Introduction

http://www.cs.cmu.edu/~16385/

16-385 Computer Vision
Spring 2019, Lecture 1

Overview of today's lecture

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

Teaching staff introductions

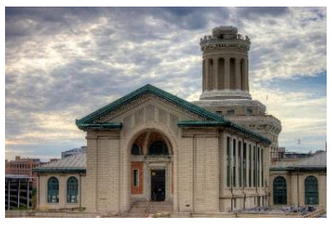
Instructor: Ioannis (Yannis) Gkioulekas

I won't hold it against you if you mispronounce my last name

Originally from Greece

National Technical University of Athens (2004-09)

Harvard University (2009-17)



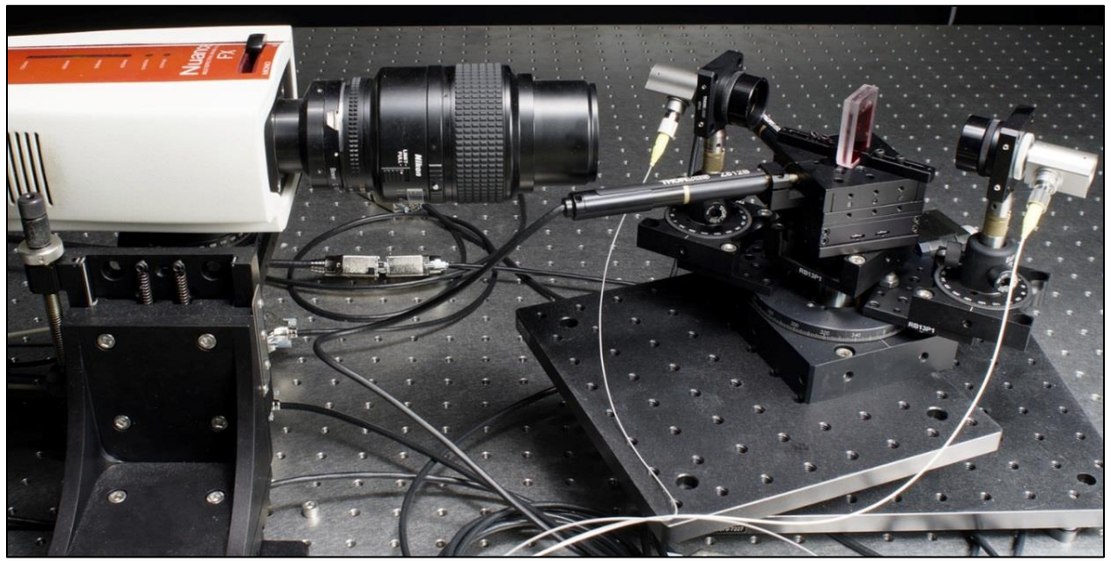
Carnegie Mellon University (2017-now)

me at Harvard in 2011
(obviously need new photo)

