Introduction

16-385 Computer Vision
Fall 2020, Lecture 1

Overview of today's lecture

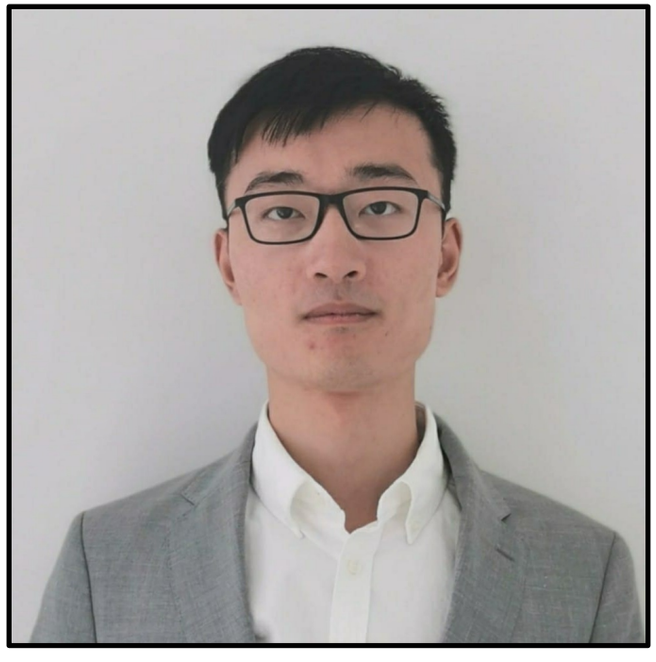
- Teaching staff introductions
- What is computer vision?
- Course fast-forward and logistics

Teaching staff introductions

Hi!

Matthew O'Toole
(Instructor)

Prakhar Kulshreshtha

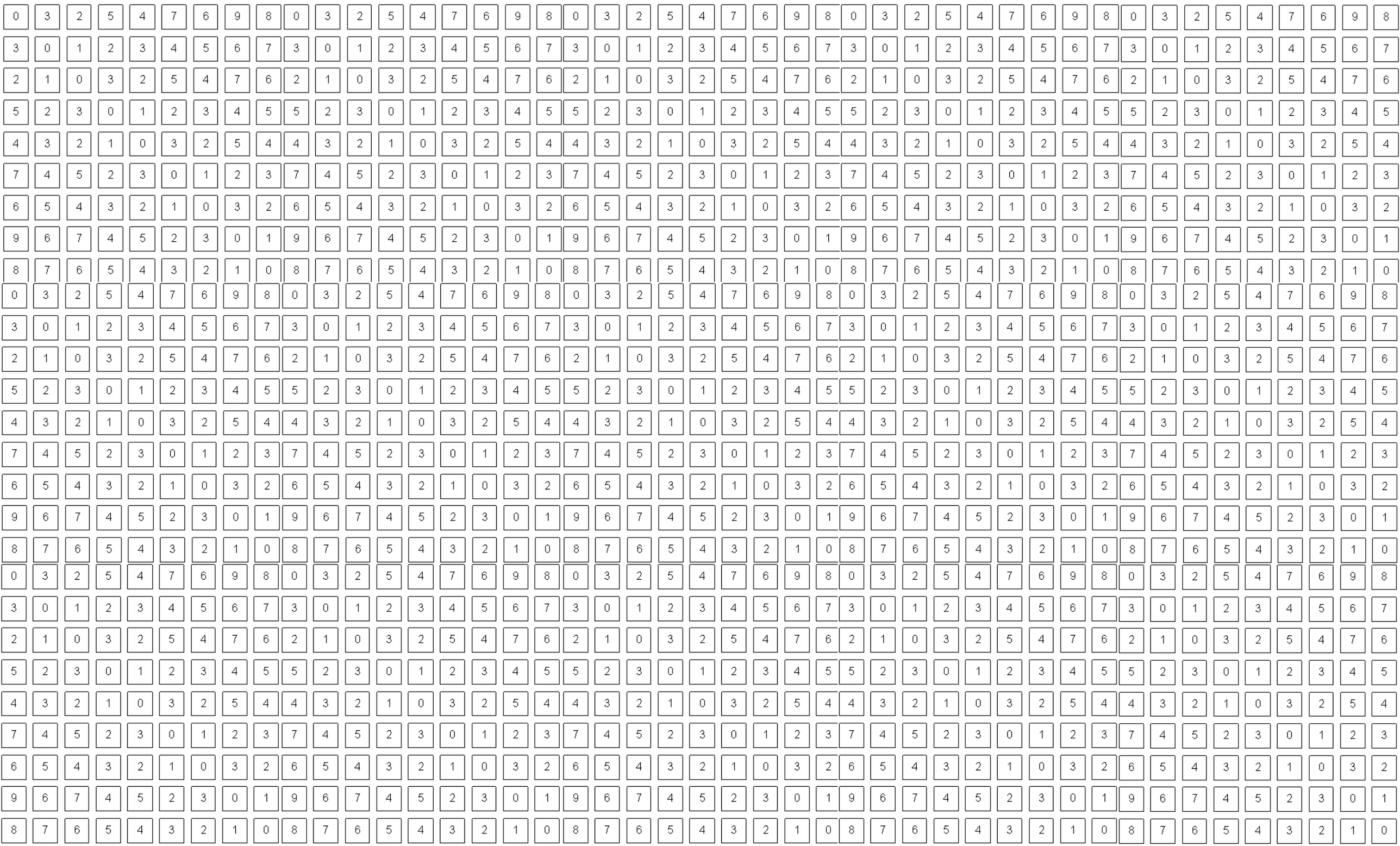


Chaoyang Wang

Varun Jain

What is computer vision?

What a person sees



What a computer sees

Why are we able to interpret this image?

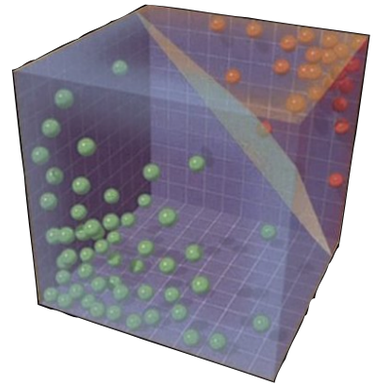
The goal of computer vision is

to give computers

(super) human-level perception

typical perception pipeline

representation

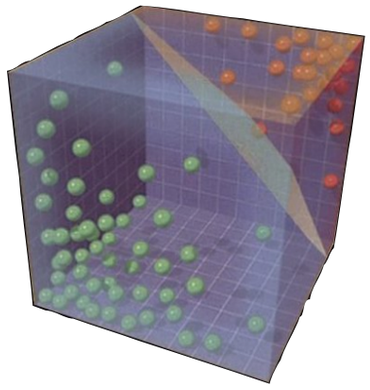


‘fancy math’

output

typical perception pipeline

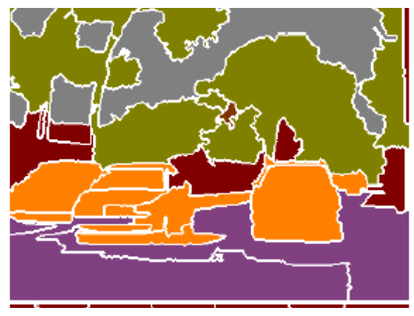
representation



‘fancy math’

what should we look at?
(image features)

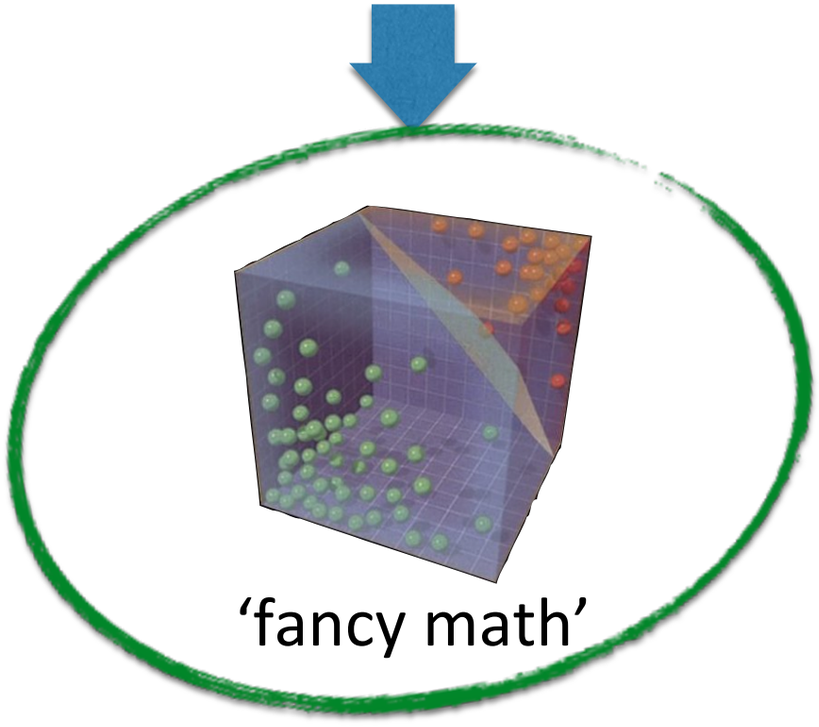
output



what can we understand?
(semantic segmentation)

typical perception pipeline

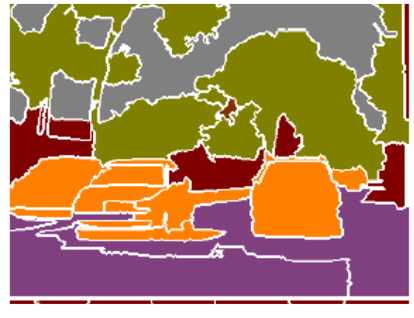
representation



output

easy to get lost in the techniques

what should we look at?
(image features)



what can we understand?
(semantic segmentation)

typical perception pipeline

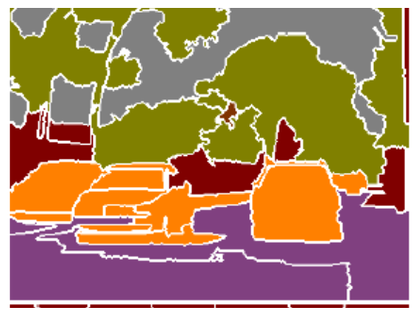
representation

what should we look at?
(image features)

