

Intro to Computer Vision



Yoni Chechik

www.AliMath.com

contents

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

References

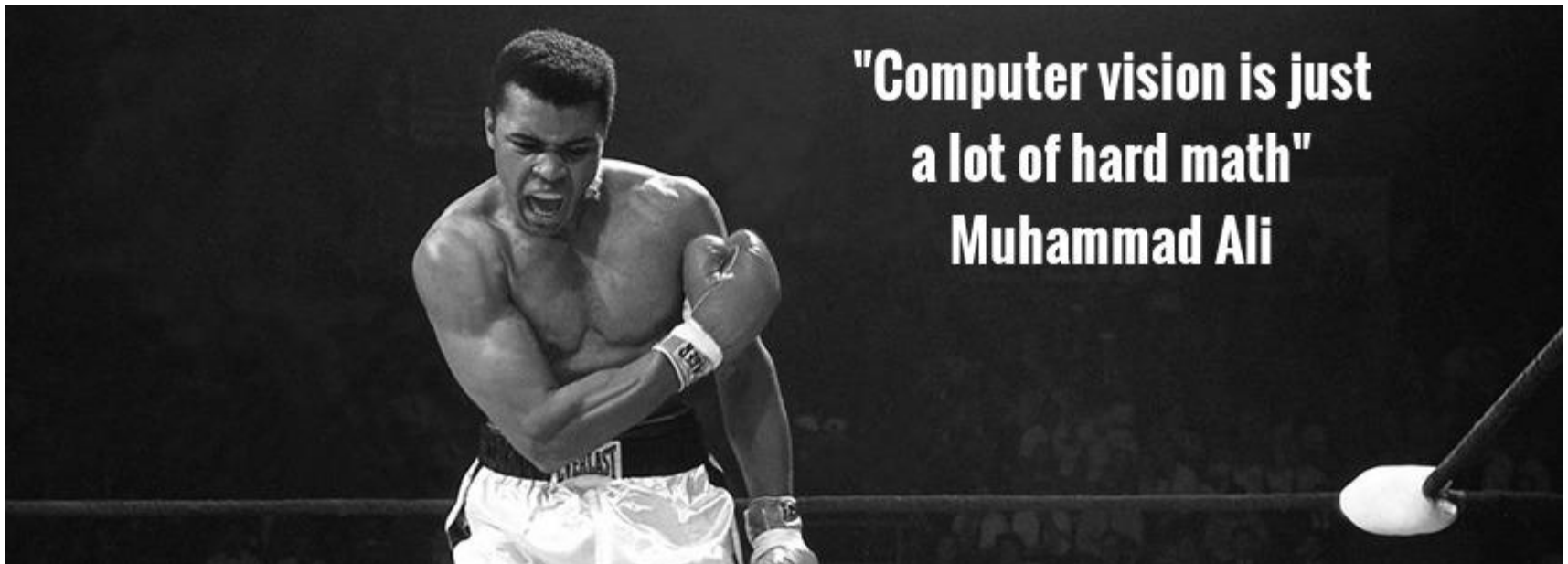
- Lectures Based on the book: **Computer Vision: Algorithms and Applications**, 2010, Richard Szeliski (<http://szeliski.org/Book/>)