My website: http://www.cs.cmu.edu/~igkioule

Building a scatterometer

Camera for measuring parameters of scattering materials



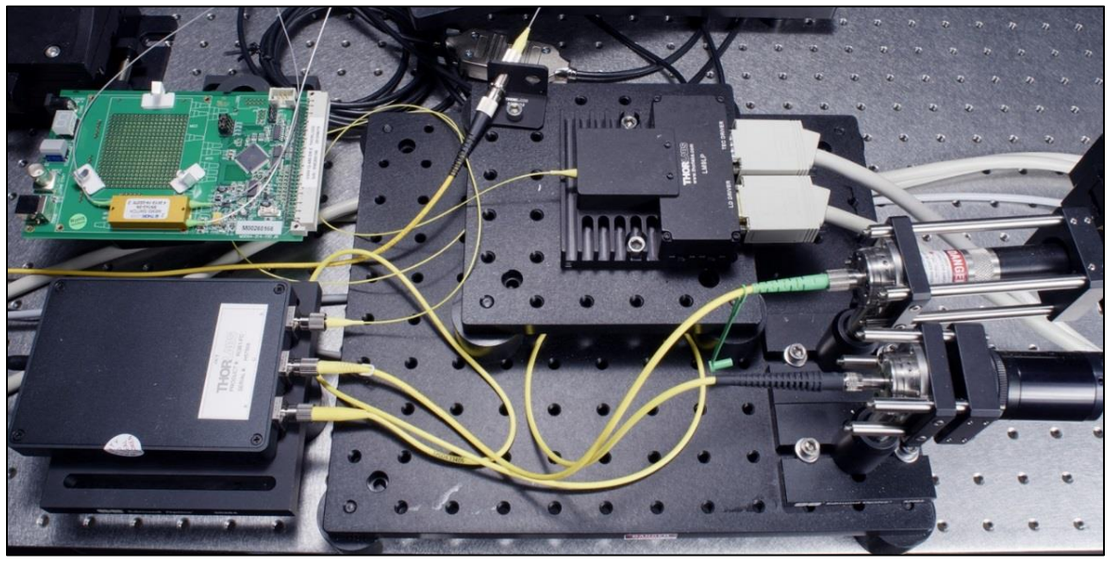
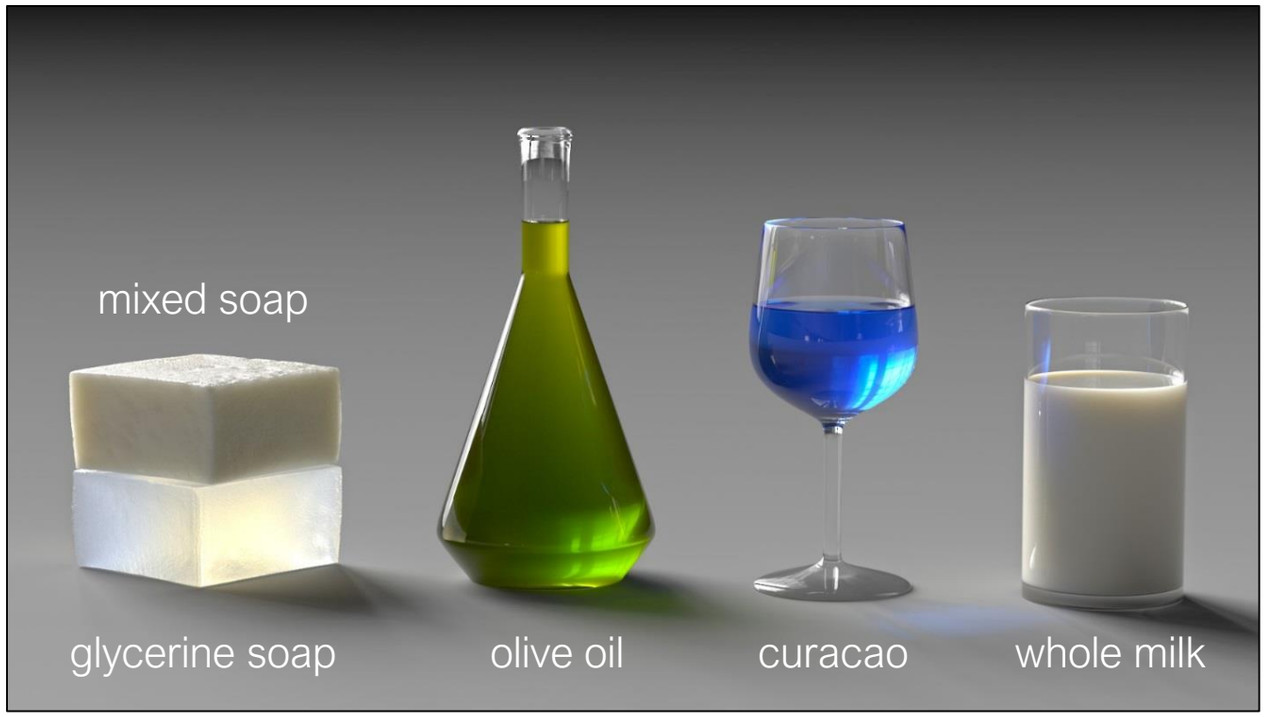
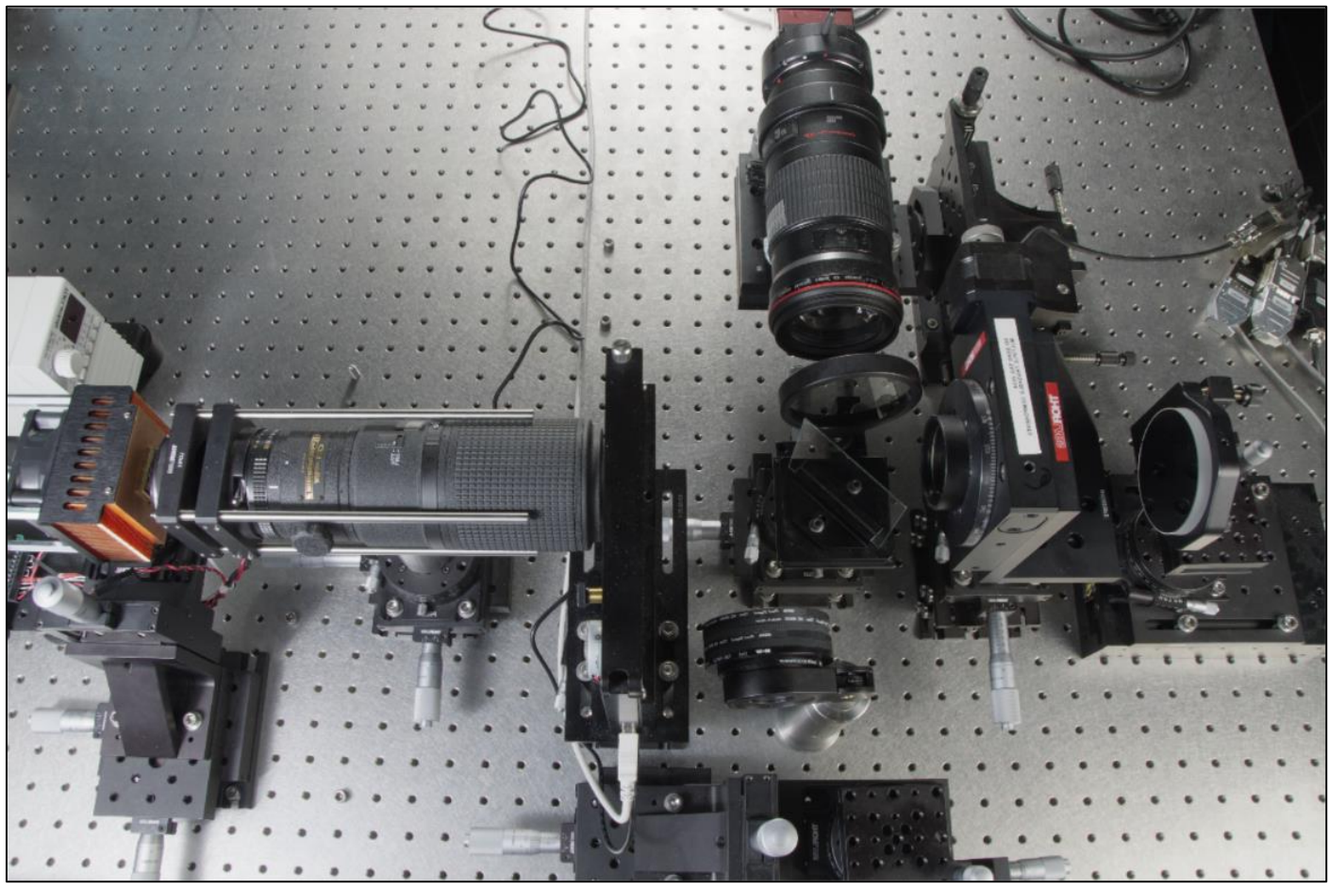
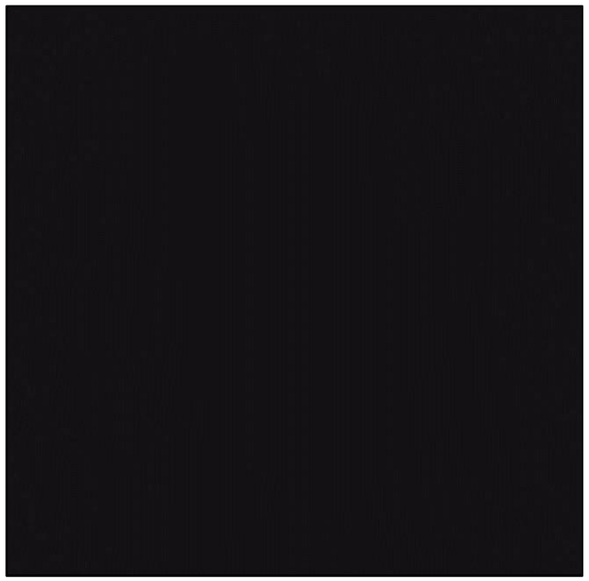


