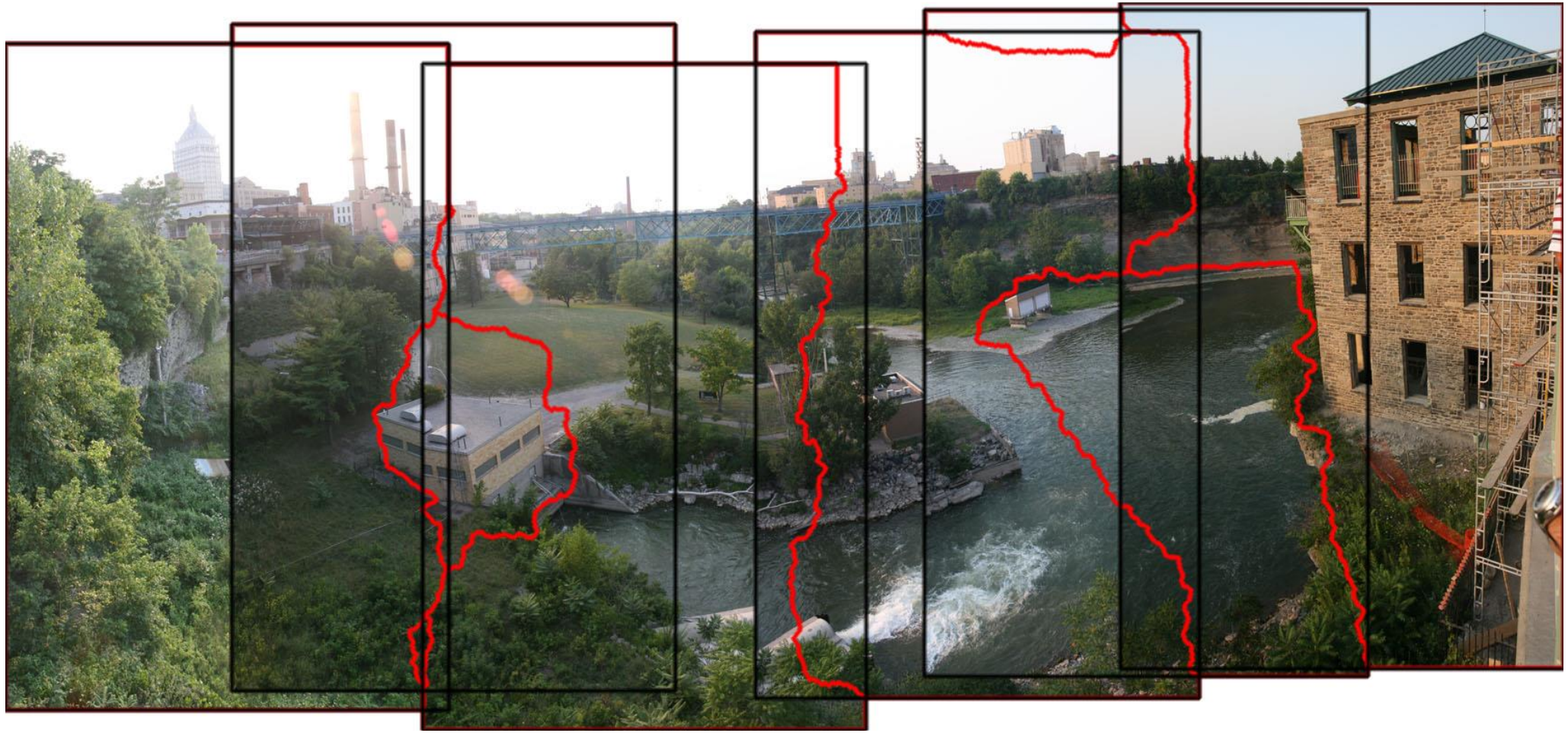
Friedrich-Alexander-Universität
Technische Fakultät