The parts that we are most interested in

‘fancy math’

output



what can we understand?
(semantic segmentation)

Important note:

In general, computer vision does not work

Important note:

In general, computer vision does not work

(except in certain situations/conditions)

Applications of computer vision

Machine Vision

Automated visual inspection

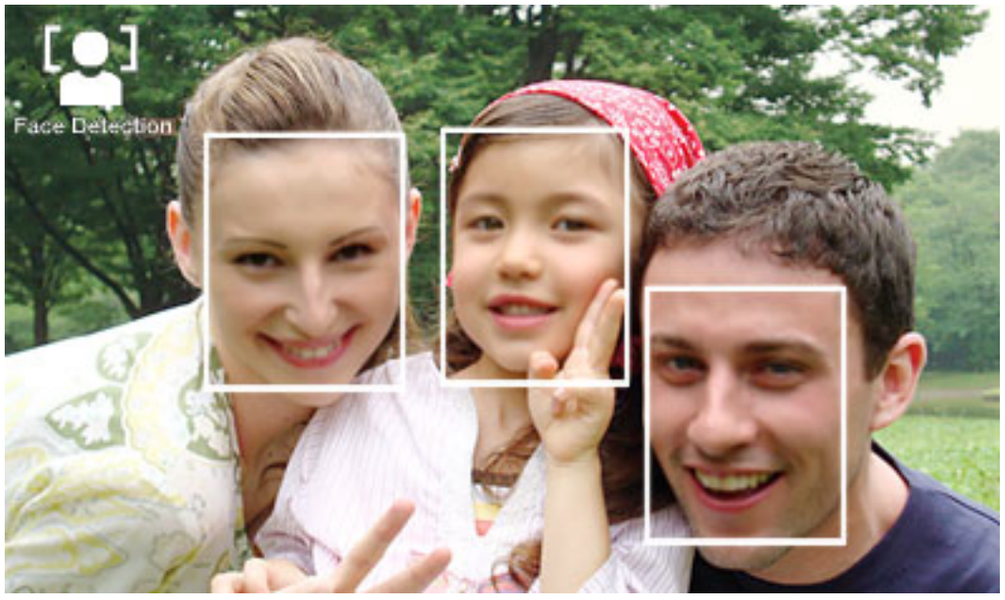
Object Recognition



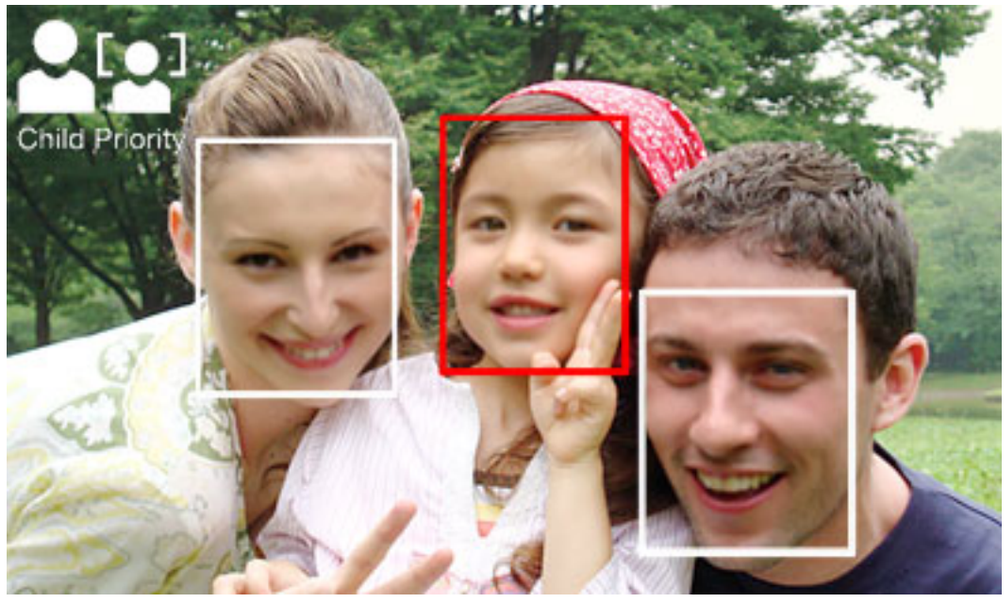
Toshiba Tech IS-910T 2013


DataLogic LaneHawk LH4000 2012

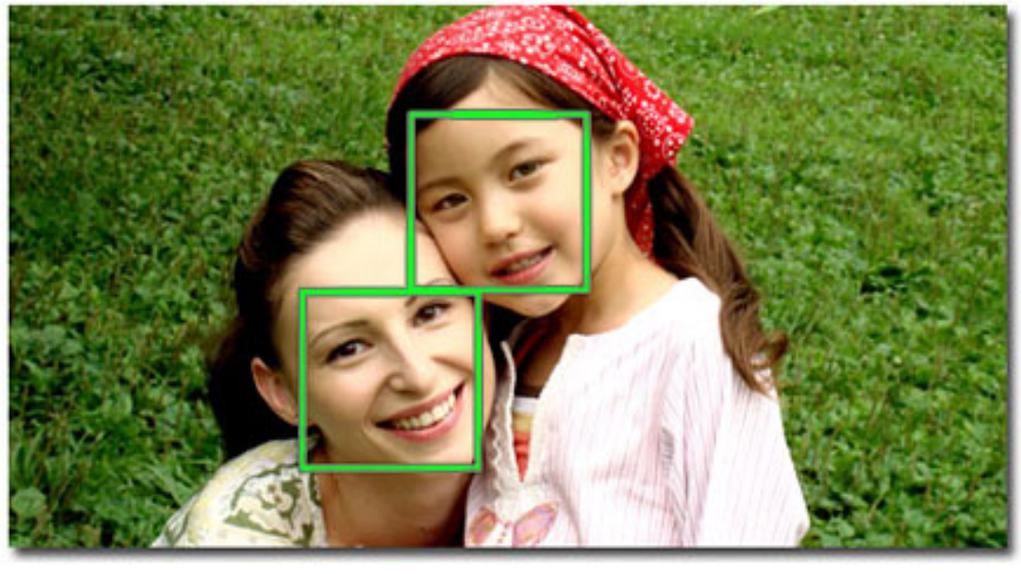
Face detection



Sony Cyber-shot