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.**

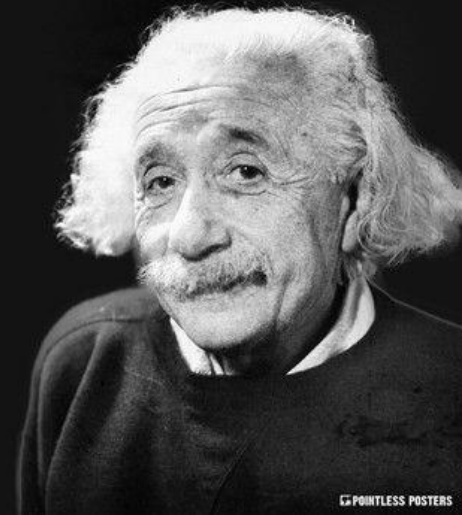


contents

- 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

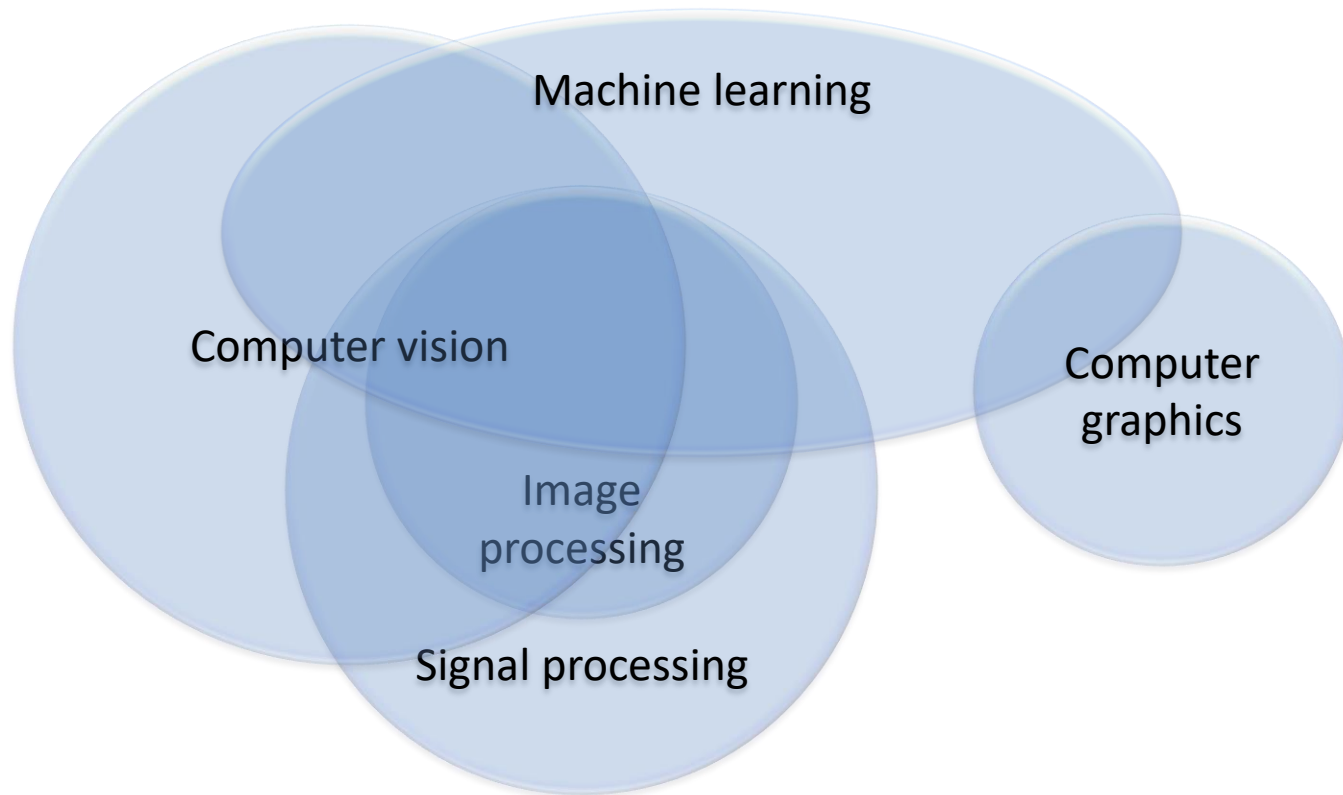


What is CV?