Introduction to Computer Vision

Computer Vision

Summer Semester 2023

Phone Cameras – Image Stitching

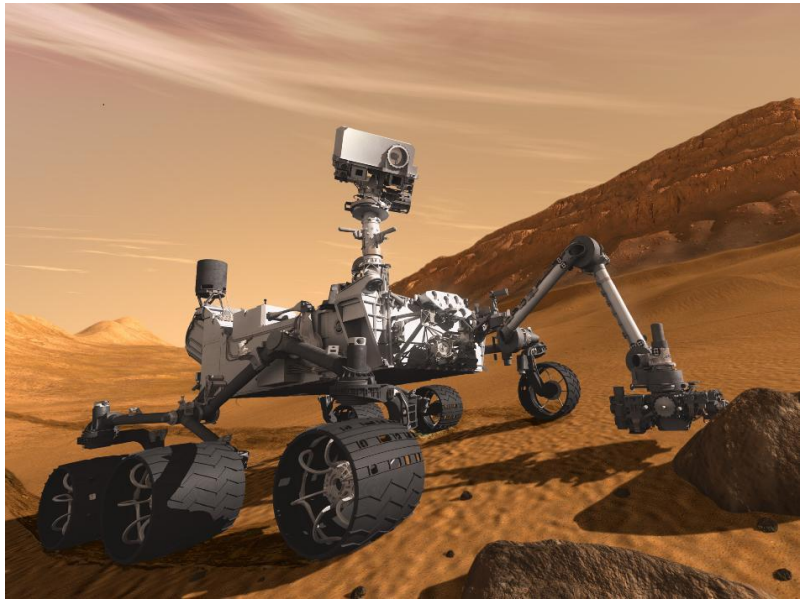


https://en.wikipedia.org/wiki/Image_stitching#/media/File:Rochester_NY.jpg

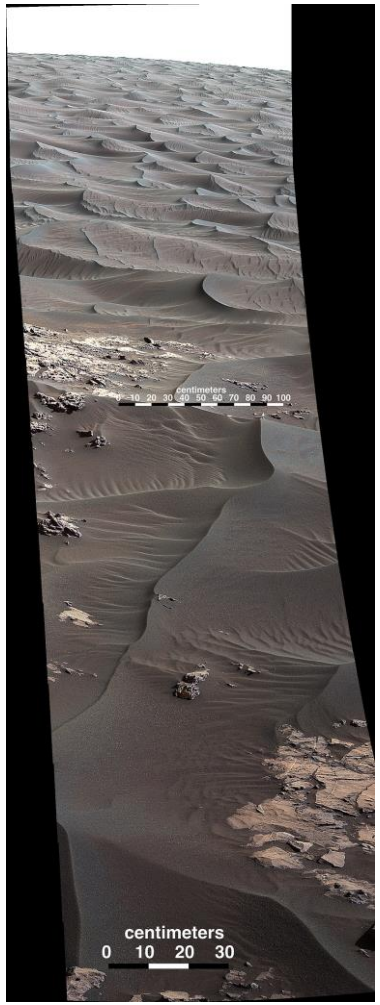
Google Street View

Picture: El bes
https://de.wikipedia.org/wiki/Datei:Google_Street_View_Vienna_02.JPG

Vision In space



https://en.wikipedia.org/wiki/Computer_vision#/media/File:Mars_Science_Laboratory,_2011-Present.jpg



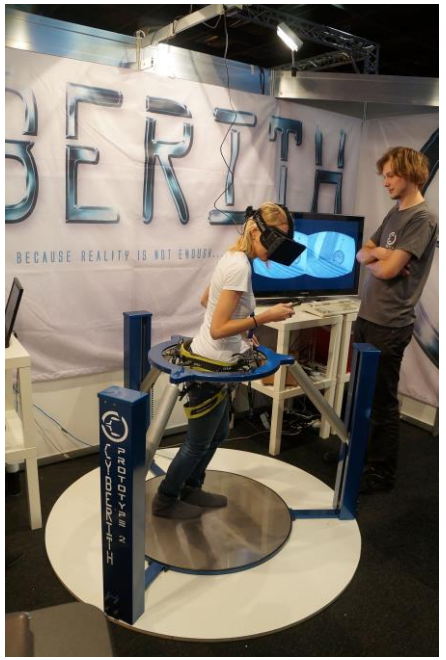
https://de.wikipedia.org/wiki/Mars_Science_Laboratory#/media/Datei:Pia20168-figa_sol-1176ml05329_scale.jpg

Vision systems (JPL) used for several tasks

- Panorama stitching
- 3D terrain modeling
- Obstacle detection, position tracking
- For more, read “Computer Vision on Mars” by Matthies et al.

VR/AR

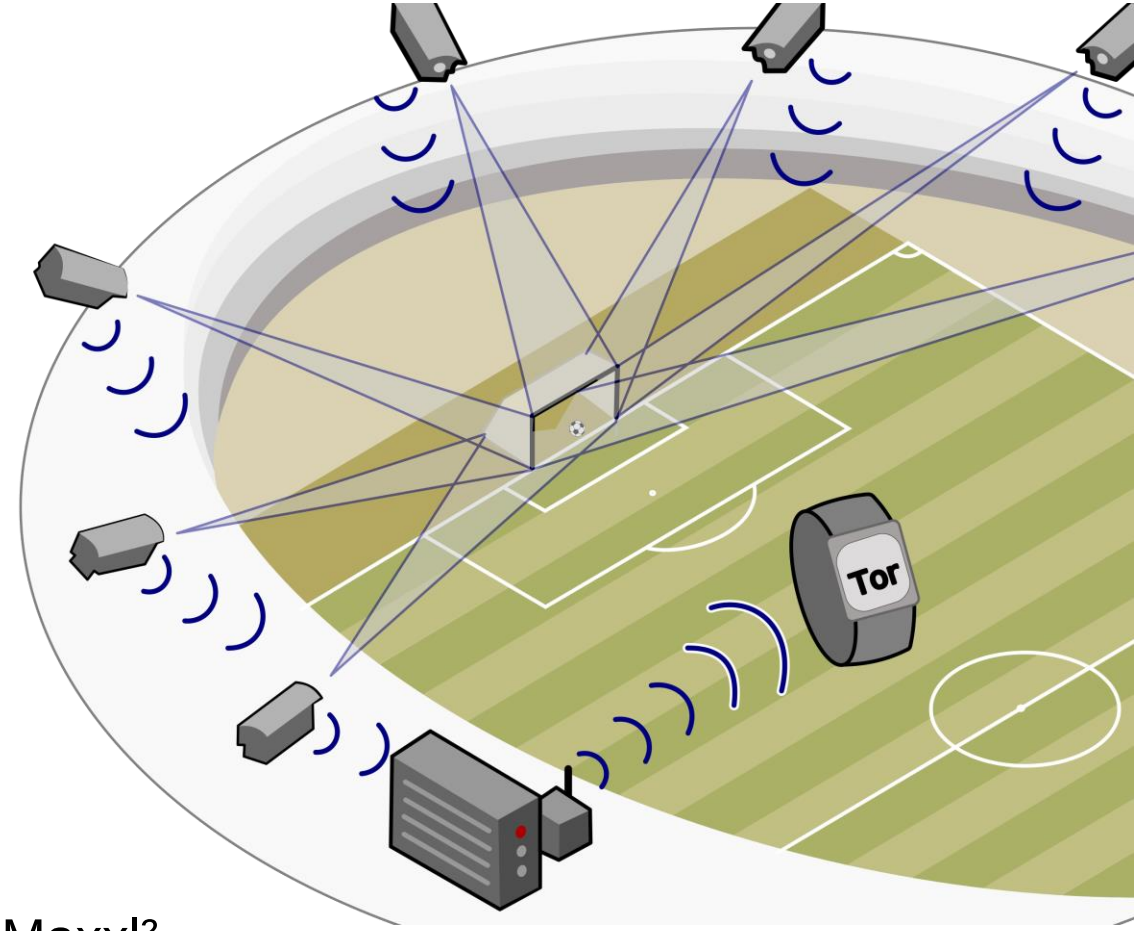
Picture: Maxibu
https://de.wikipedia.org/wiki/Erweiterte_Realit%C3%A4t#/media/Datei:AR_Virtual_Art.png