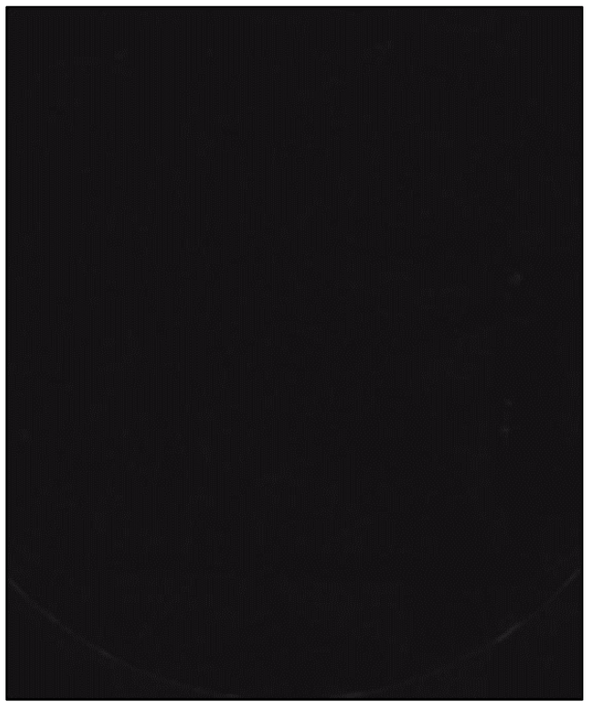
image synthesized from measurements



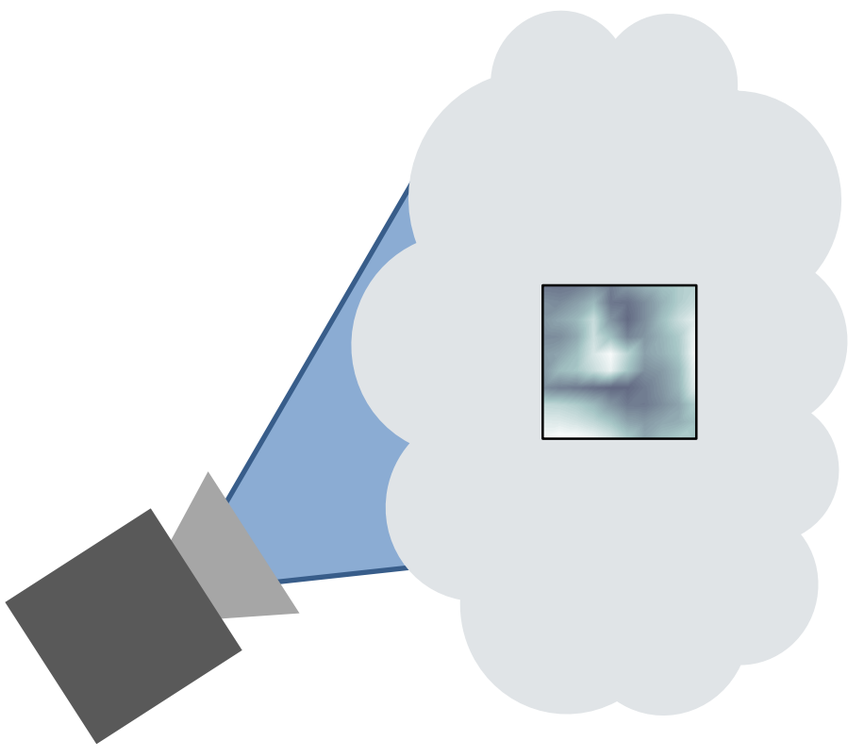
Quadrillion FPS video







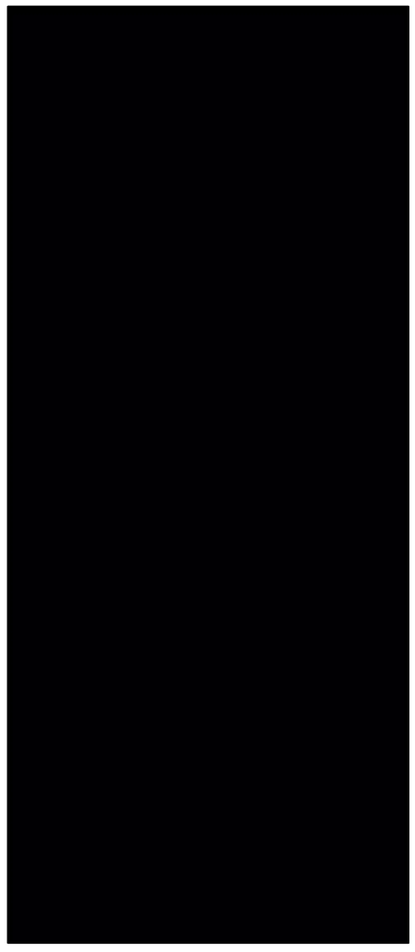
Seeing inside objects



camera

thick smoke cloud

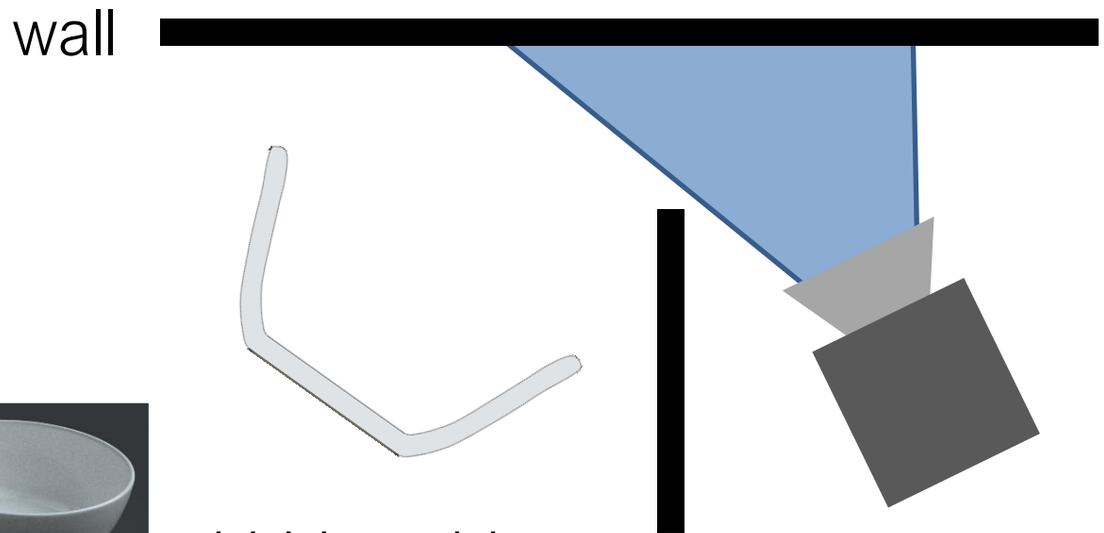
what a regular camera sees



what our camera sees

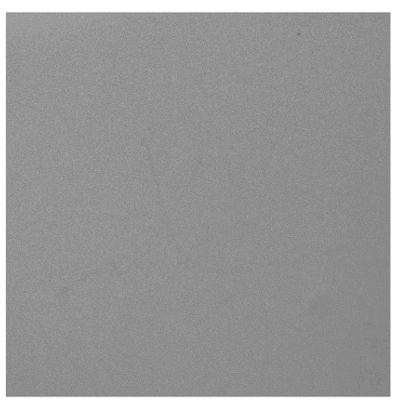
a slice through the cloud

Seeing around walls

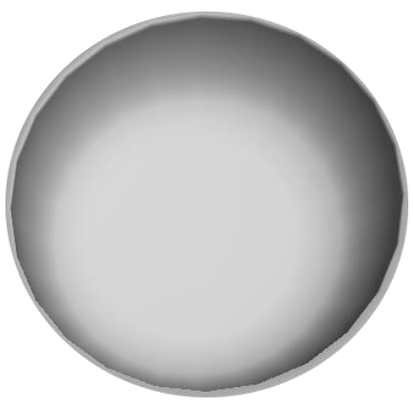


hidden object

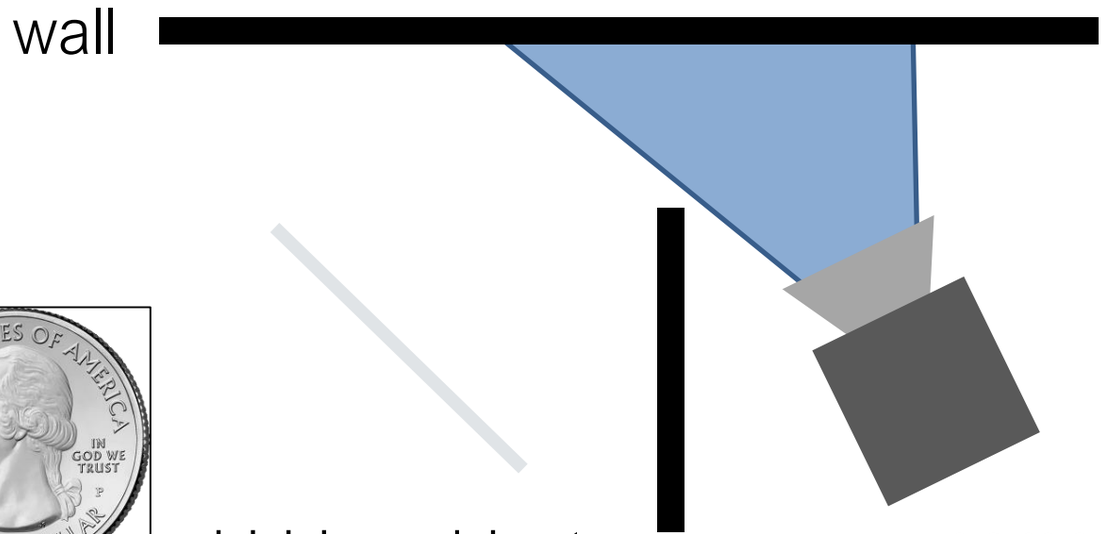
camera



what a regular camera sees

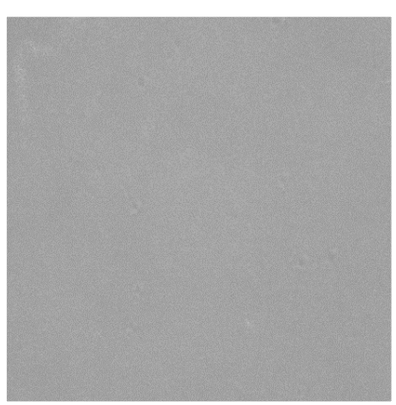


what shape our camera sees



hidden object

camera



what a regular camera sees

what depth our camera sees

TA: Sharvani Chandu

Master of Science in Computer Vision (MSCV)

Research Interests
Multimodal machine learning, Deep Learning,
Medical Image Processing

Current Area of Research
Sony Chef – Learning a Simulator for Cooking
(under Prof. Katerina)

Past Research

- Micro Aneurysm detection using deep learning