- **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
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	 October – 2016 NA
	 November – 2013 \$360.0M	 January – 2016 NA	 January – 2016 NA	 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>



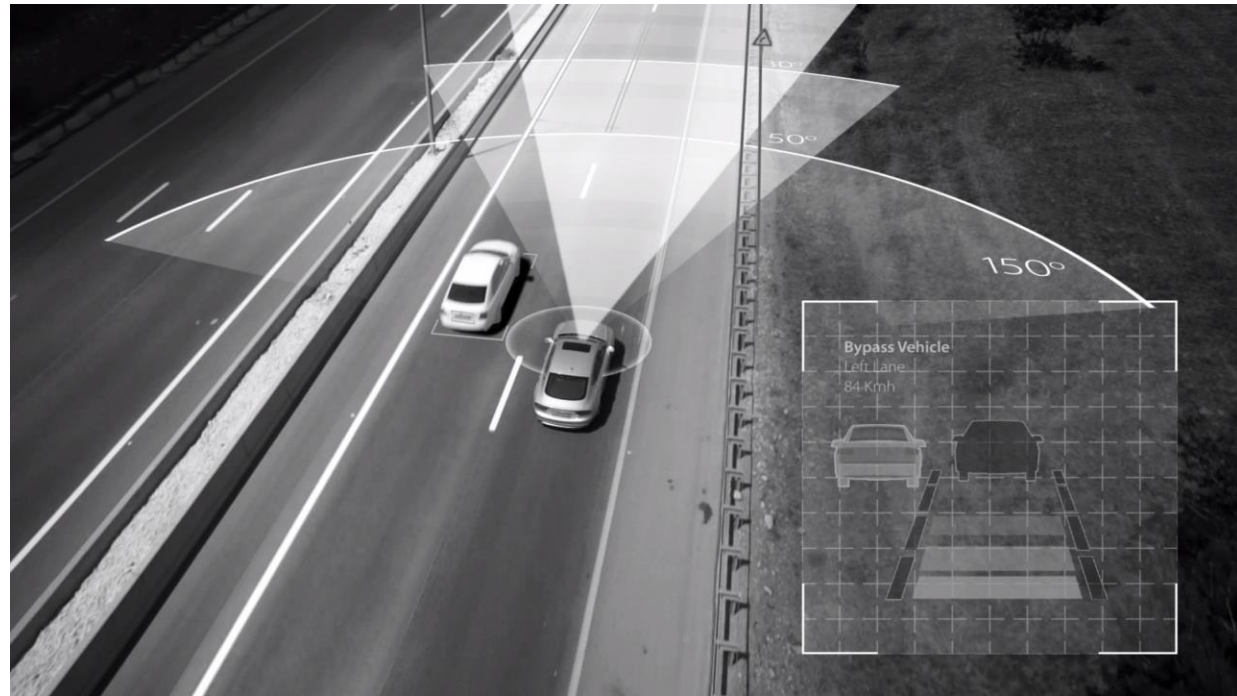
Why CV?

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=JDUb6CurYJM>
- <https://www.youtube.com/watch?v=fKXztwtXaGo> (Tesla-cooler!)



Why CV?