Picture: Oleg 2525
https://de.wikipedia.org/wiki/Virtuelle_Realit%C3%A4t#/media/Datei:Cyberith_Virtualizer.JPG

MS HoloLens, Oculus,
Magic Leap,
ARCore / ARKit

Sports



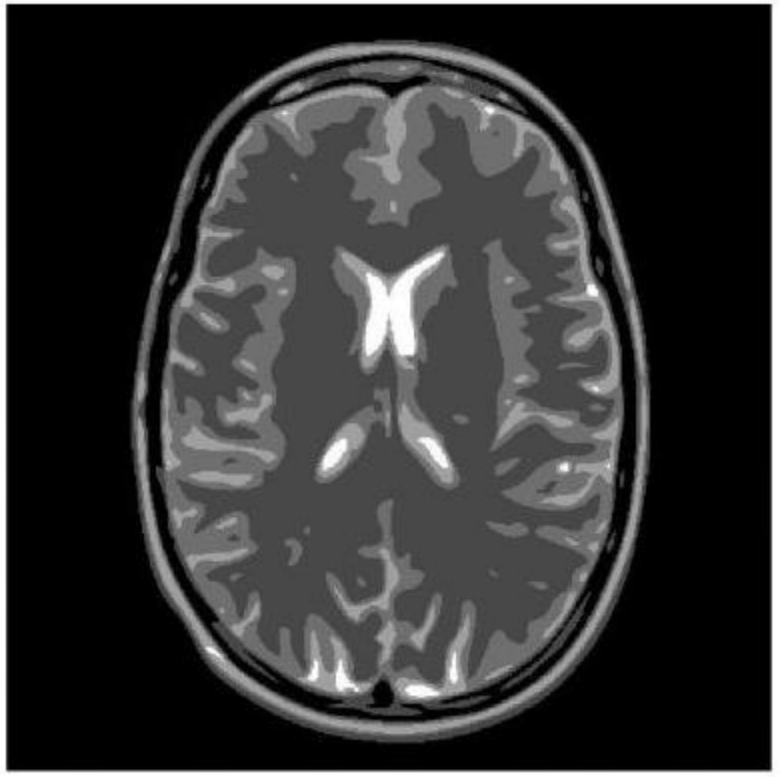
Picture: Maxxl²

https://en.wikipedia.org/wiki/Goal-line_technology#/media/File:Goalcontrol.svg

Industrial Robots - Automation

Picture: Siyuwj
https://en.wikipedia.org/wiki/Automotive_industry#/media/File:Geely_assembly_line_in_Beilun,_Ningbo.JPG

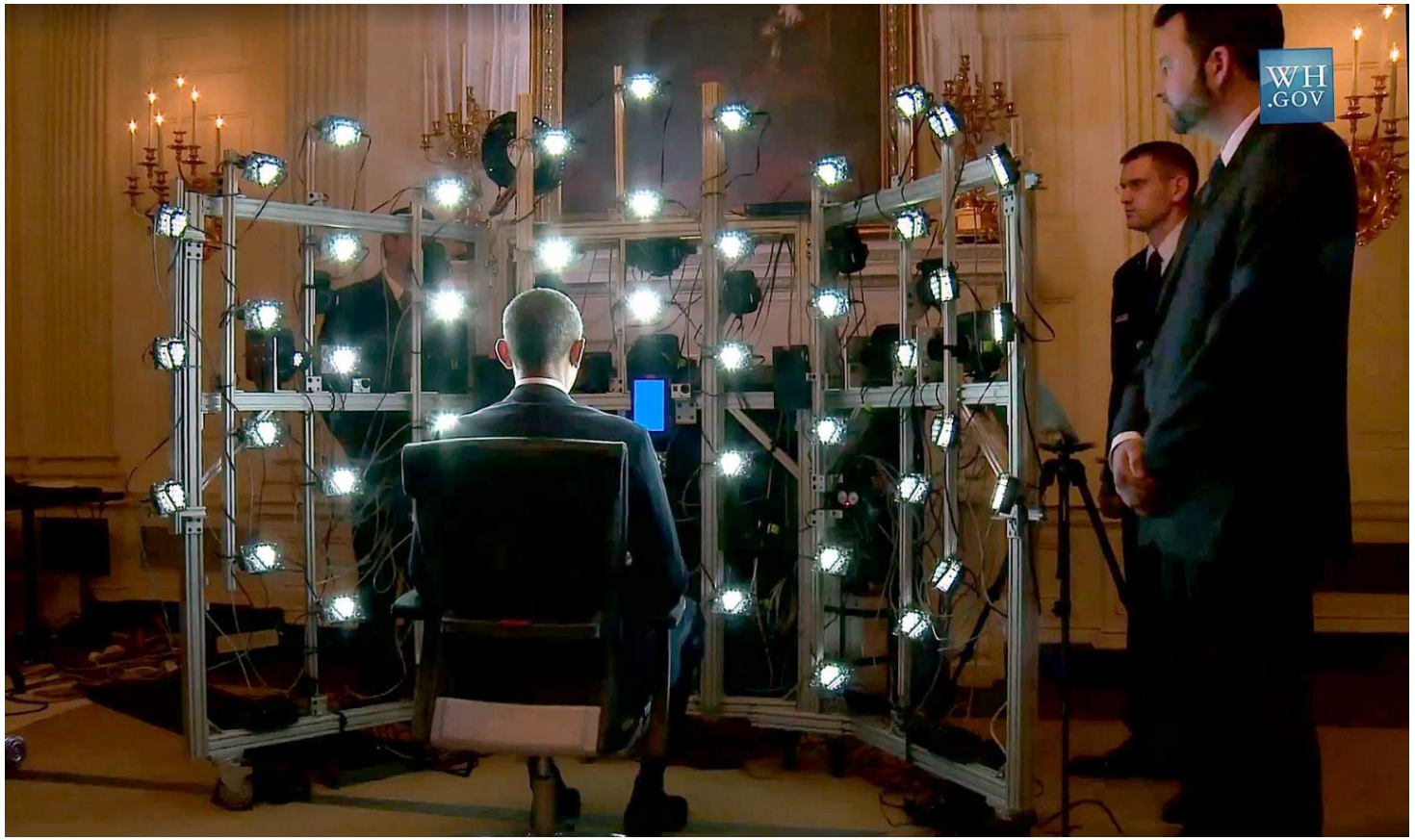
Medical Imaging



3D imaging
MRI, CT

Image from the Medical Engineering lecture under CC BY 4.0
https://medium.com/codex/how-to-reveal-the-secrets-of-the-human-body-part-2-f1331f559eba