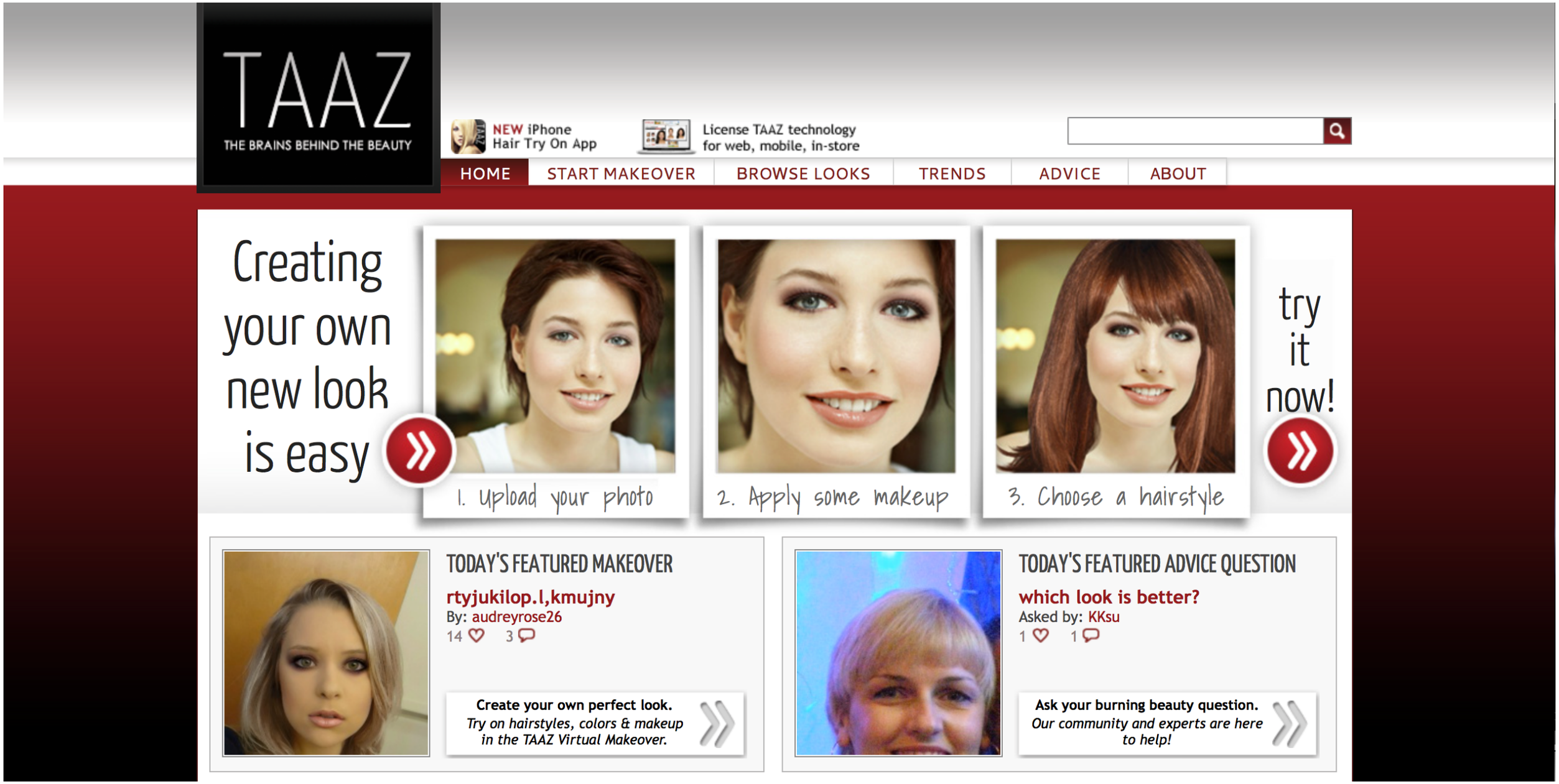


Age recognition



Smile recognition

Face makeovers



leafsnap

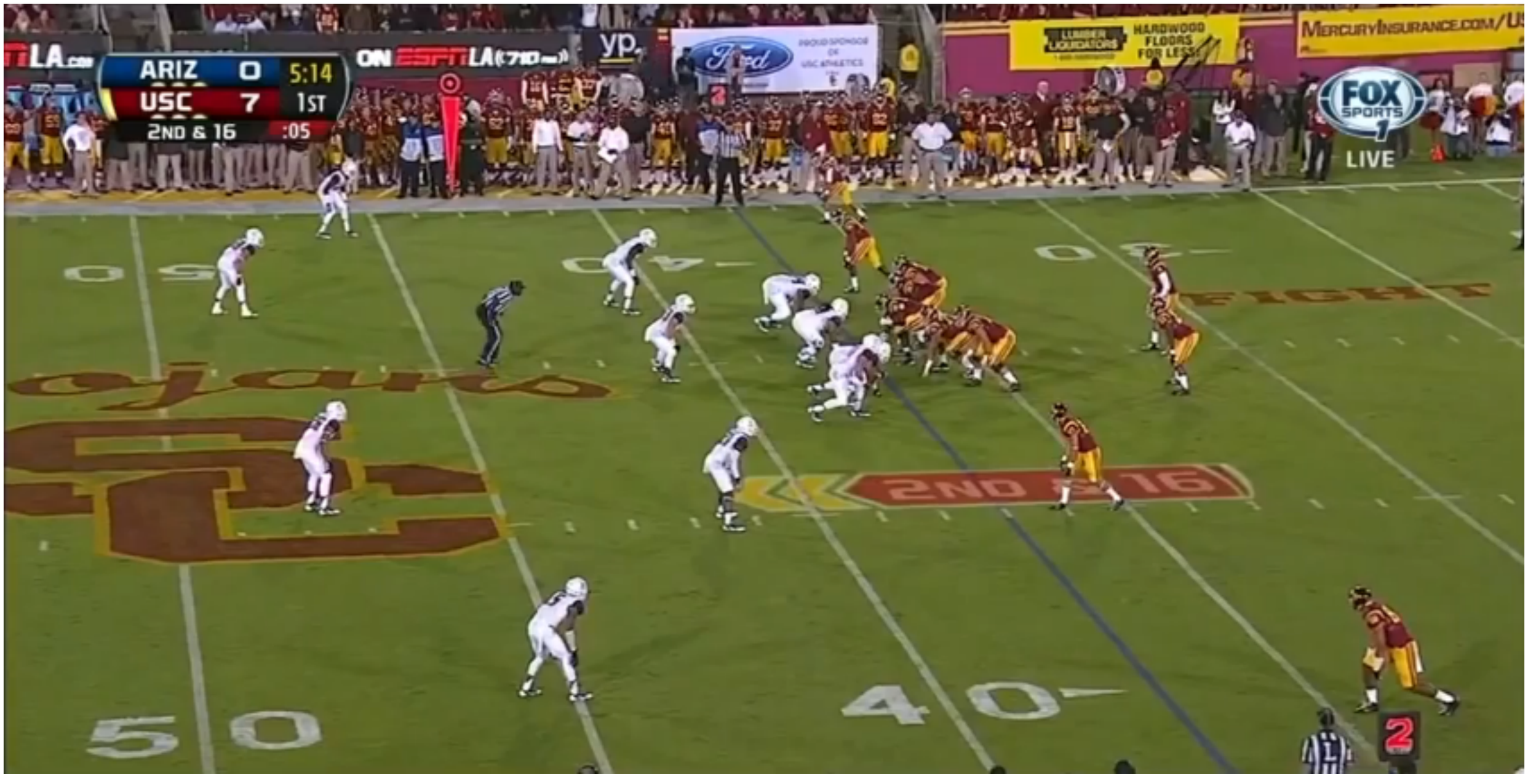

Verizon
12:38 PM
Back
Results
Map
Snap It! Results
1
Red Maple
Acer rubrum
2
Striped Maple
Acer pensylvanicum
3
Sycamore Maple
Acer pseudoplatanus
12:20 PM
100%
First
Last
Scientific
Ilex opaca
American Hornbeam
Carpinus caroliniana
American Linden
Tilia americana
American Sycamore
Platanus occidentalis
Amur Corktree
Phellodendron amurense
Q A B C D E F G H J K L M N O P Q R S T U W Y
Home
Browse
Collection
Options
Snap It!