StartupHub.ai

ISRAEL'S COMPUTER VISION STARTUPS

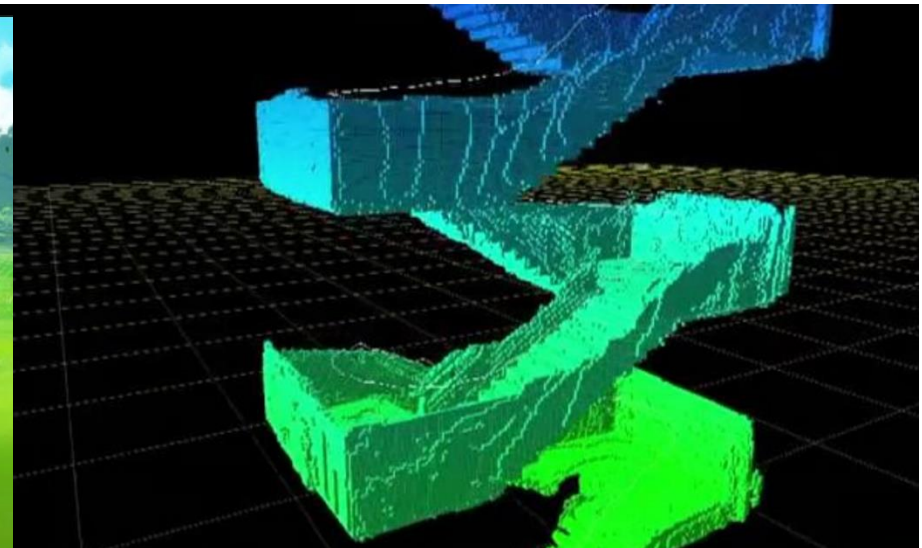


COMPUTER VISION TECHNOLOGY		HEALTHCARE	AUTOMOTIVE	AGRICULTURE	INDUSTRIAL	RETAIL	SECTORS
CHIPS	VIDEO INTELLIGENCE	MEDICAL IMAGING	AUTONOMOUS	CROP MANAGEMENT	ROBOTICS & UTILITIES	MONITORING & ANALYTICS	SMART CITY
Hailo INTEL Movidius Brodmann Edgify REDFALCON Vayyar Kaya Instruments Trieve Newsight Imaging Unispectral Missinglink.ai Allegro.ai Clay Sciences Innereye DataGen Technologies Edgecase.ai Voyager Labs Cortica Blink	Agent EyeSafe Quantum RGB Dvision Viisights GETALERT VIDEO Inform SENSORITY videocites ZyroBot XR Vision 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 MEDICAL VISION iz.ai aidoc BODY VISION DIA MobileODT maxQ sight Biomedical FDNA innogy HT DeePathology.ai ORCA DENTAL AI PerSimo RADLogics TECHSOMED IBEX X-PRINT XRAY MEDICAL VISION MAGENTIQ IMedis Deep Oncology nucleai SCOPIO @ MedHub-AI	arbe Imagry INNOVIZ TECHNOLOGIES Kodiak i4drive ADASXY Oryx Vectoraic RIDEVISION RAM StreetLight.ai CRadar.AI BWV Bright Way Vision RFISSE IONTERRA VAYAVISION VOYAGE 81 MDGO eyesight neteera CLAIR LABS GUARDIAN optical technologies JUNGO S AVERONE CAARESYS	TARANIS prospera See Tree SKYX fieldin AgroScout arugga saillog SeedX GemmaCert HiGrade HARVESTING METOMOTION AUTOMATO meshek (76); NEW MEDIA PHOTO & VIDEO CREATION Lightricks Magisto Photomyne WIBBITZ tunity DEEPNEN TELEOPERATION Phantom Auto ottopia INSPECTION UVEYE NEOMATIX DASHCAM & ROUTING WHITE RAVEN VIA Parkam flexar	Planet Watchers KITOV SYSTEMS DLR COGNITEAM MOVI ROBOTICS SKYLINE ROBOTICS IPV ORCA AI pzartech BladeRanger DRONES SURVEILLANCE & AUTONOMY XTEND AerialGuard AIROBOTICS skywatch.ai EDGY BEES ClearVuze Sightec HIGH LANDER Sightec CIVDRONE vHive PERCEPTO CONSTRUCTION INSPECTION & MANAGEMENT INTSITE astralink OKIBO Datamate CLONE ARCadio Buildots LIGHTYX CONSTRU	trax trigo eyezon WISE SHELF memomi MYSTOR-E SPORTS ANALYTICS & CONTENT playsight TRACK160 WSC Sports PhysiMax Pixellot SenSwim Zone7 LVISION Baseline ENTERPRISE SECURITY, DEV. & SUPPORT intervyo minereye appltools tuuqi INTELLIGO voca.ai ActiView TechSee MARKETING VIDEO, CONTENT & SECURITY Taboola anyclip BrandTotal AdVeriFai CHEQ TAILOR BRANDS minute cedate COMIGO	ZENCITY SPATIAL LOGIC UTILIS VISUAL SEARCH syte dlonde CONSUMER ROBOTICS & TECH nanit intuition robotics t e m i robotics RES scio FITNESS FITSCANNER MyselfFit REAL ESTATE Leaperr Flatspace FASHION SIZER fitfully ZEEKIT WATER VISION 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, 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.