Human Face Capture

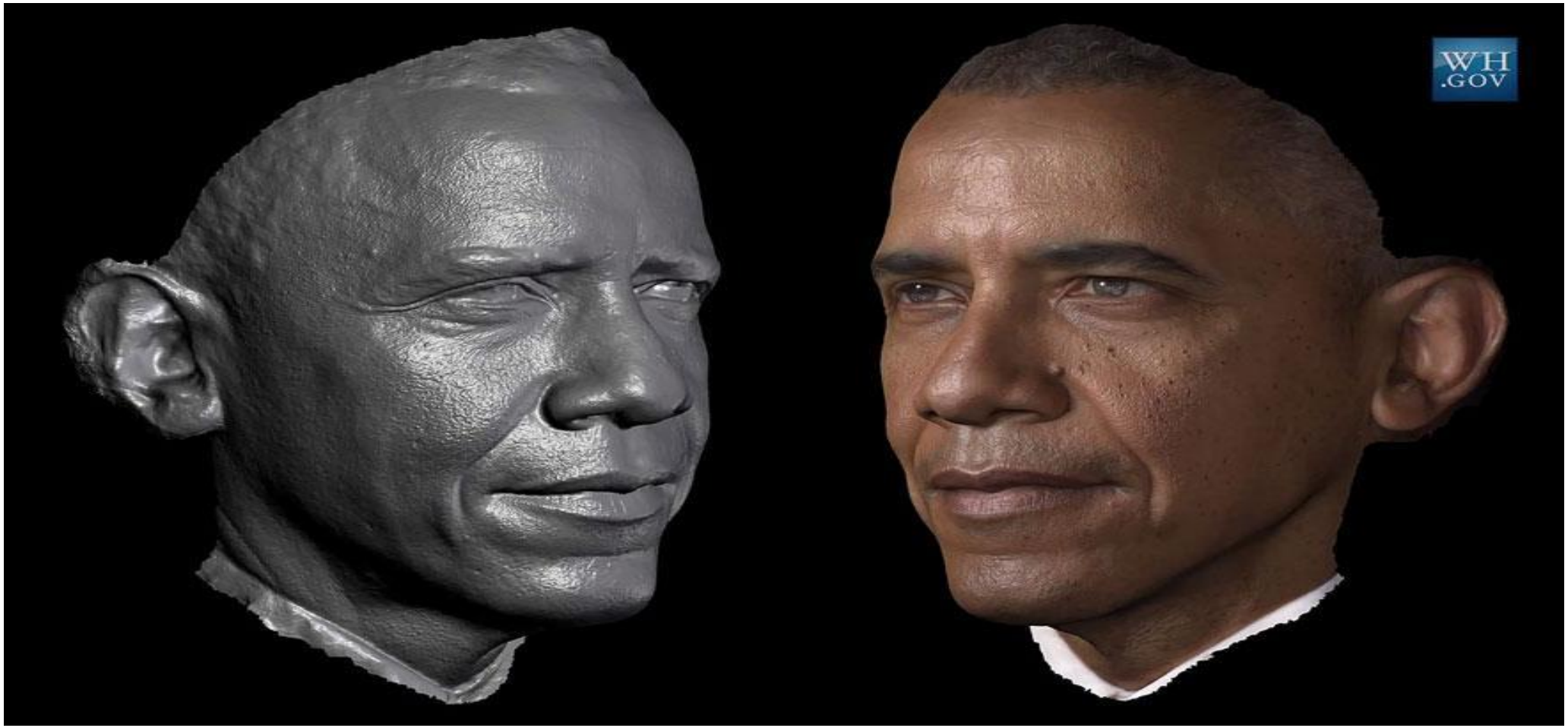


https://vgl.ict.usc.edu/Research/PresidentialPortrait/

Human Face Capture

https://vgl.ict.usc.edu/Research/PresidentialPortrait/

Human Face Capture



https://vgl.ict.usc.edu/Research/PresidentialPortrait/

Human Face Capture

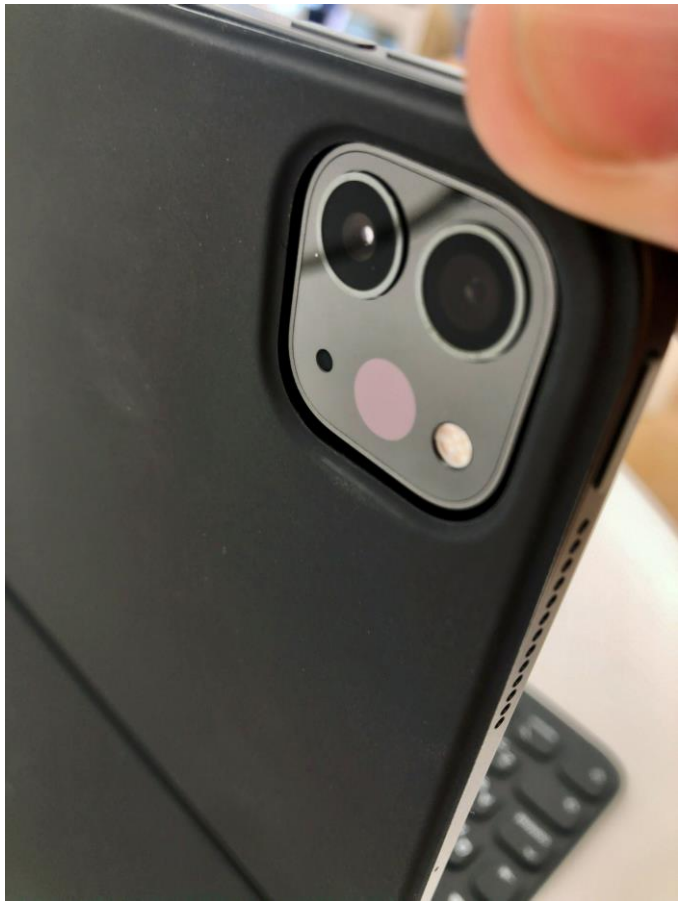
https://vgl.ict.usc.edu/Research/PresidentialPortrait/