- Automatic target extraction from satellite images
- Text summarization and intent extraction from documents

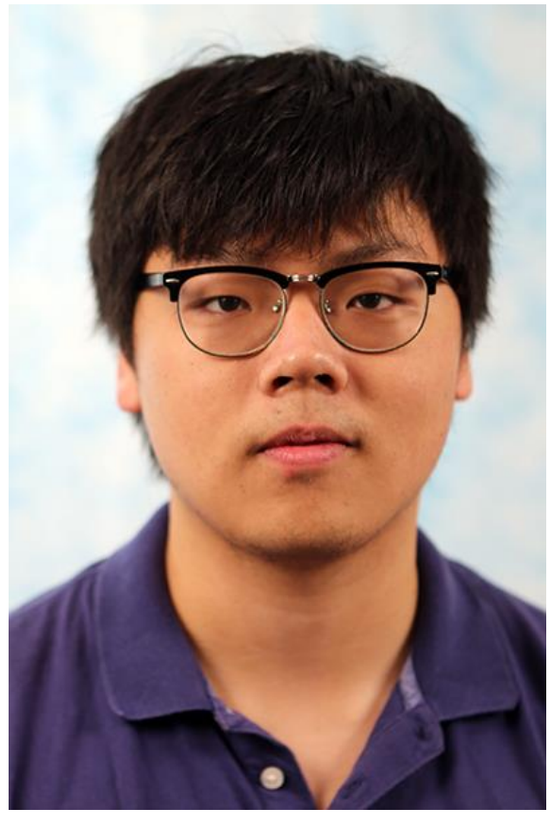
TA: Chengqian Che(Bruce)

Ph.D in Robotics

Research Interests
Physics-based Vision; Computer graphics; Deep learning

Current Research area
Inverse rendering/ Differentiable rendering; Material inference

Past Research
Medical imaging analysis; Ultrasound imaging segmentation/registration



TA: Abhay Gupta

- **Master of Science in Computer Vision (MSCV)**
- **Research Interests:**
  - Multi-View Stereo, Video Context Understanding, Visual Reinforcement Learning
- **Current Areas of Research:**
  - Trajectory Prediction for Self-Driving Cars
- **Past Research:**
  - Partial Face Segmentation and Recognition
  - Action Recognition in Videos
  - Emotion Recognition in Videos

TA: Anshuman Majumdar

Master of Science in Computer Vision

Research Interests
Object Detection, Tracking and Pose Estimation
SLAM and Tracking for AD/AR/VR
OCR and Analysis of Handwritten Document Images