Word Lens

Word Lens

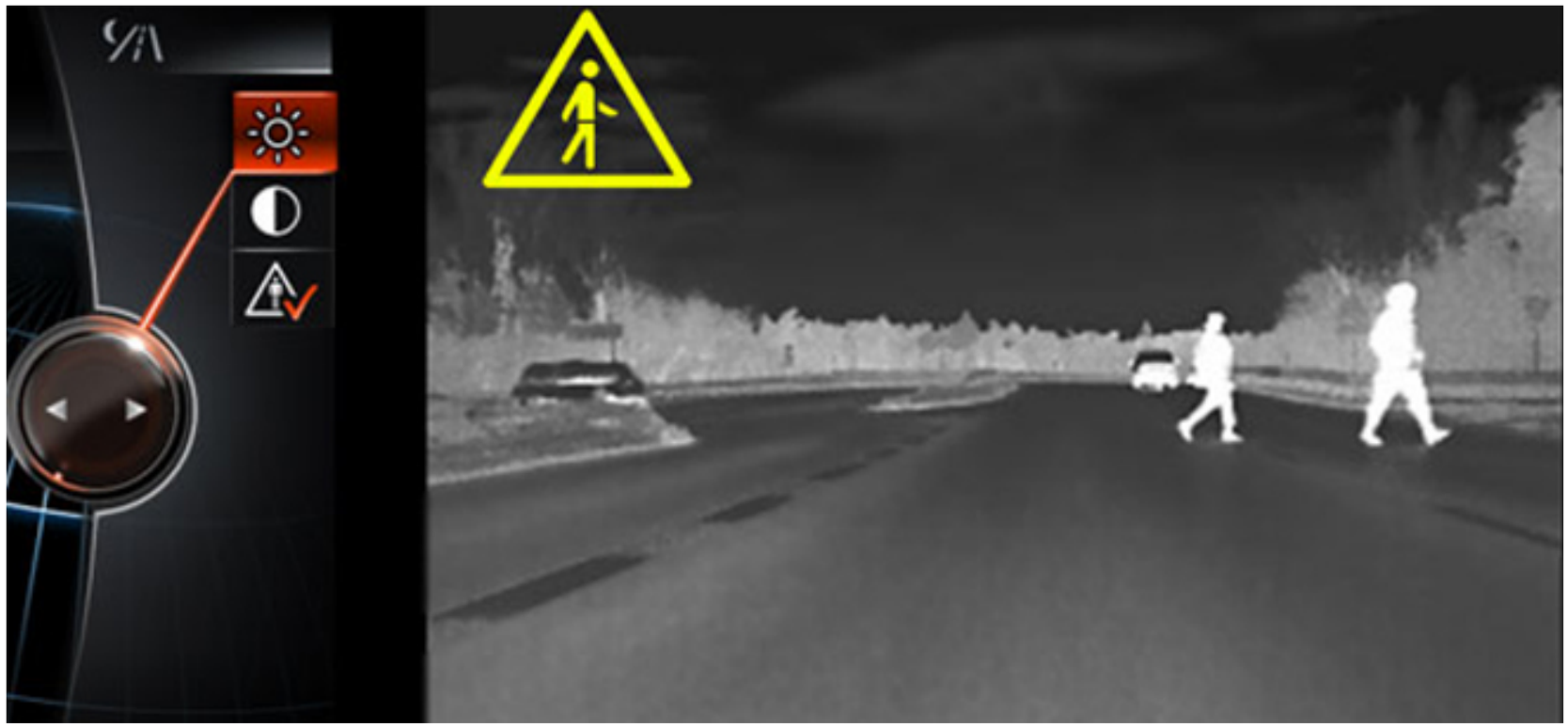
www.QuestVisual.com

First-down line



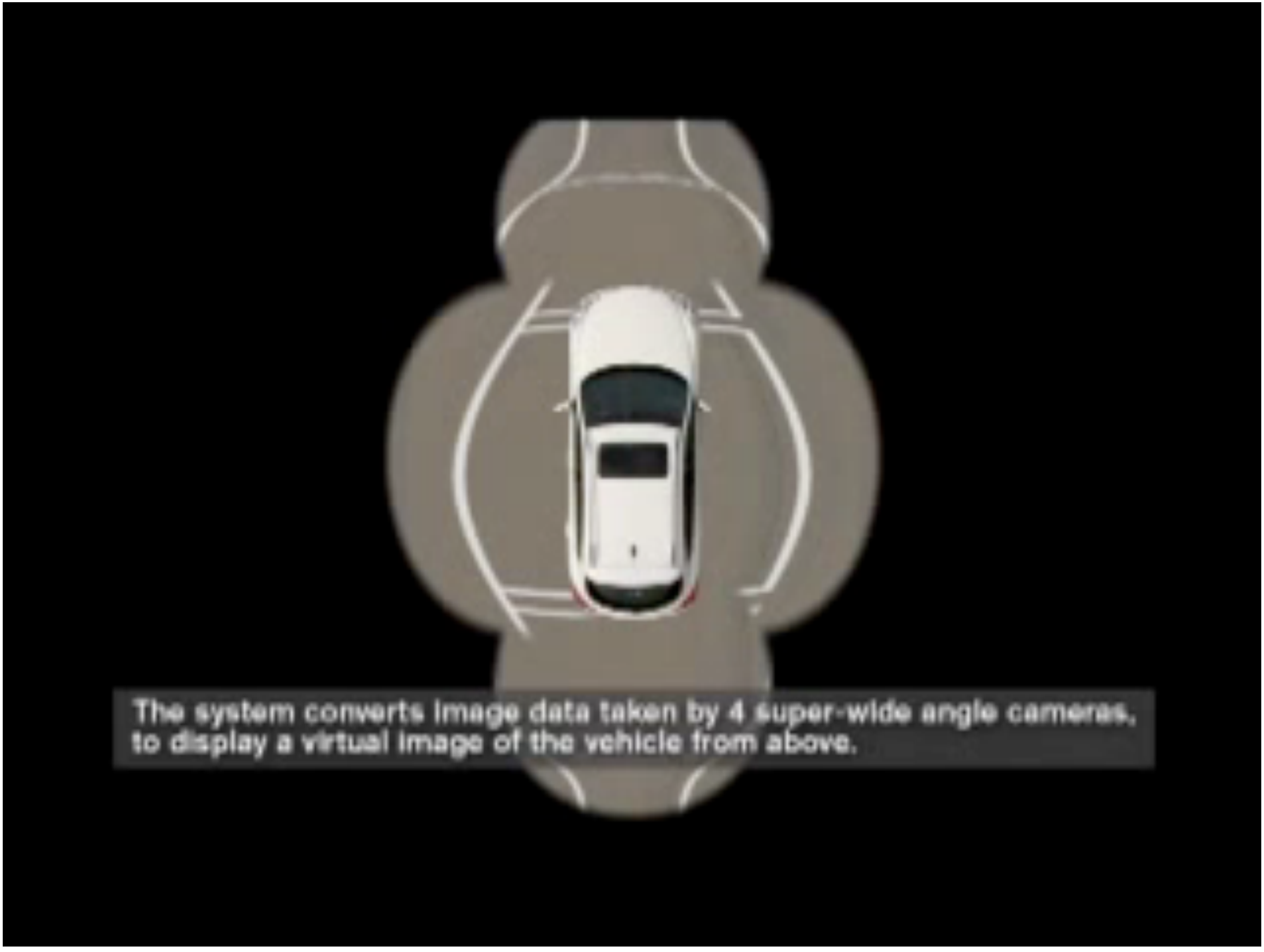
BMW 5 series

BMW night vision



Infinity EX

“Around view” camera


The system converts image data taken by 4 super-wide angle cameras,
to display a virtual image of the vehicle from above.