Specialised Hardware

Picture: Stefan Kühn
https://de.wikipedia.org/wiki/Laserscanning#/media/Datei:LKW_Maut_Deutschland_Messbruecke_Detail.jpg

Picture: Alexander Lucke
https://de.wikipedia.org/wiki/Industriekamera#/media/Datei:SVCam-ECO%C2%B2_Series_II.jpg

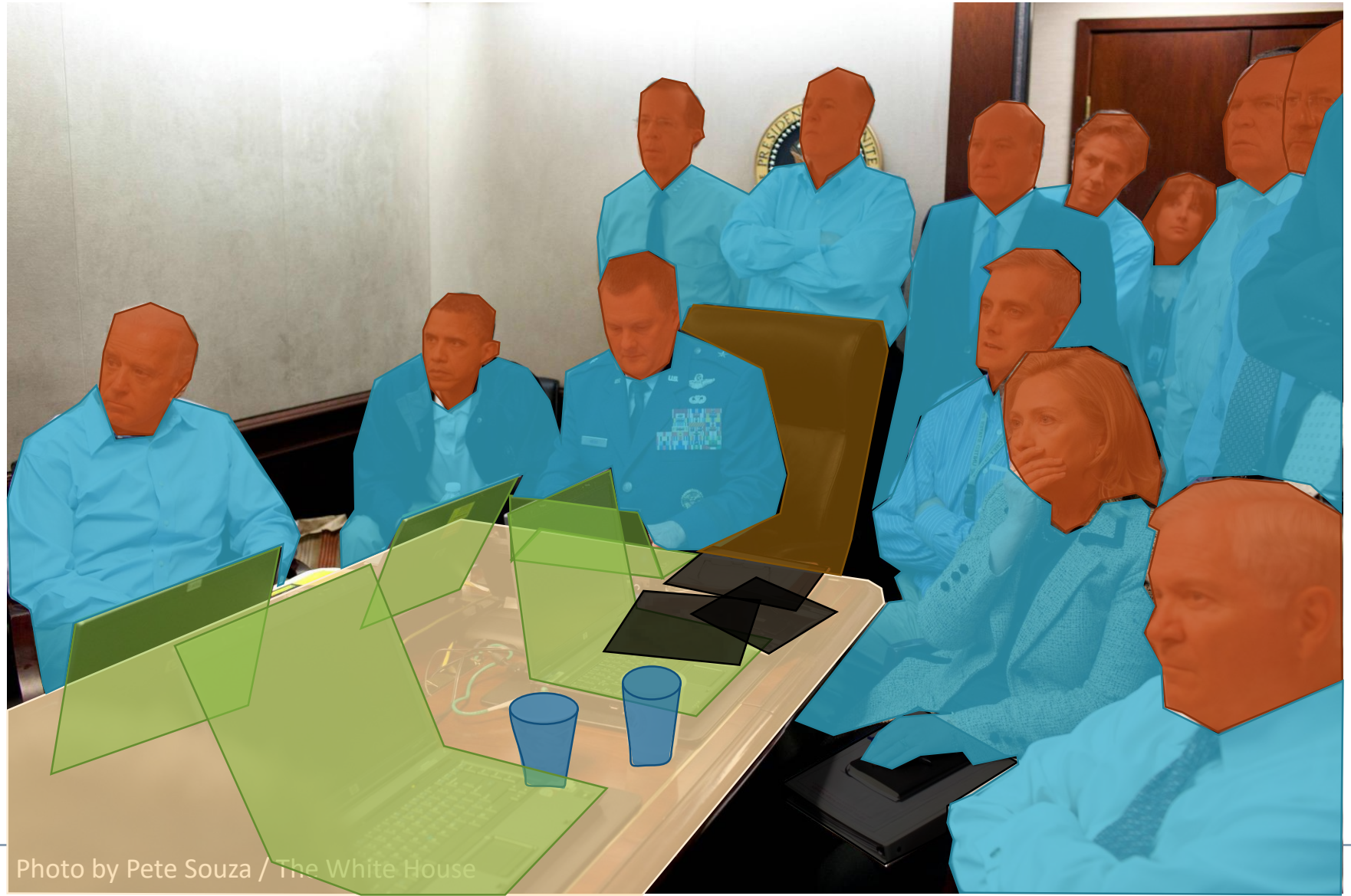
Specialised Hardware in Consumer Products



https://en.wikipedia.org/wiki/Computer_vision#/media/File:LiDAR_Scanner_and_Back_Camera_of_iPad_Pro_2020_-_3.jpg