Current Area of Research
Visual Inspection for Aircraft and Power Lines

Past Research
- Robust 6-DoF Positional Tracking in presence of Motion Blur for AR/VR
- Monocular Reconstruction of Vehicles on Graded Roads in Dynamic Scenes
- Roadsign Detection, Tracking and Classification
- Visual Aesthetic Analysis for Handwritten Document Images

TA: Neeraj Sajjan

Master of Science in Computer Vision[MSCV]

Research Interests:

3D Vision, Deep Learning, Object Detection and Tracking

Current Area of Research:

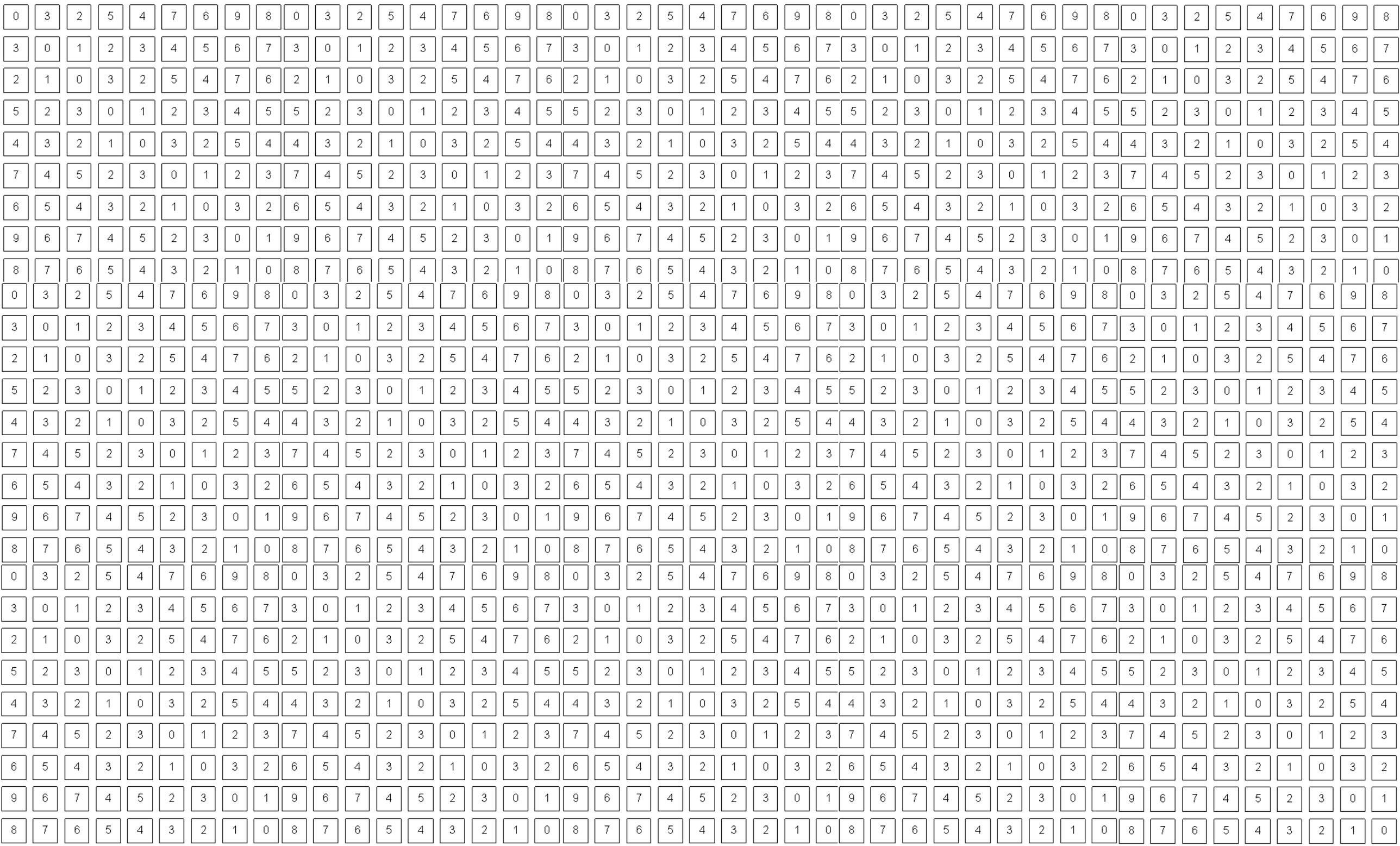
Deep 3D Mesh Reconstruction

Past Research:

- 3D Object Detection and Tracking
- Crowd Counting
- Overlapped Speech Detection

What is computer vision?

What a person sees



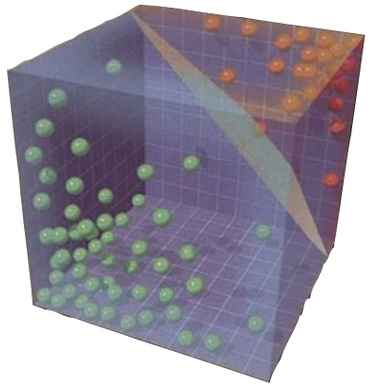
What a computer sees

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

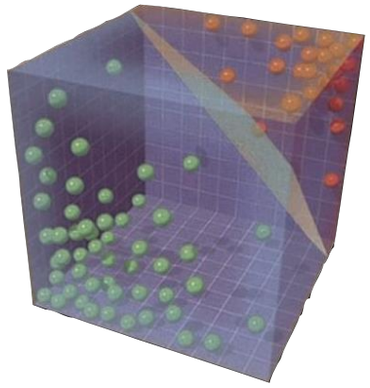


‘fancy math’

output

typical perception pipeline

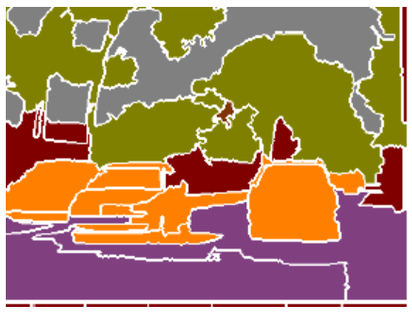
representation



‘fancy math’

what should we look at?
(image features)

