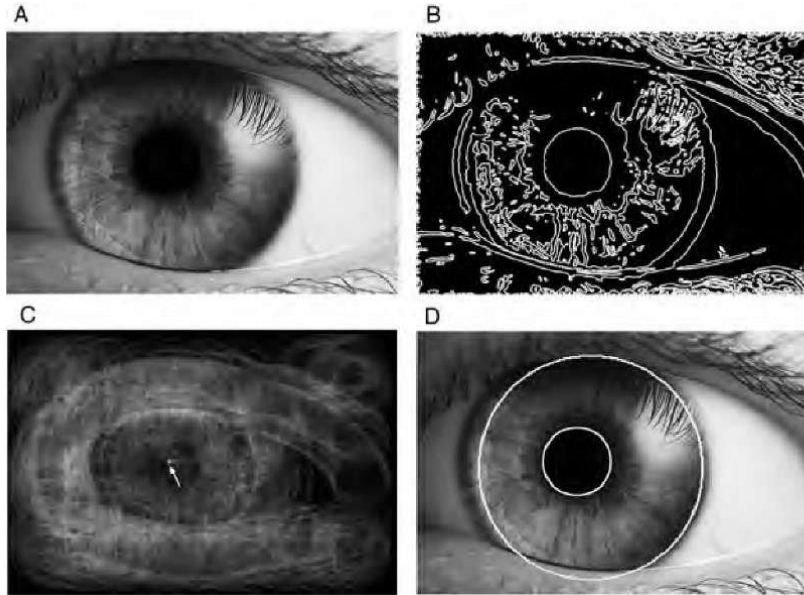


Edge Detection

- <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.

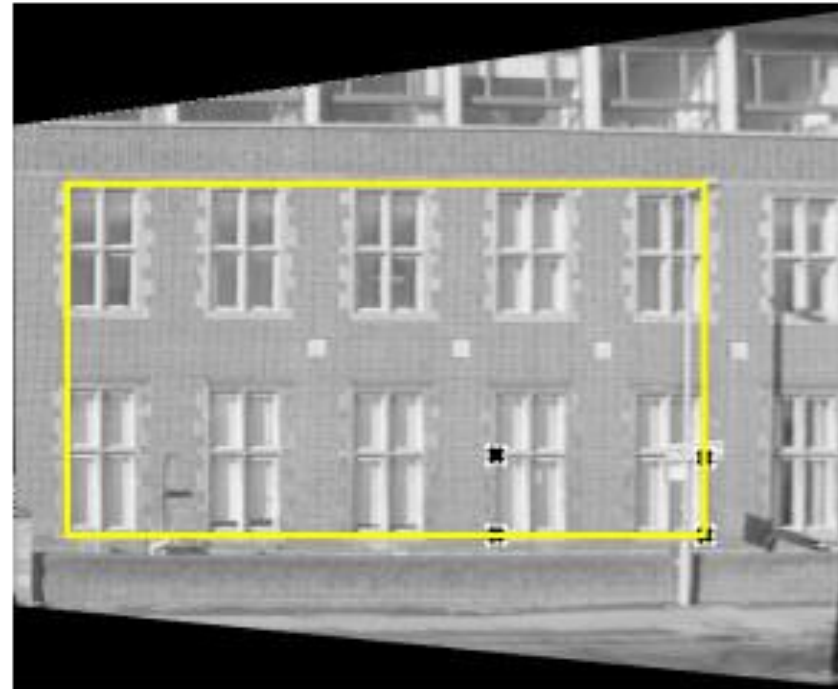
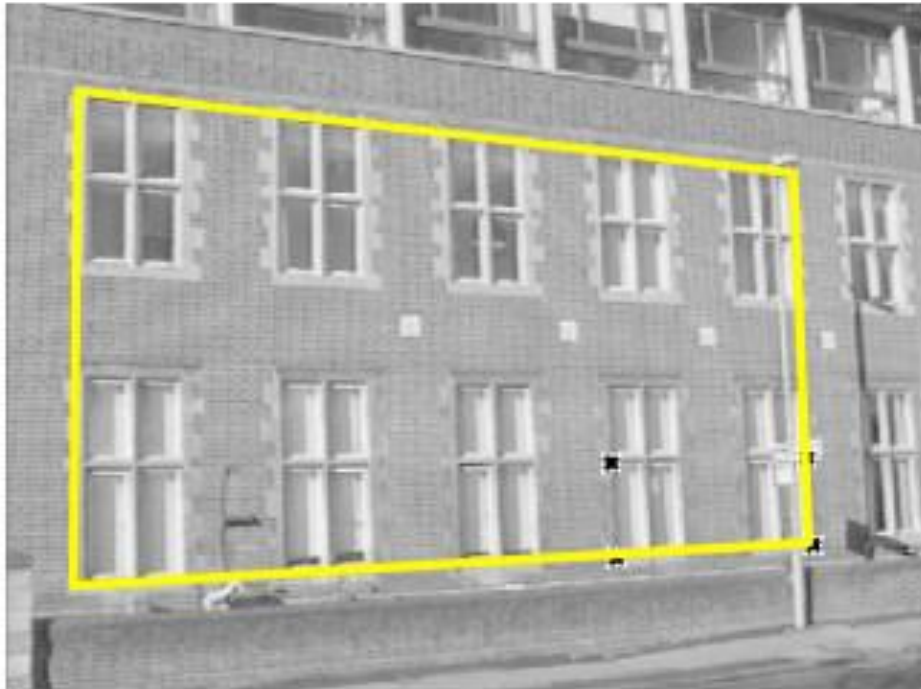