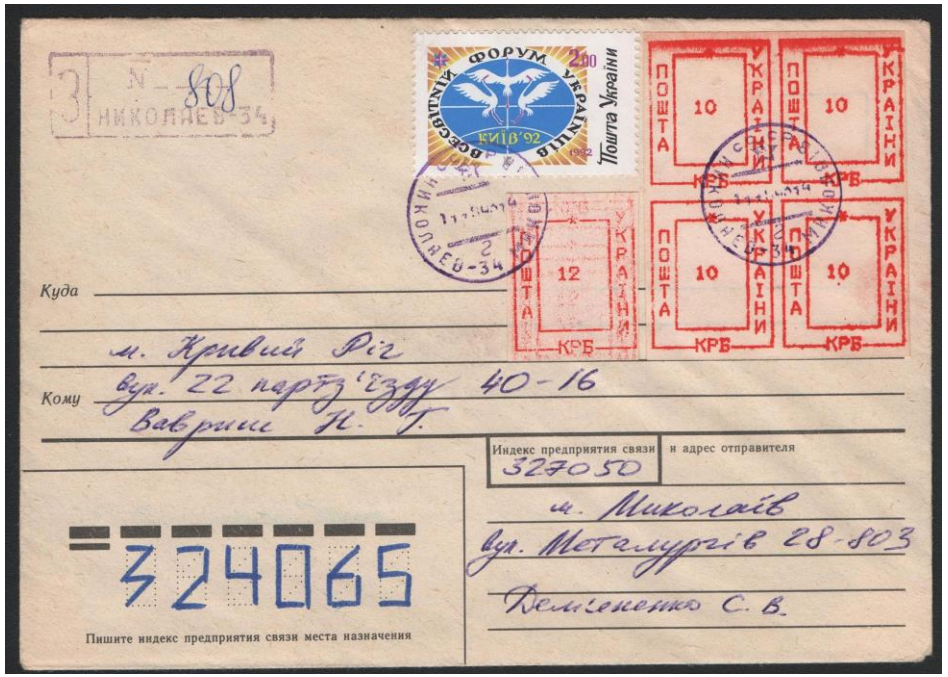
https://de.wikipedia.org/wiki/Kinect#/media/Datei:Xbox-360-Kinect-Standalone.png

Scene Understanding



Scene Understanding

Solved Problems in Computer Vision



https://de.wikipedia.org/wiki/Postanschrift#/media/Datei:Envelopes_001_ua0017.jpg

Early successes
with edge detection

https://www.nist.gov/programs-projects/face-recognition-vendor-test-frvt

Self driving cars

The New York Times

In a Retreat, Uber Ends Its Self-Driving Car Experiment in San Francisco

Give this article

A self-driving Uber car in a garage in San Francisco last week. Eric Risberg/Associated Press

By Christopher Mele

Dec. 21, 2016

The New York Times

The Costly Pursuit of Self-Driving Cars Continues On. And On. And On.

Many in Silicon Valley promised that self-driving cars would be a common sight by 2021. Now the industry is resetting expectations and settling in for years of more work.

Give this article 329

By Cade Metz

Published May 24, 2021 Updated Sept. 15, 2021

Self driving cars

THE WALL STREET JOURNAL.

Waymo to Send Driverless Cars Through San Francisco

Alphabet's Waymo will begin giving fully autonomous rides to employees

A driver prepared to take out a Jaguar I-Pace from a Waymo operations center in San Francisco last year.

PHOTO: PETER DASILVA/REUTERS

Military use

https://www.rheinmetall-defence.com

Bias in Computer Vision Systems

MIT News
ON CAMPUS AND AROUND THE WORLD

SUBSCRIBE BROWS

Study finds gender and skin-type bias in commercial artificial-intelligence systems

Examination of facial-analysis software shows error rate of 0.8 percent for light-skinned men, 34.7 percent for dark-skinned women.

Watch Video

Larry Hardesty | MIT News Office
February 11, 2018

FACE RECOGNITION VENDOR TEST 2002

Evaluation Report

March 2003

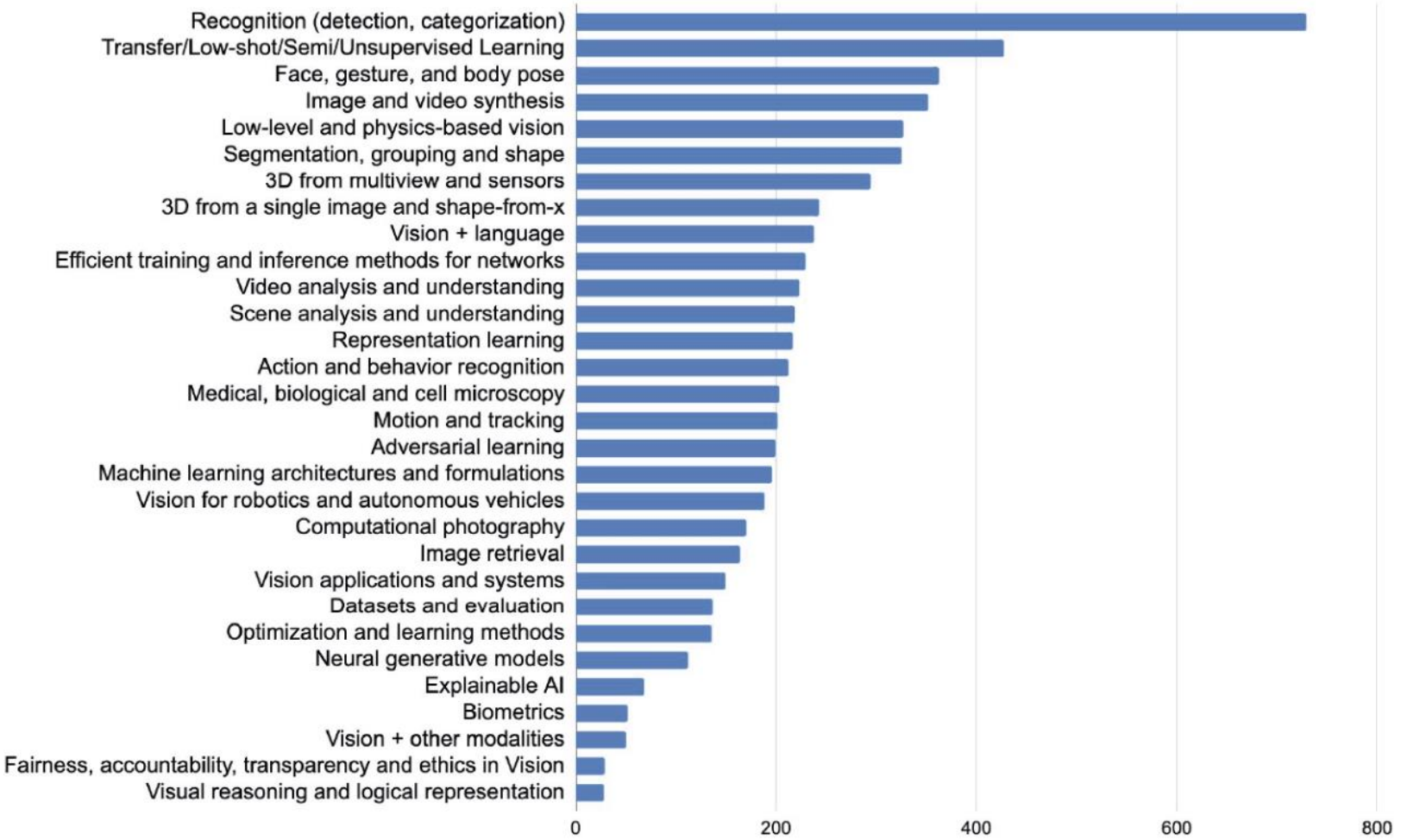
P. Jonathon Phillips[1,2], Patrick Grother[2], Ross J. Micheals[2],
Duane M. Blackburn[3], Elham Tabassi[2], Mike Bone[4]