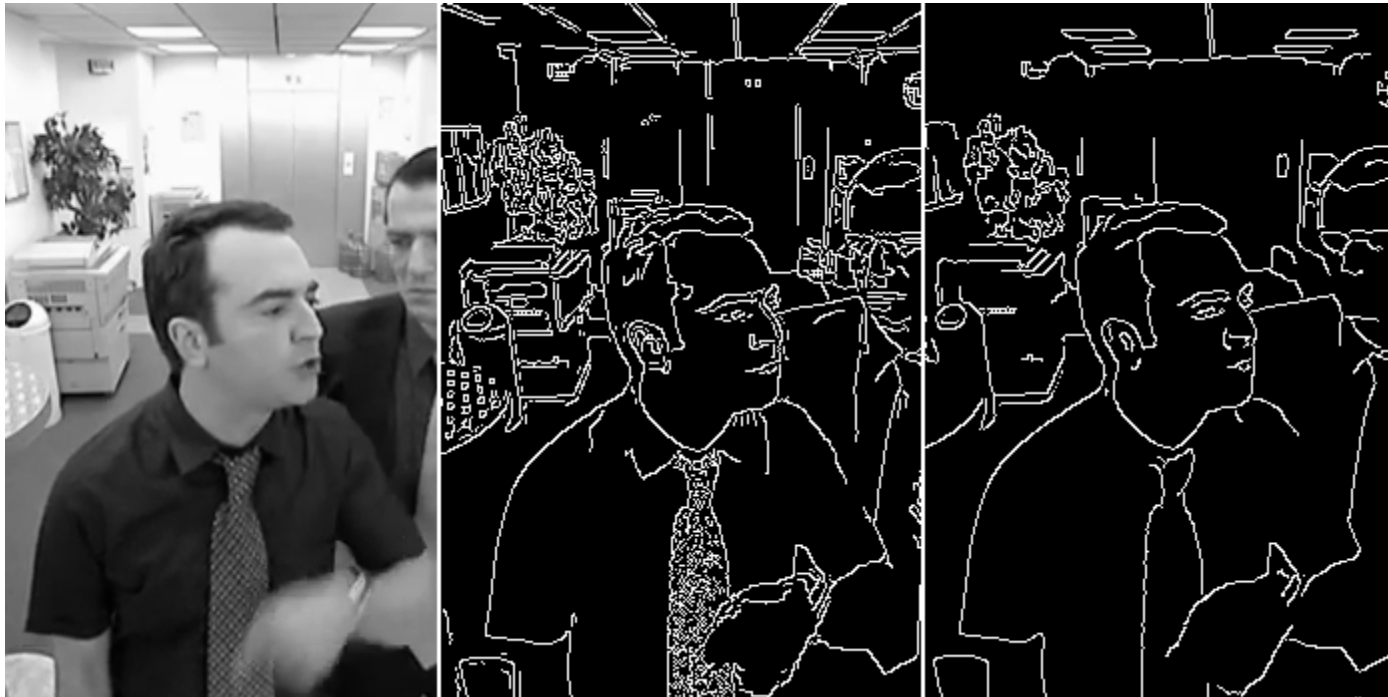
Image processing

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

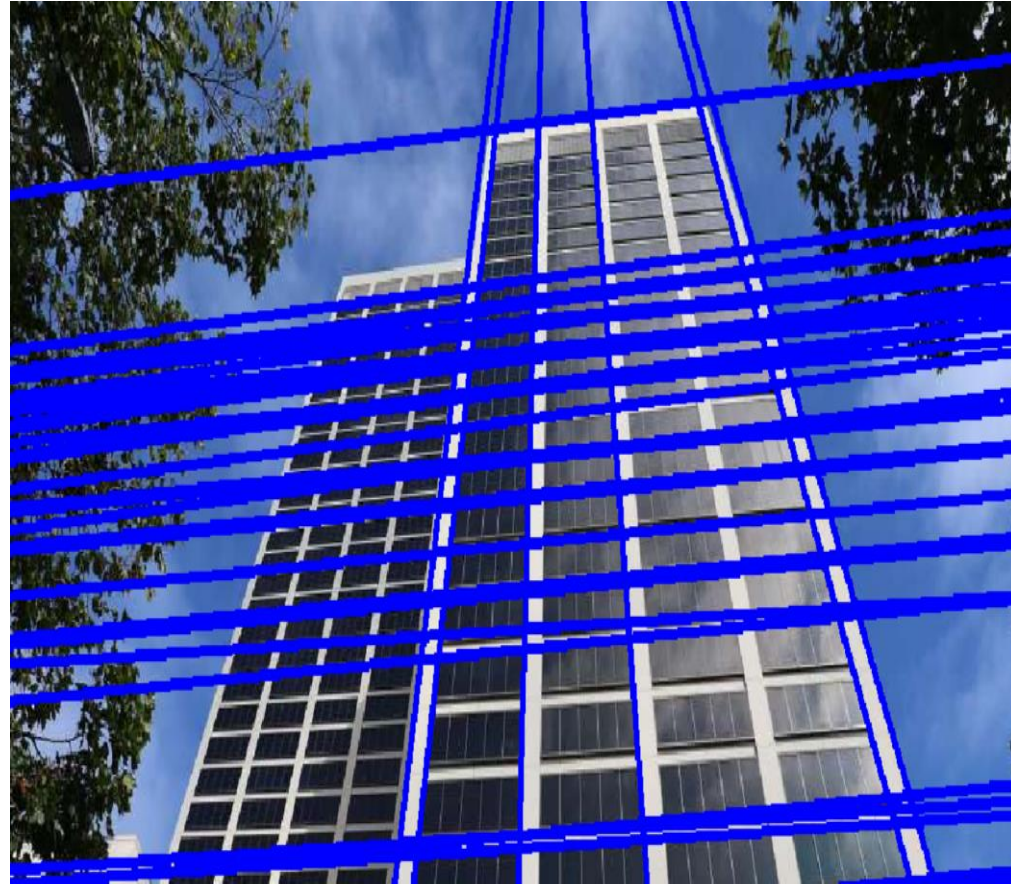