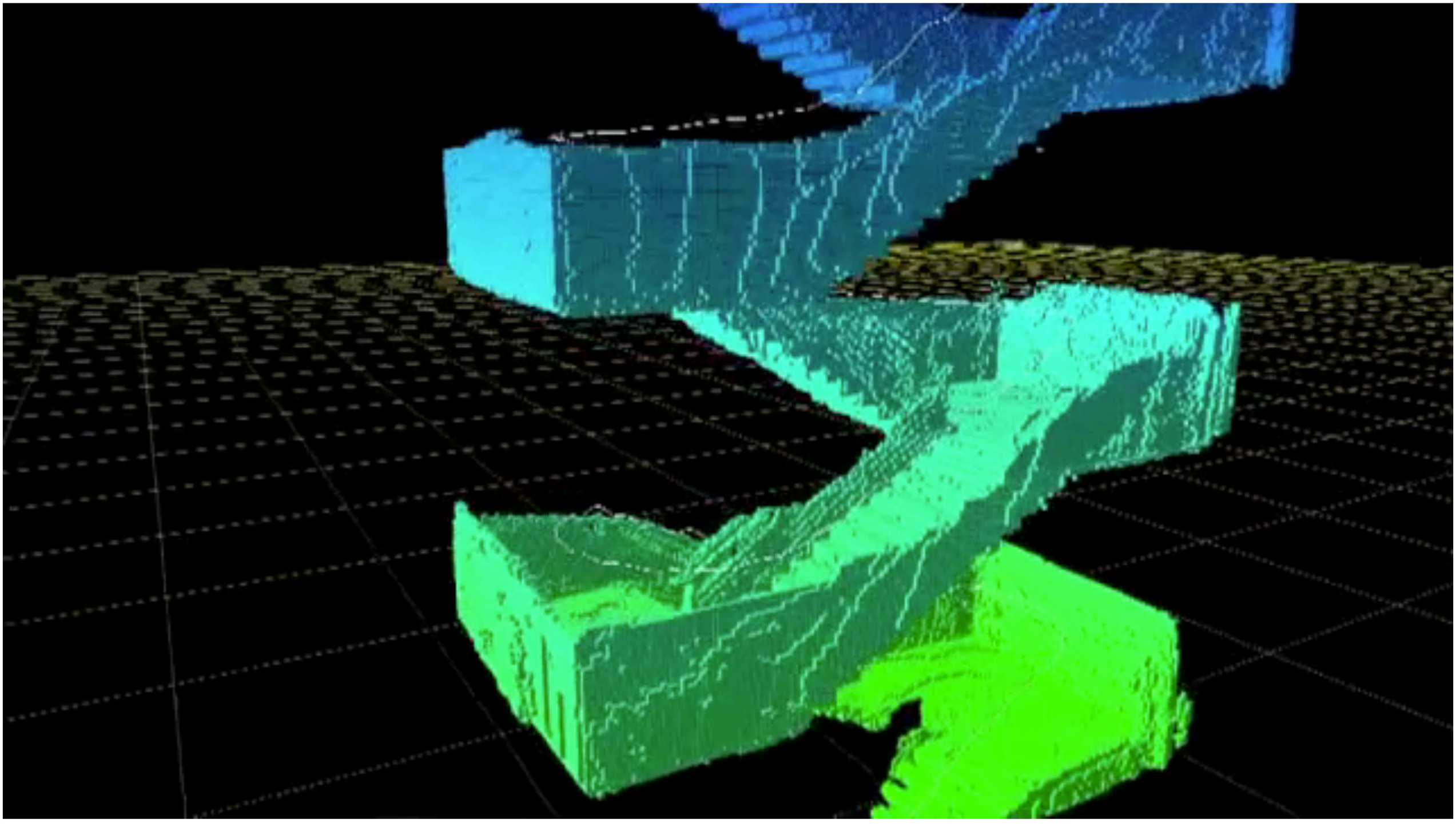
2015

Vision in Cars

Image stitching

Photosynth

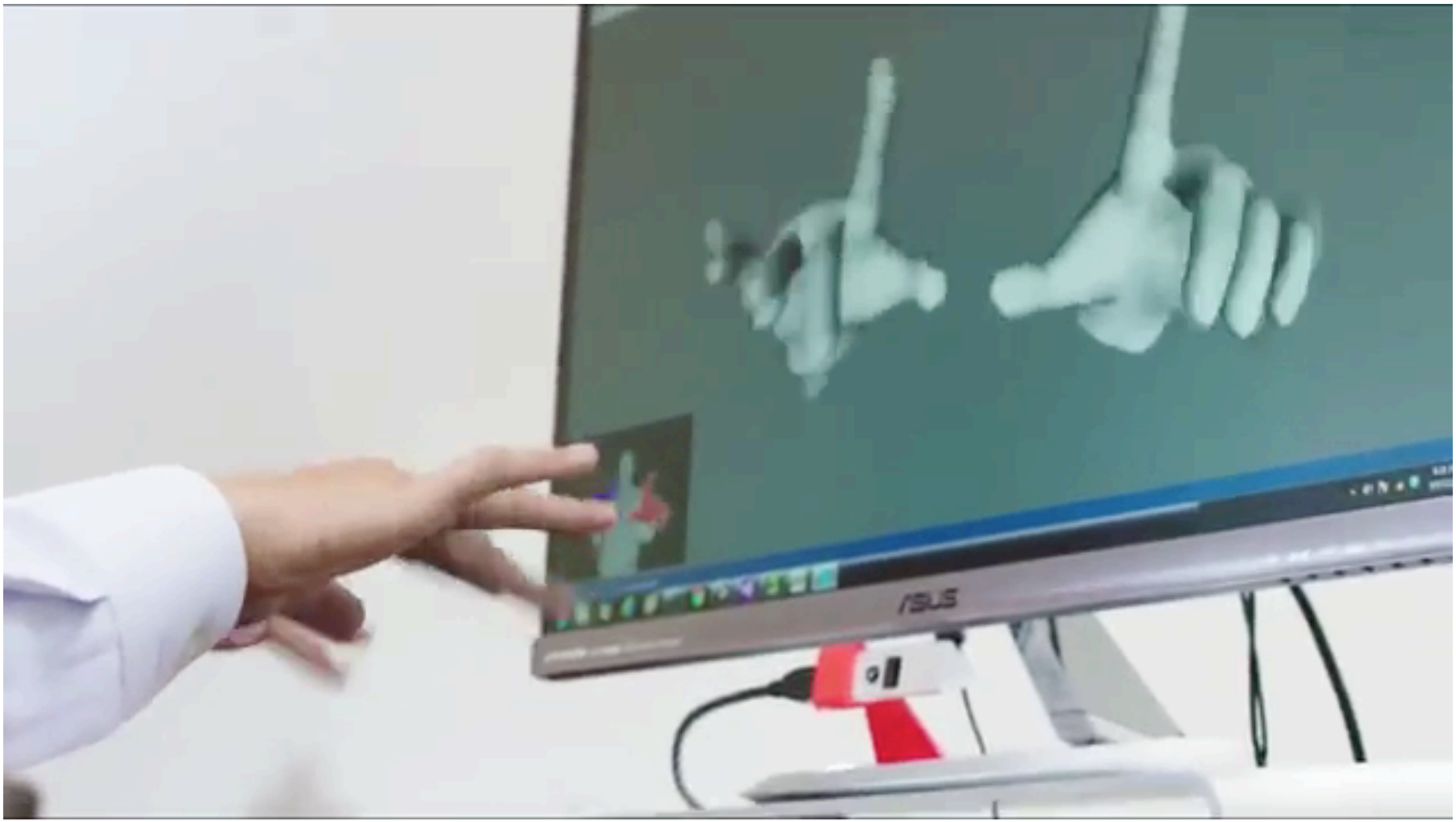
Tango



Virtual Fitting

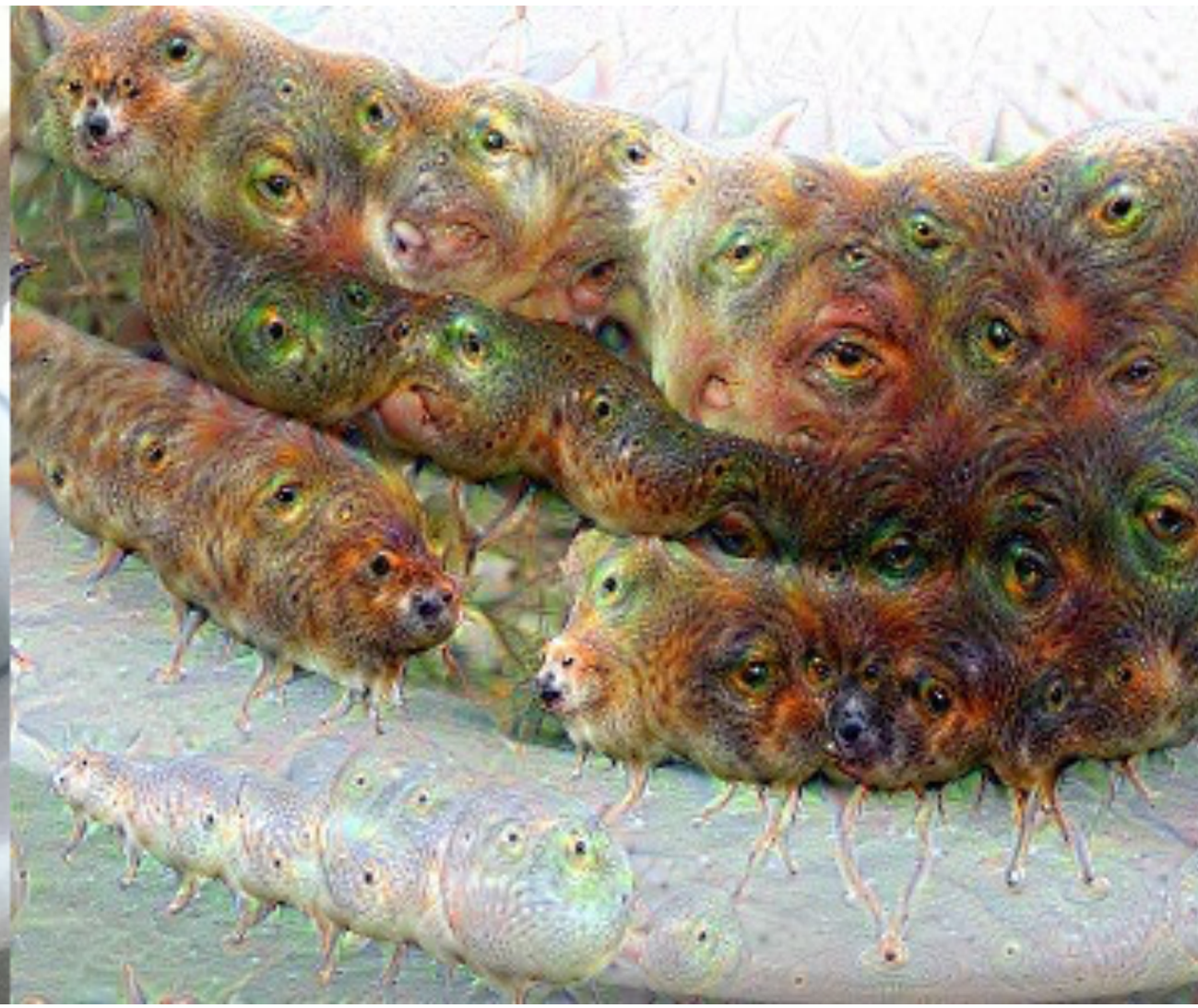
2015

Computer Vision for VR



Deep Face

Deep Dream



Facebook video style transfer 2016

Face2Face: Real-time Face Capture and Reenactment of RGB Videos

Justus Thies[1], *Michael Zollhöfer*[2],
Marc Stamminger[1], *Christian Theobalt*[2],
Matthias Nießner[3]

[1]University of Erlangen-Nuremberg
[2]Max-Planck-Institute for Informatics
[3]Stanford University

CVPR 2016 (Oral)

It’s a good time to do computer vision

Industry aggressively hiring CV faculty from universities

UW 

Berkeley 

CMU 

Toronto 

UBER

UCLA 

USC 

Dropbox

UCSD 

Columbia 

NYU 

CMU CMU 

NVIDIA

Toronto

amazon.com

CalTech

UW

Stanford 

CMU 

Stanford 

NYU 

GTech 

GTech 

UT Austin 

NYU 

Google

Zillow

Oculus VR

ARGO AI

SFU 

CMU 

CMU CMU 

GTech 

CMU 

MIT 

MIT 

Toronto 

UW 

Industry aggressively hiring CV graduates, or even students!

(~~strong~~ dominant industrial presence at conferences for recruitment)

facebook research | Research Areas | Publications | People | Programs | Downloads | Careers | Blog