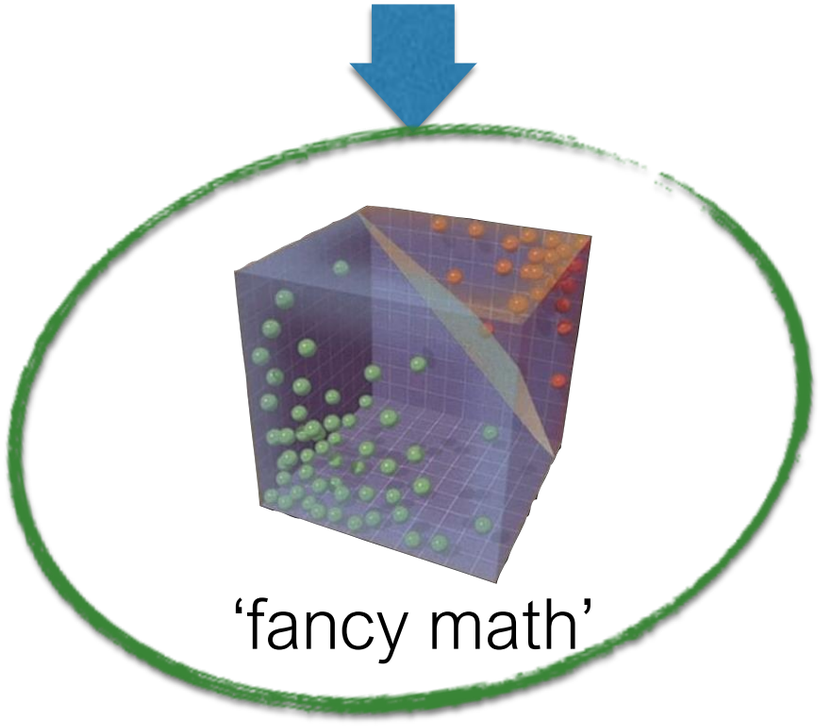
output



what can we understand?
(semantic segmentation)

typical perception pipeline

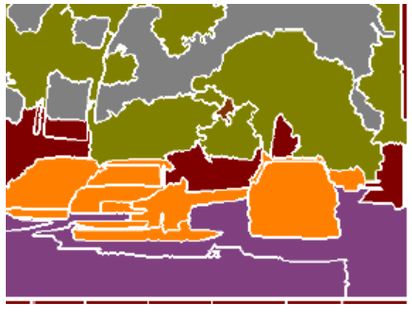
representation



output

what should we look at?
(image features)

easy to get lost in
the techniques



what can we understand?
(semantic segmentation)

typical perception pipeline

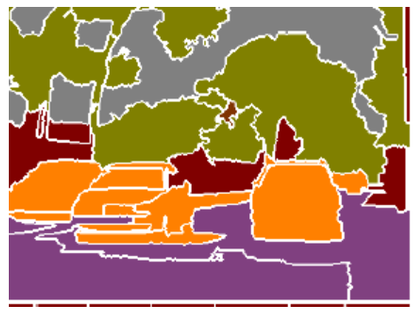
representation

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:

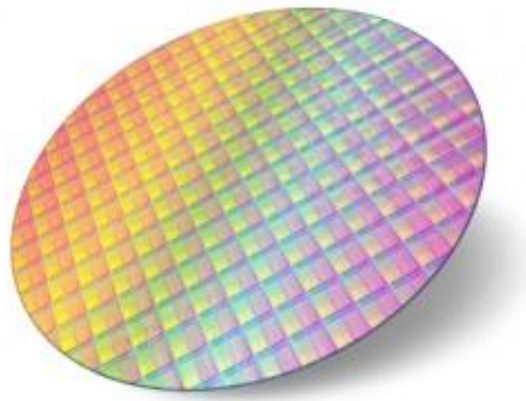
In general, computer vision does not work

(except in certain situations/conditions)