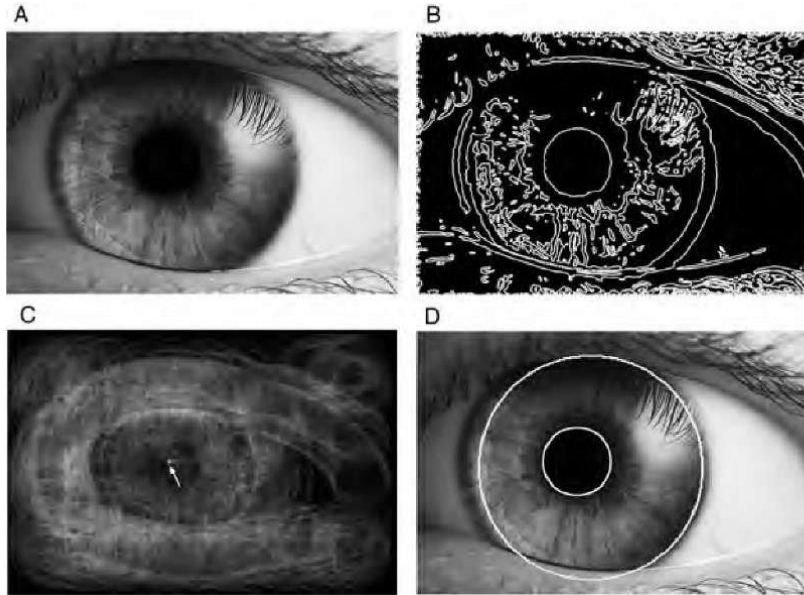


Edge Detection

- <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.