JULY 21, 2017

Advancing computer vision technologies at CVPR 2017

By: Facebook Research

Google Research Blog

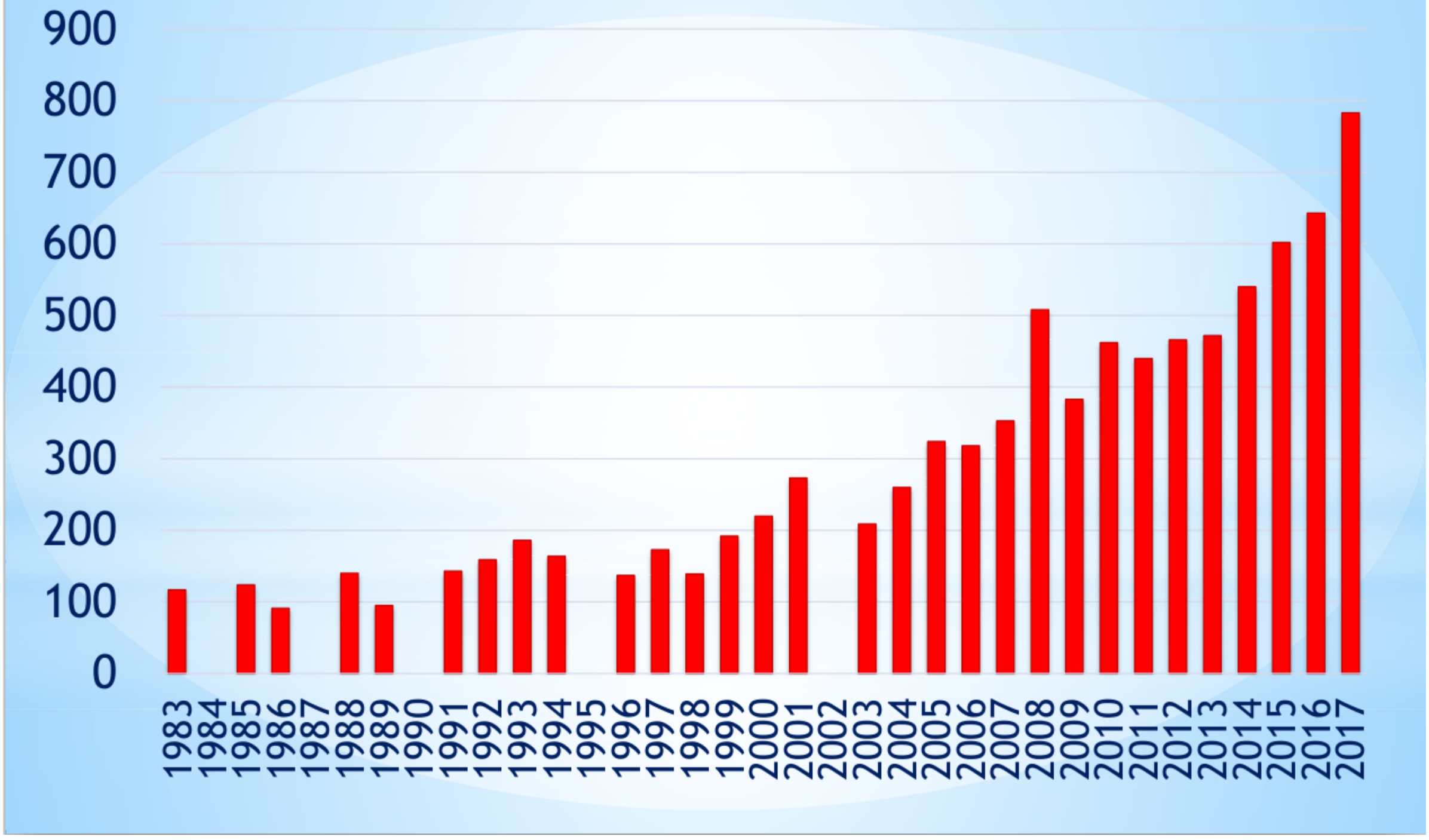
The latest news from Research at Google

Google at CVPR 2017

Friday, July 21, 2017

CVPR GROWTH

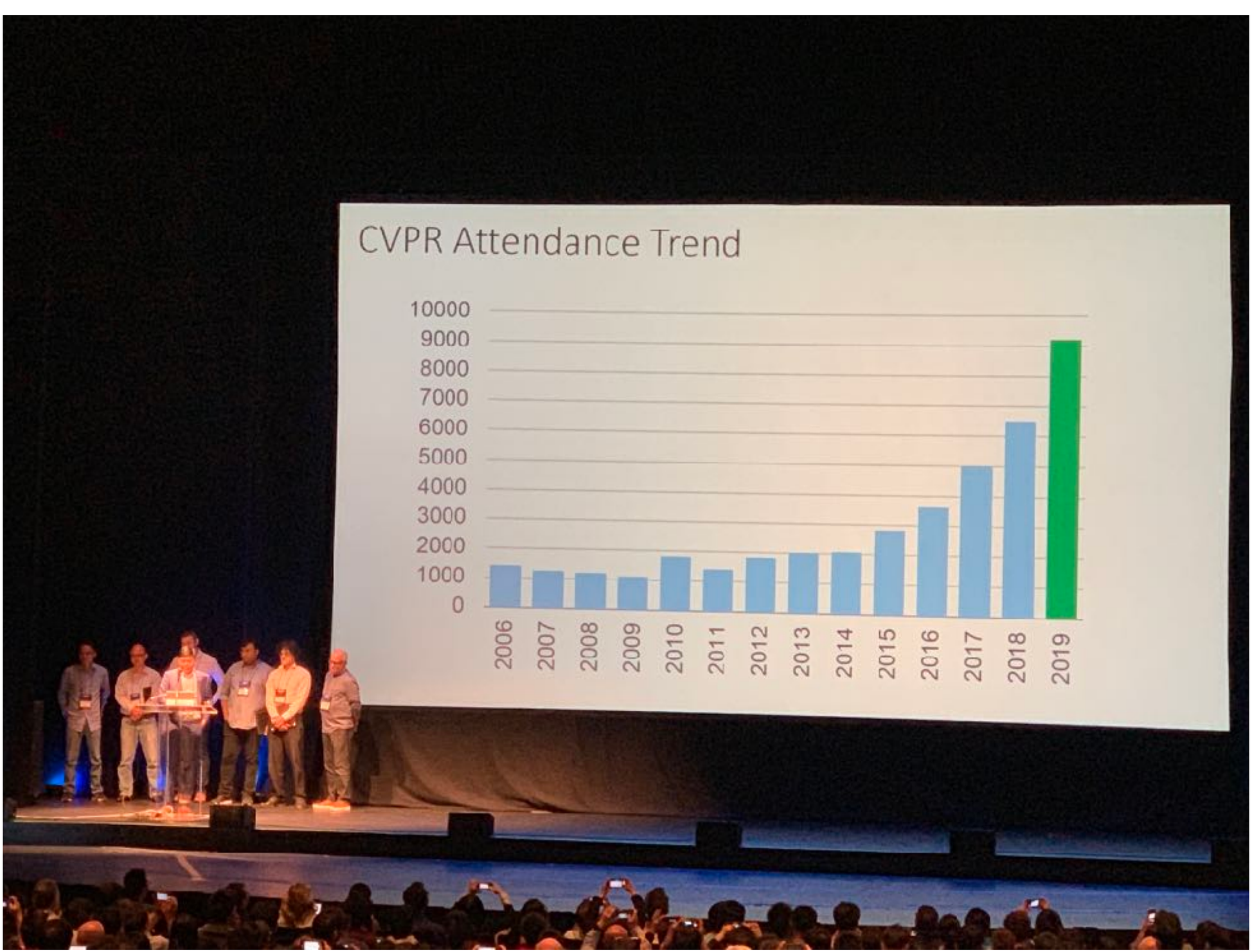
Original slide courtesy of CVPR 2016



CVPR GROWTH

Number of attendees at CVPR

Original slide courtesy of CVPR 2016


CVPR Attendance Trend
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019

Computer vision at CMU

Dedicated courses for each subject we cover in this class:

- Physics-based Methods in Vision
- Geometry-based Methods in Computer Vision
- Computational Photography
- Visual Learning and Recognition
- Statistical Techniques in Robotics
- Sensors and sensing

… plus an entire department's worth of ML courses.

Master in Computer Vision at CMU

Course logistics

Website

http://16385.courses.cs.cmu.edu/

(includes links to Canvas and Piazza)

Assignments Canvas

https://canvas.cmu.edu/courses/19897

Discussion & Notes piazza

https://piazza.com/class/kehd7pdme0a4e

(you should sign up here on your own)

Topics to be covered

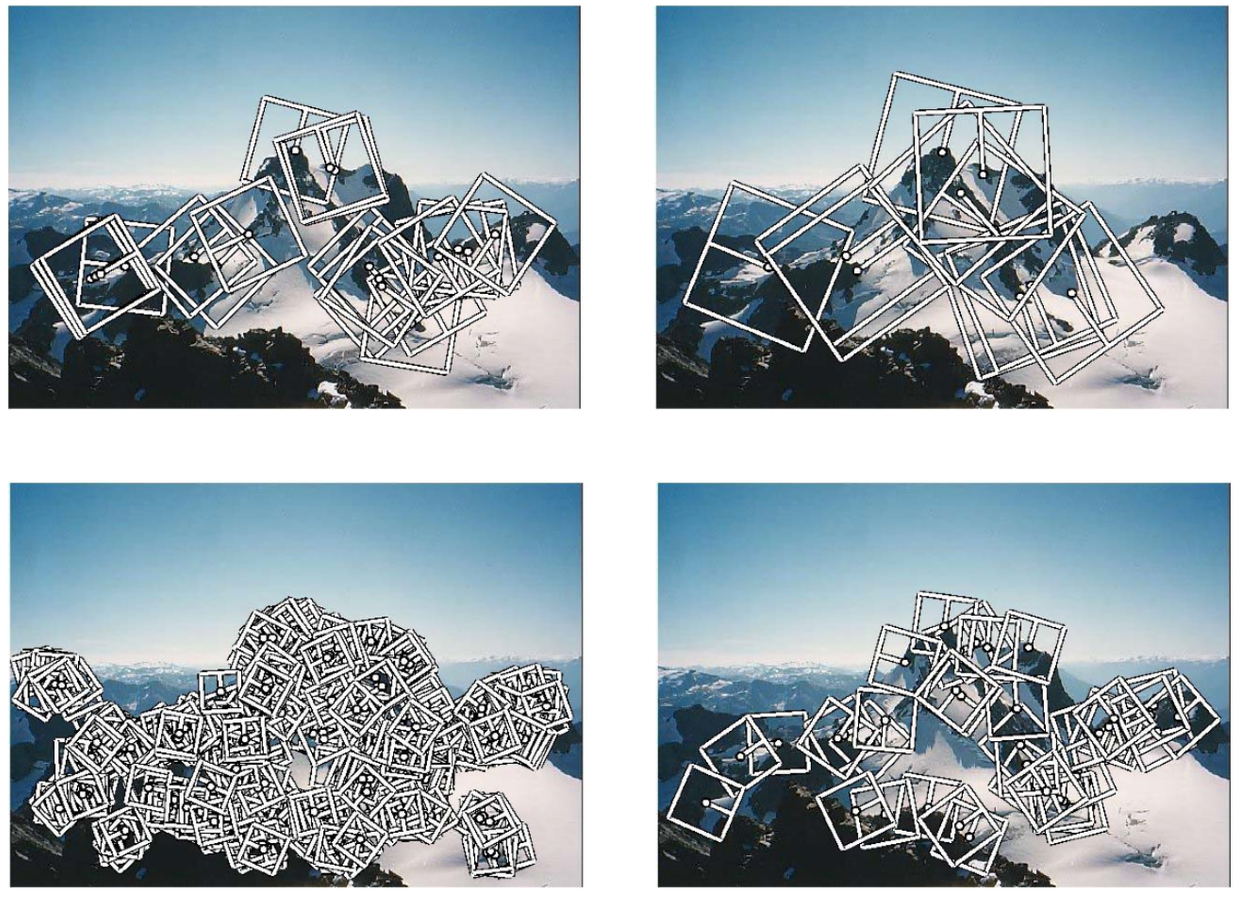
Image processing:

- Basics of filtering.
- Image pyramids.
- Gradients and lines.
- Hough transforms.