[1]DARPA
3701 North Fairfax Dr.
Arlington, VA 22203

Not a new issue!

The results from FRVT 2002 and in the literature provide evidence that automatic recognition tasks are easier for males than for females. The underlying reason that males are easier to recognize is not known. Additional experiments are required to provide an explanation. Possible explanations range from facial hair on men to the general observation that women are more likely to have greater day-to-day variation in their appearance than men. However, follow-up experiments are required to determine the explanation for the bias.

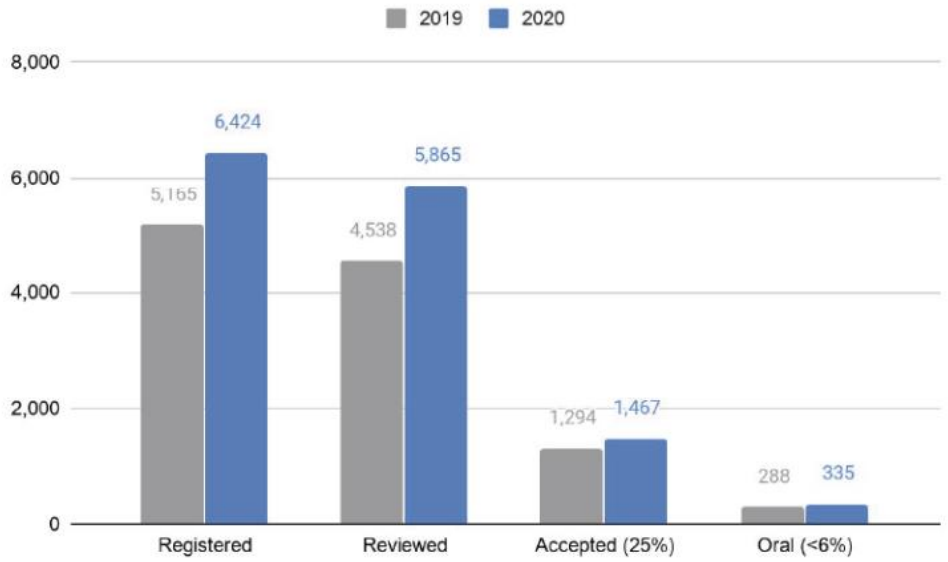
CVPR – the highest impact conference

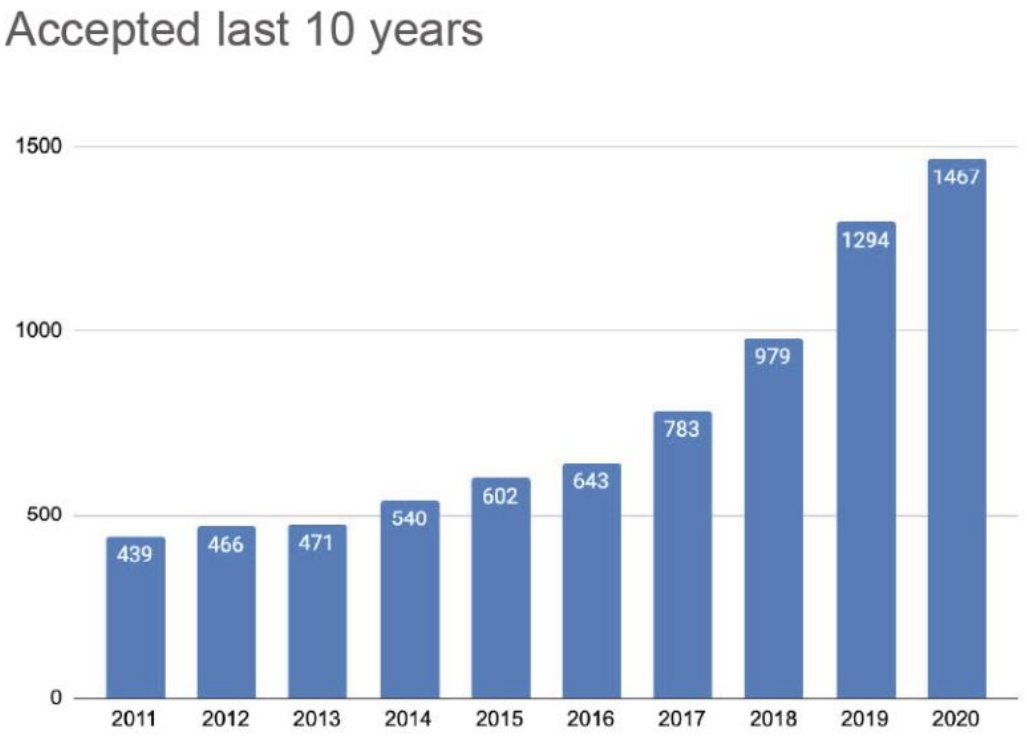


https://yassouali.github.io/ml-blog/cvpr2020/

CVPR – the highest impact conference

- **6,424 registered** (vs. 5,165 in 2019)
- **5,865 valid submissions** (vs. 4,538 in 2019)
- **1,467 accepted (25.0%)**
- **335 orals (5.7%)**