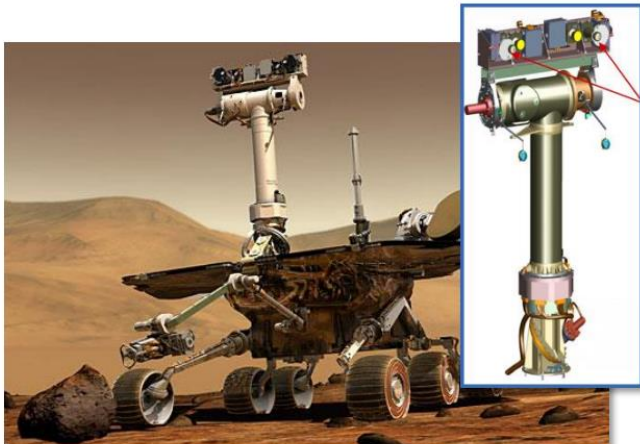
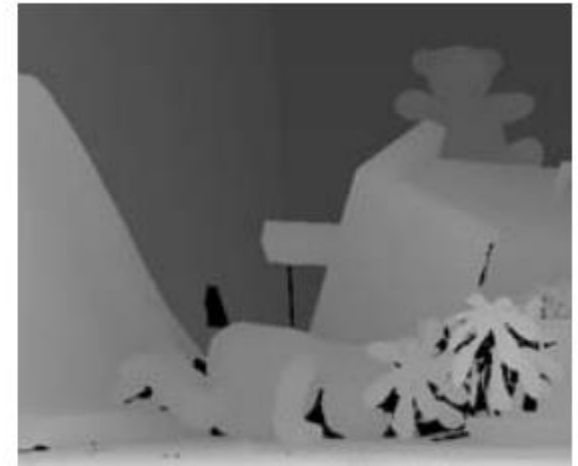
Image calibration

- Fisheye correction from go-pro for example



Stereo & 3d cameras

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



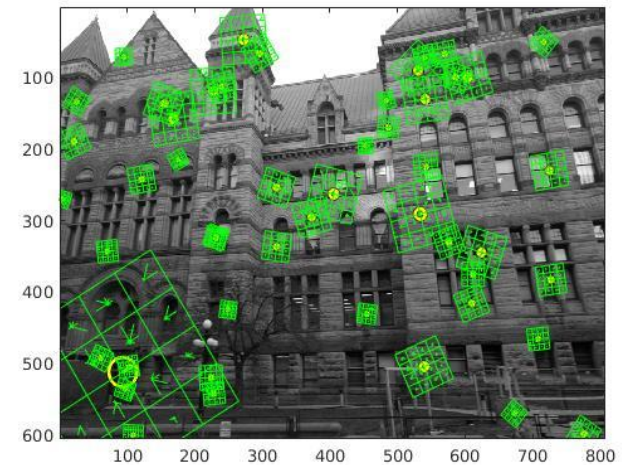
(a)



(b)

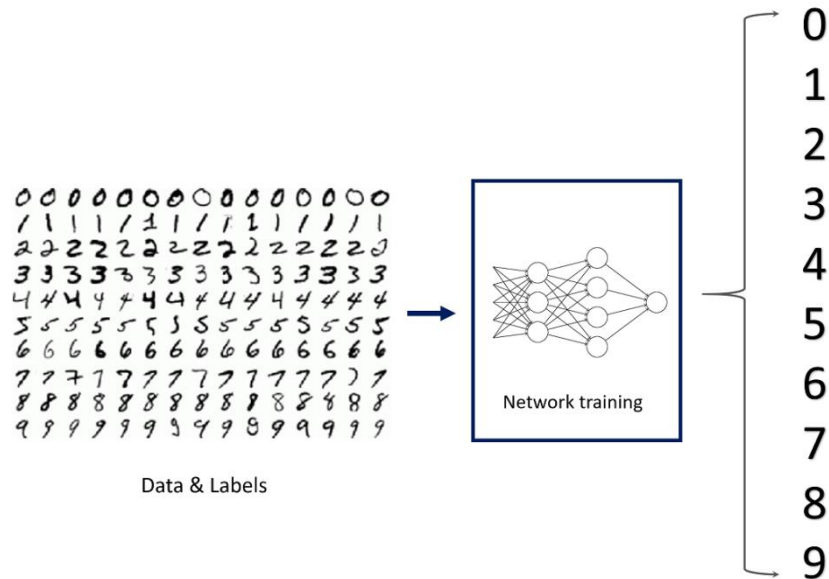
Features

- 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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