Topics to be covered

Feature detection and correspondences:

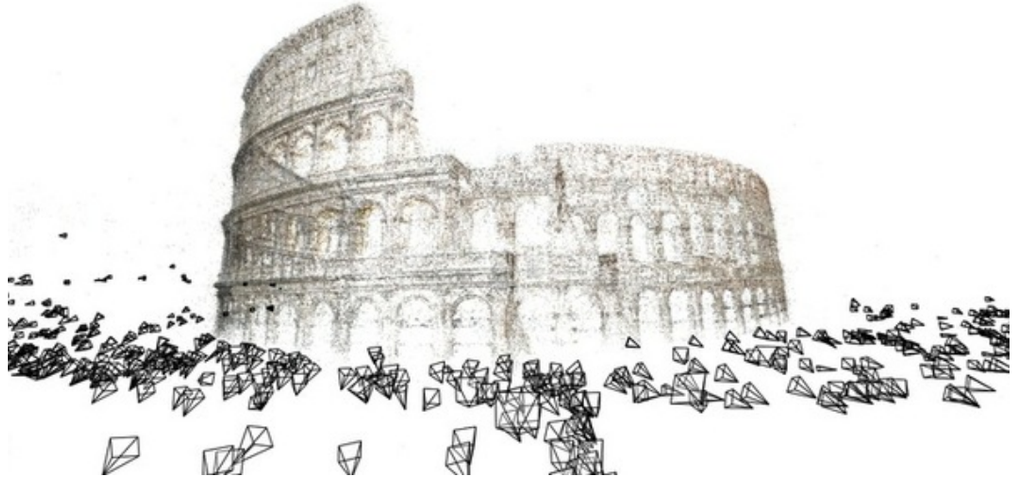
- Corner detection.
- SIFT et al.
- Feature descriptors.
- RANSAC.



Topics to be covered

Transformations and geometry:

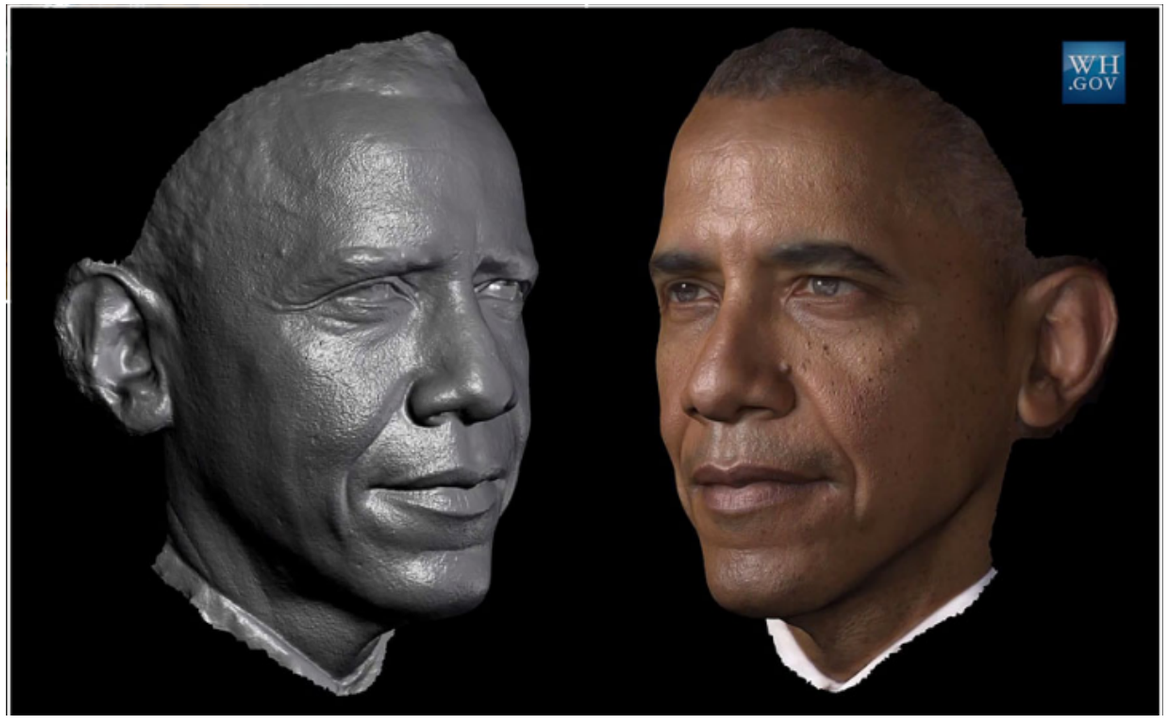
- Homographies and image alignment.
- Camera models.
- Fundamental matrix.
- Epipolar geometry and stereo.
- Structure from motion.



Topics to be covered

Physics-based vision:

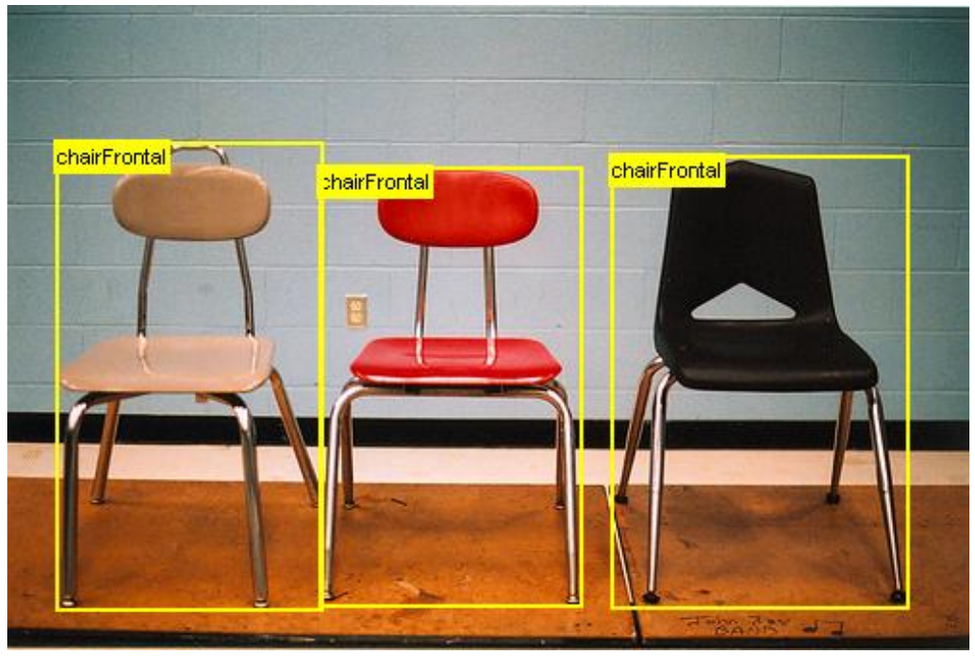
- Reflectance and image formation.
- Radiometry.
- Shape from shading.
- Photometric stereo.
- Color.



Topics to be covered

Objects, faces, and learning:

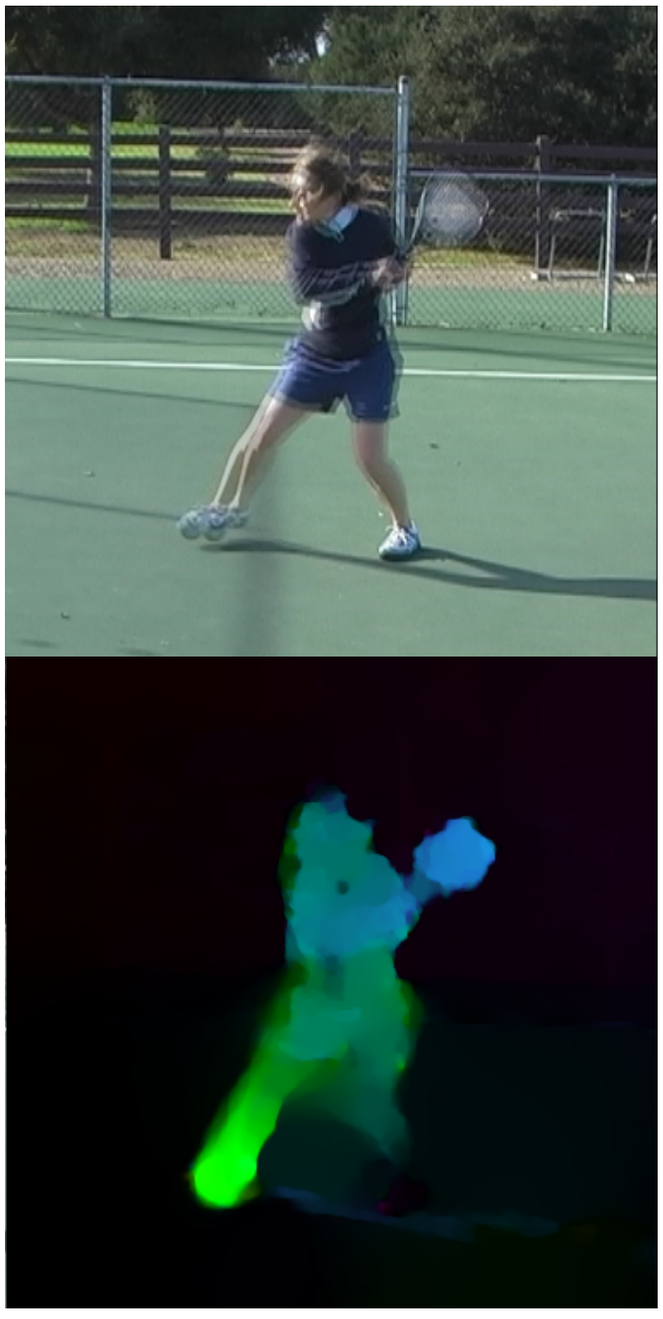
- Basics of probability.
- K-means, KNN, PCA, SVM.
- Bag of words.
- Viola-Jones face detection.
- Perceptron, backpropagation.
- Convolutional neural networks.