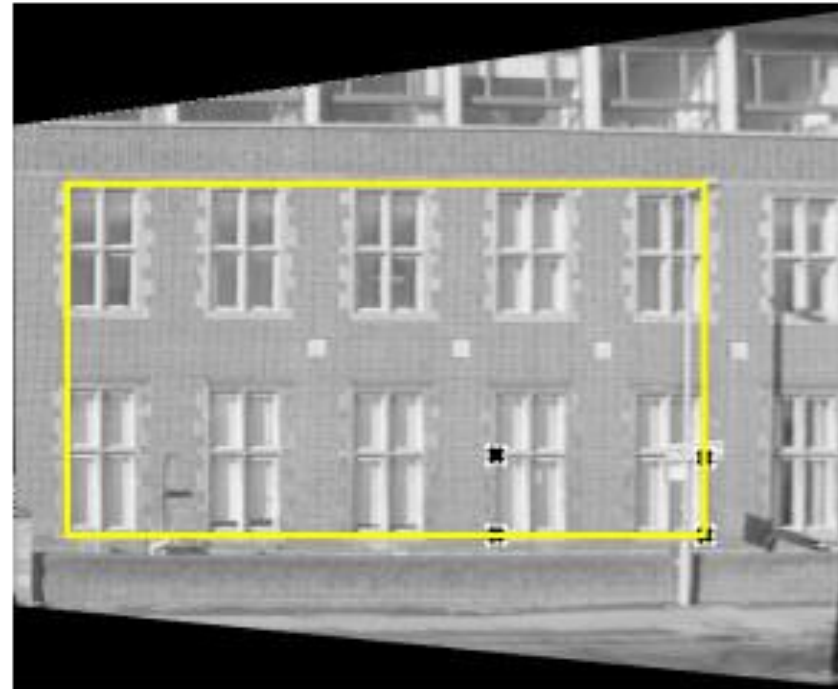
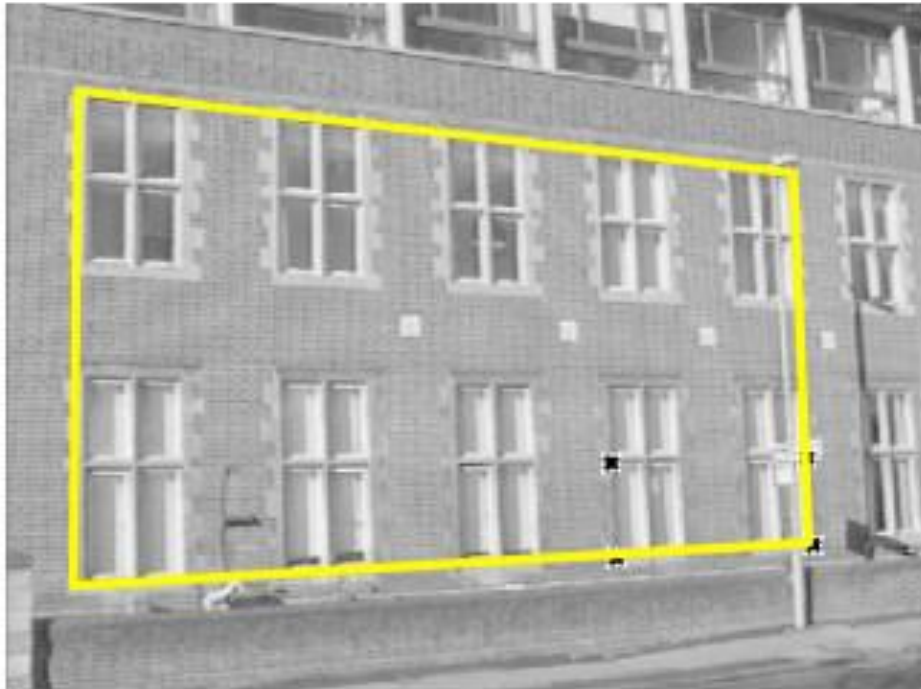