https://yassouali.github.io/ml-blog/cvpr2020/

CVPR – the highest impact conference

Google Scholar

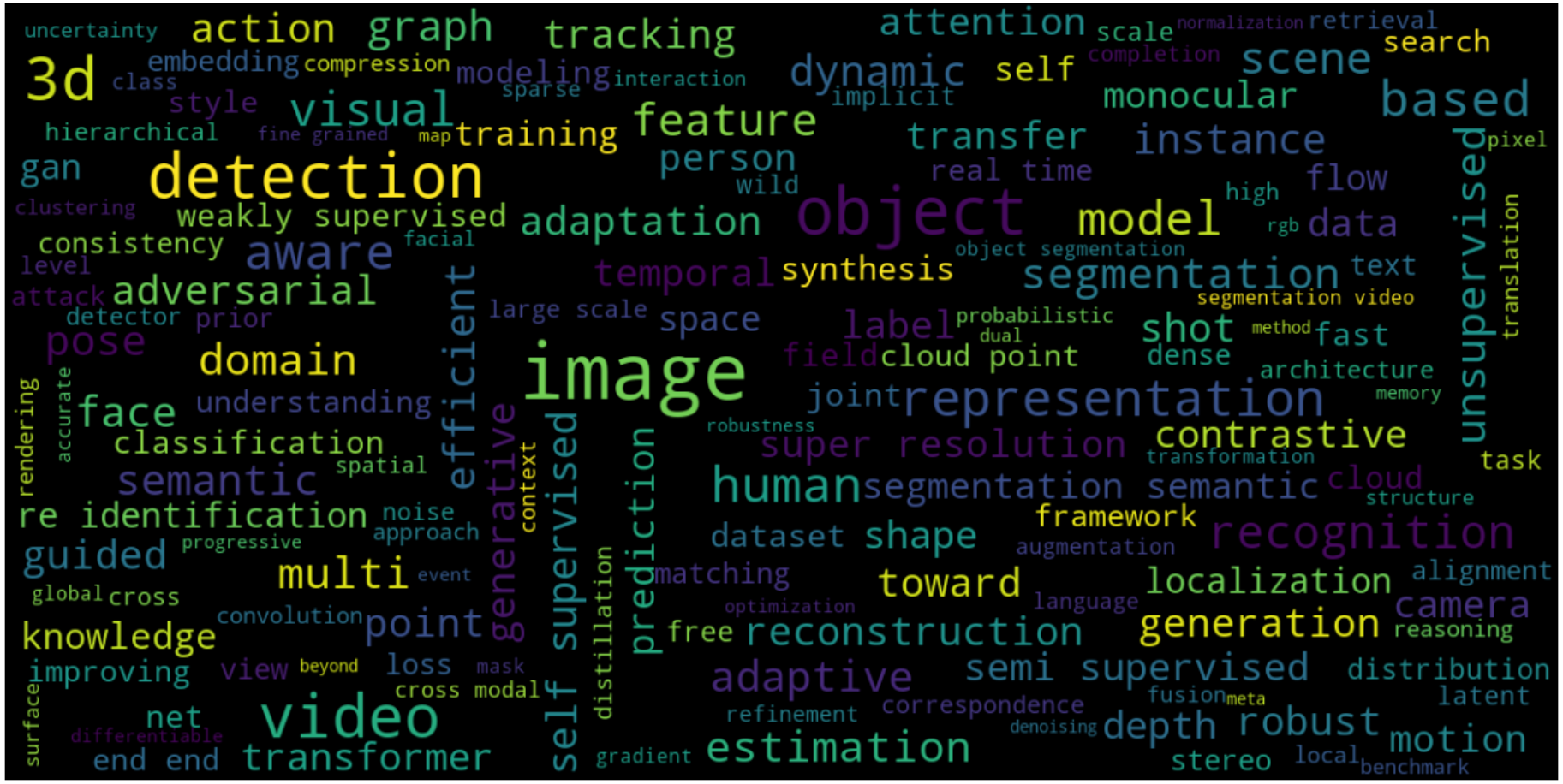
Top publications

Categories ▾ English ▾

	Publication	h5-index	h5-median
1.	Nature	414	607
2.	The New England Journal of Medicine	410	704
3.	Science	391	564
4.	IEEE/CVF Conference on Computer Vision and Pattern Recognition	356	583
5.	The Lancet	345	600
6.	Advanced Materials	294	406
7.	Cell	288	459
8.	Nature Communications	287	389
9.	Chemical Reviews	270	434
10.	International Conference on Learning Representations	253	470

https://scholar.google.com/citations?view_op=top_venues&hl=en

CVPR – the highest impact conference



https://github.com/hoya012/CVPR-2021-Paper-Statistics/blob/main/2021_cvpr/keyword_cloud.png

What this lecture does (not) cover

- This is not a deep learning lecture
- This is not a machine learning lecture

- The focus on the lecture lies in the basics of Computer Vision
- We will hint to learning based methods
- Practical Excercises are an essential parts of the experience

Organization - Schedule

Might be outdated: up to date schedule on studon!

Week	Date	Lecture Topic	Presenter	Exercise Release
1	20-Apr	Course Organisation and Introduction to Computer Vision	BE/TW	Intro
2	27-Apr	Image and Light	TW	
3	4-May	Thinking in Frequency	TW	
4	11-May	Edges and Corners	AM	Ex 1 Feature Detection
5	18-May	— *bank holiday* —		
6	25-May	Features / Cameras / Optics / Perspective	AM	
7	1-Jun	Camera Calibration	AM	Ex 2 Panorama
8	8-Jun	— *bank holiday* —		
9	15-Jun	Epipolar Geometry	AA	Ex 3 Structure from Motion
10	22-Jun	Dense Motion Estimation	BE	
11	29-Jun	Stereo Vision	BE	Ex 4 Optical Flow
12	6-Jul	Structured Light	BE	
13	13-Jul	Surface Reconstruction	TW	Ex 5 Stereo Vision
14	20-Jul	Demo / Guest Lecture	TBD	