Topics to be covered

Dealing with motion:

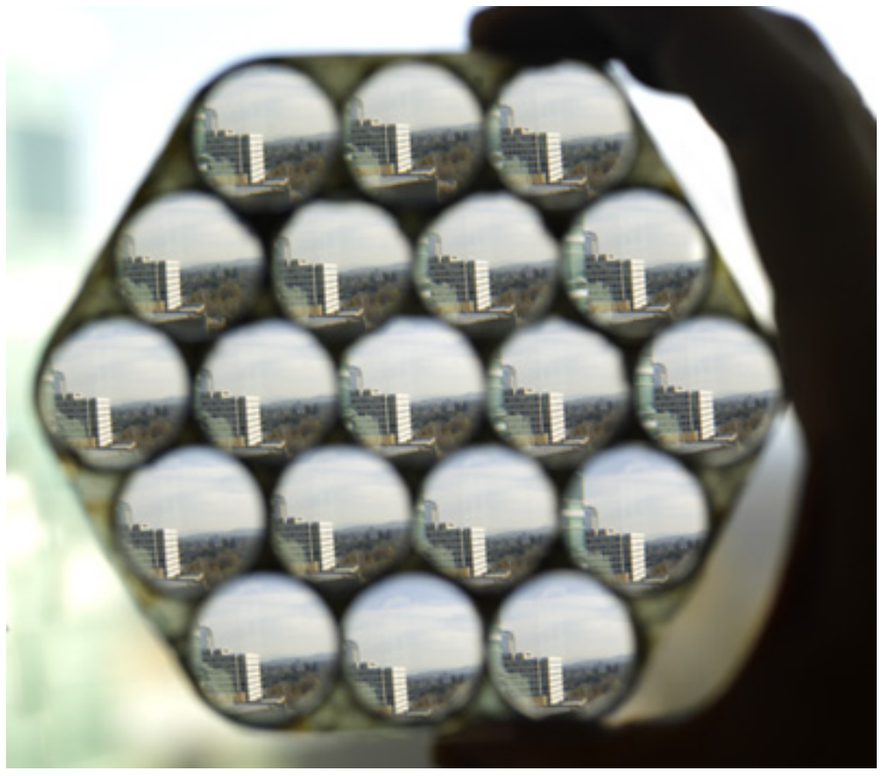
- Optical flow (LK, HS).
- Image registration.
- Kalman Filtering.
- Tracking (KLT, Mean-Shift).



Topics to be covered

Special topics:

- Computational photography.
- ???



Grading

- Seven two-week programming assignments: 70%
- Twelve weekly take-home quizzes: 27%
- Class, Website, and Piazza participation: 3%

Participation:

- Be online for lectures (if possible).
- Post on Piazza discussions.
- Ask and answer questions.

Programming Assignments

- a lot of programming in Python.
- hours and hours of programming.
- days and days of debugging.
- generous grading policy (like grad school)
- take advantage of extra credit

Assignment 1 Hough Transform
Assignment 2 Homography
Assignment 3 Stereo
Assignment 4 Photometric Stereo
Assignment 5 Bag of Words
Assignment 6 Convolutional Neural Nets
Assignment 7 Lucas-Kanade Tracking

Programming Assignments

- a lot of programming in Python.
- hours and hours of programming.
- days and days of debugging.
- generous grading policy (like grad school)
- take advantage of extra credit

Assignment 1 Hough Transform
Assignment 2 Homography
Assignment 3 Stereo
Assignment 4 Photometric Stereo
Assignment 5 Bag of Words
Assignment 6 Convolutional Neural Nets
Assignment 7 Lucas-Kanade Tracking

Seriously.. a lot of programming, so start early!

Leniency

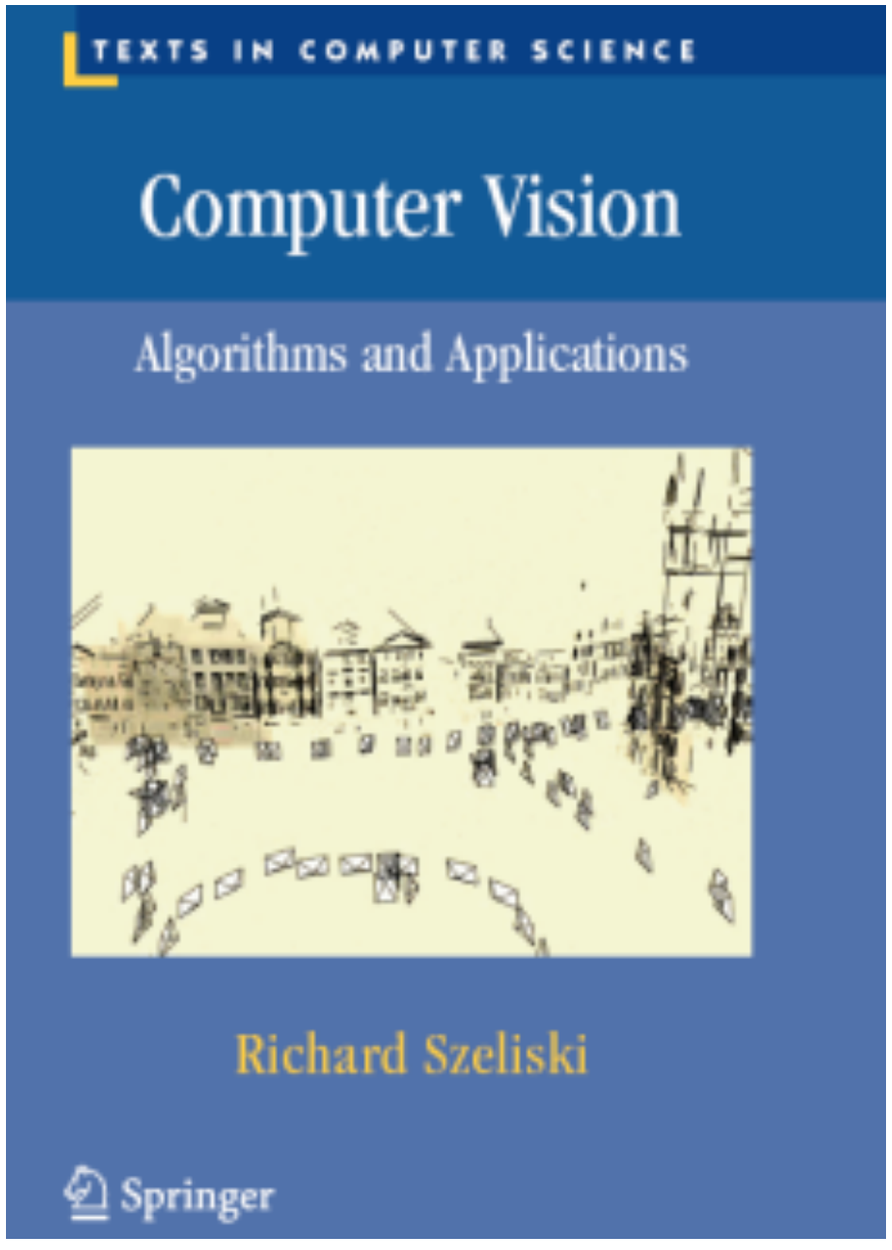
Late days for programming assignments:

- 10% reduction of points per late day
- 6 free late days total
- use them wisely… save for later (harder) assignments!

Option to skip take-home quizzes:

- you only need to submit 8 out of 11 quizzes
- late quizzes will not be graded

Book



PDF online

http://szeliski.org/Book/

Prerequisites

We assume familiarity with calculus, linear algebra, basic probability, and programming.

Formal prerequisites:

- "Mathematical Foundations of Electrical Engineering" (18-202) and "Principles of Imperative Computation" (15-122)

OR

- "Matrix Algebra with Applications" (21-240) and "Matrices and Linear Transformations" (21-241) and "Calculus in Three Dimensions" (21-259) and "Principles of Imperative Computation" (15-122)

If you are missing a prerequisite but still want to enroll, let me know and we'll discuss it.

Contact information

- Feel free to email us about administrative questions.
  - please use [16385] in email title!
- Technical questions should be asked on Piazza.
  - we won't answer technical questions through email.
  - you can post anonymously if you prefer.
- Office hours will be determined by poll.
  - feel free to email Matt about additional office hours.

<u>Matt will announce office hours for this week.</u>