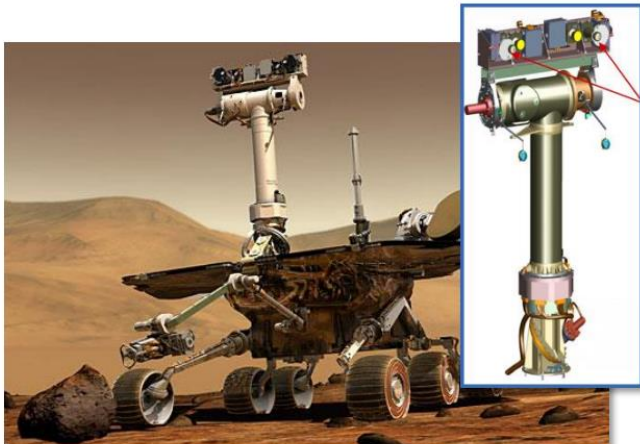
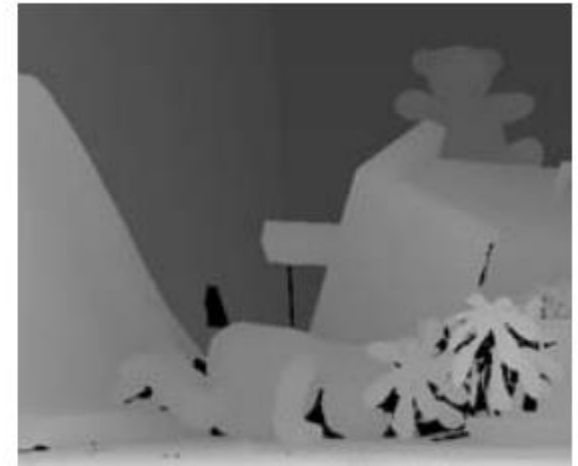
Image calibration

- Fisheye correction from go-pro for example



Stereo & 3d cameras

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



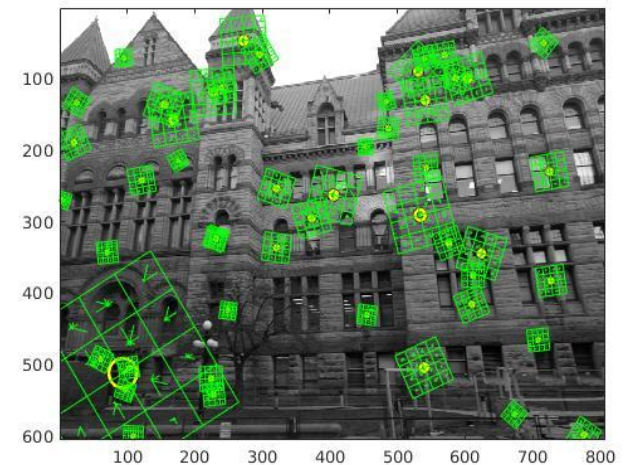
(a)



(b)

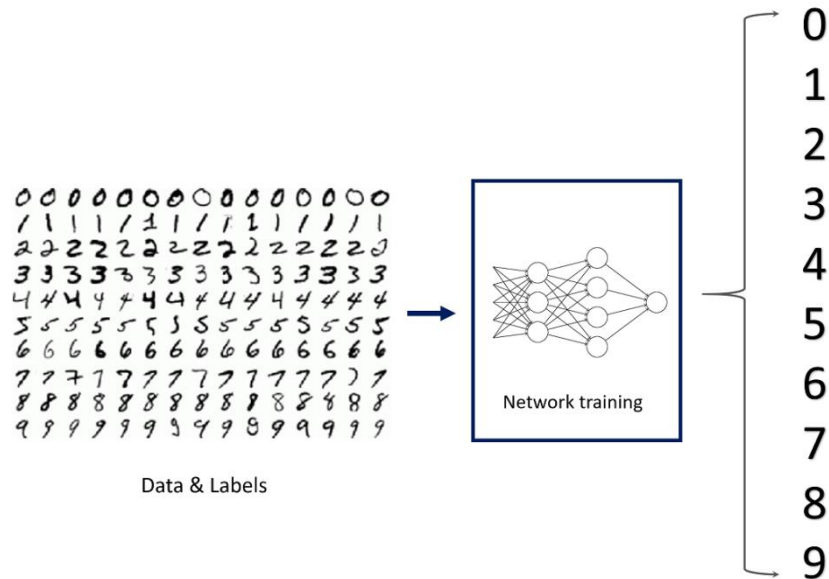
Features

- 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>

contents

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