Applications of computer vision

Machine vision

Automated visual inspection

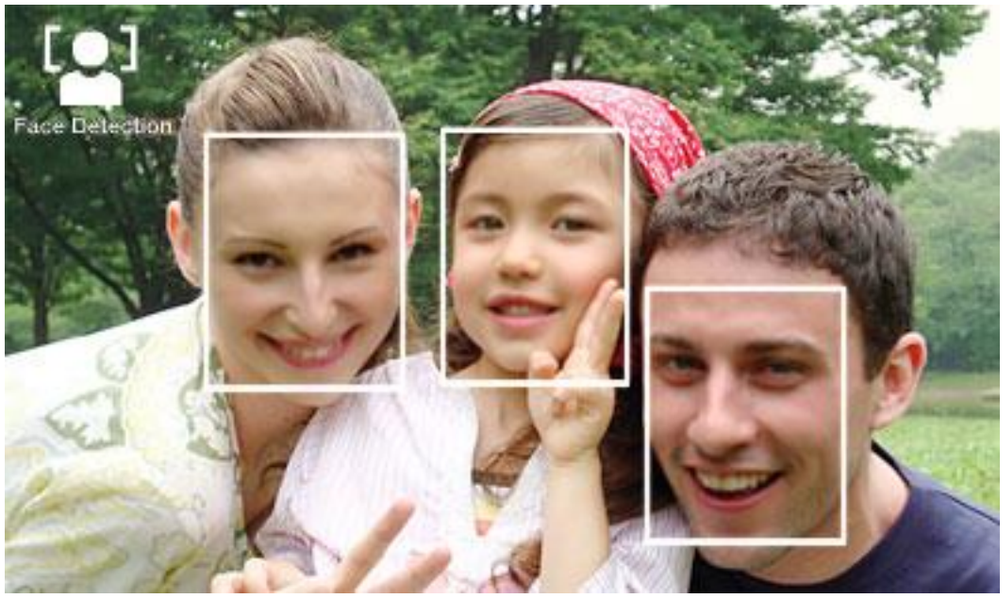


Object Recognition

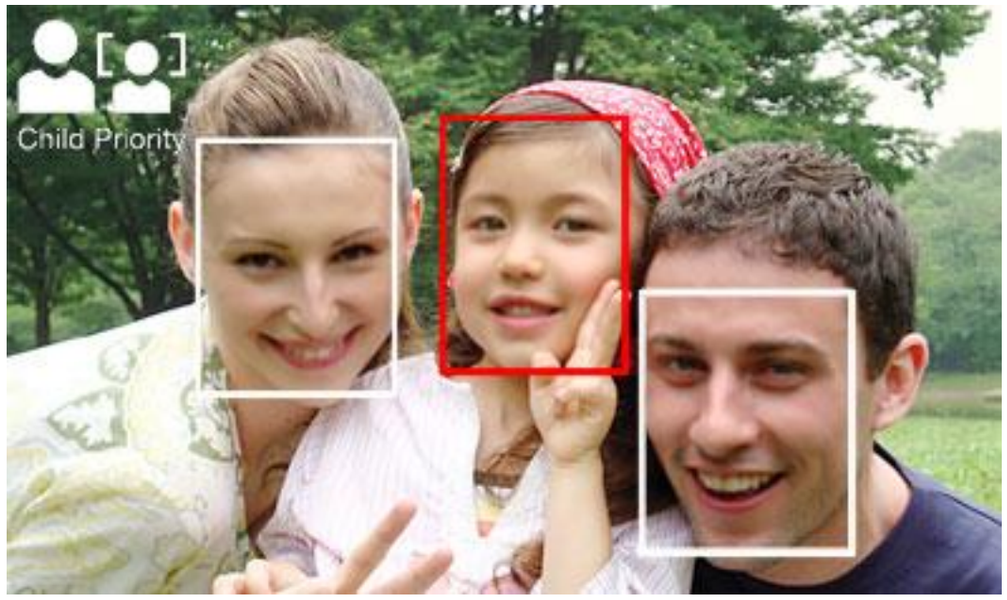
Toshiba Tech IS-910T 2013

DataLogic LaneHawk LH4000 2012

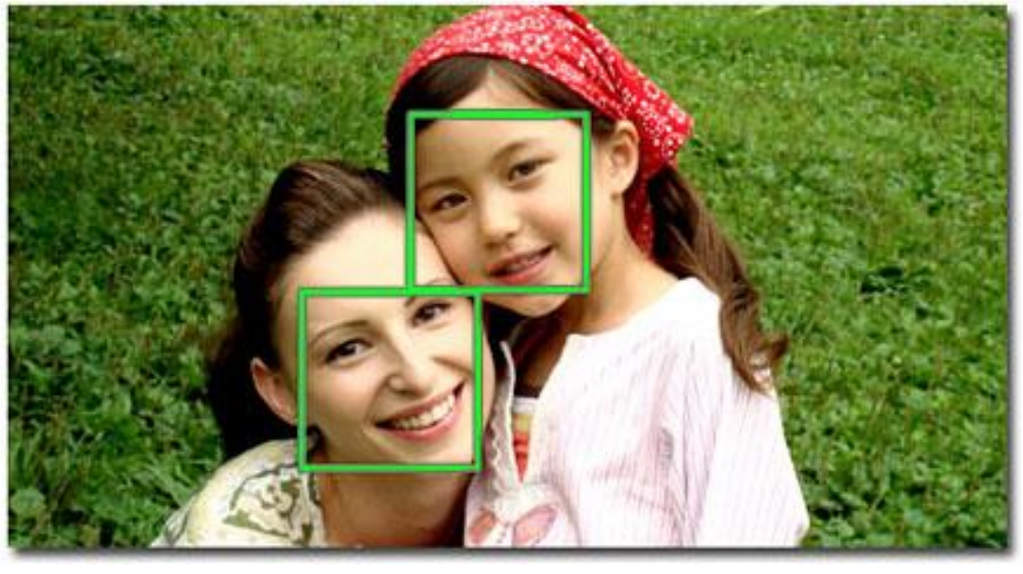
Face detection



Sony Cyber-shot

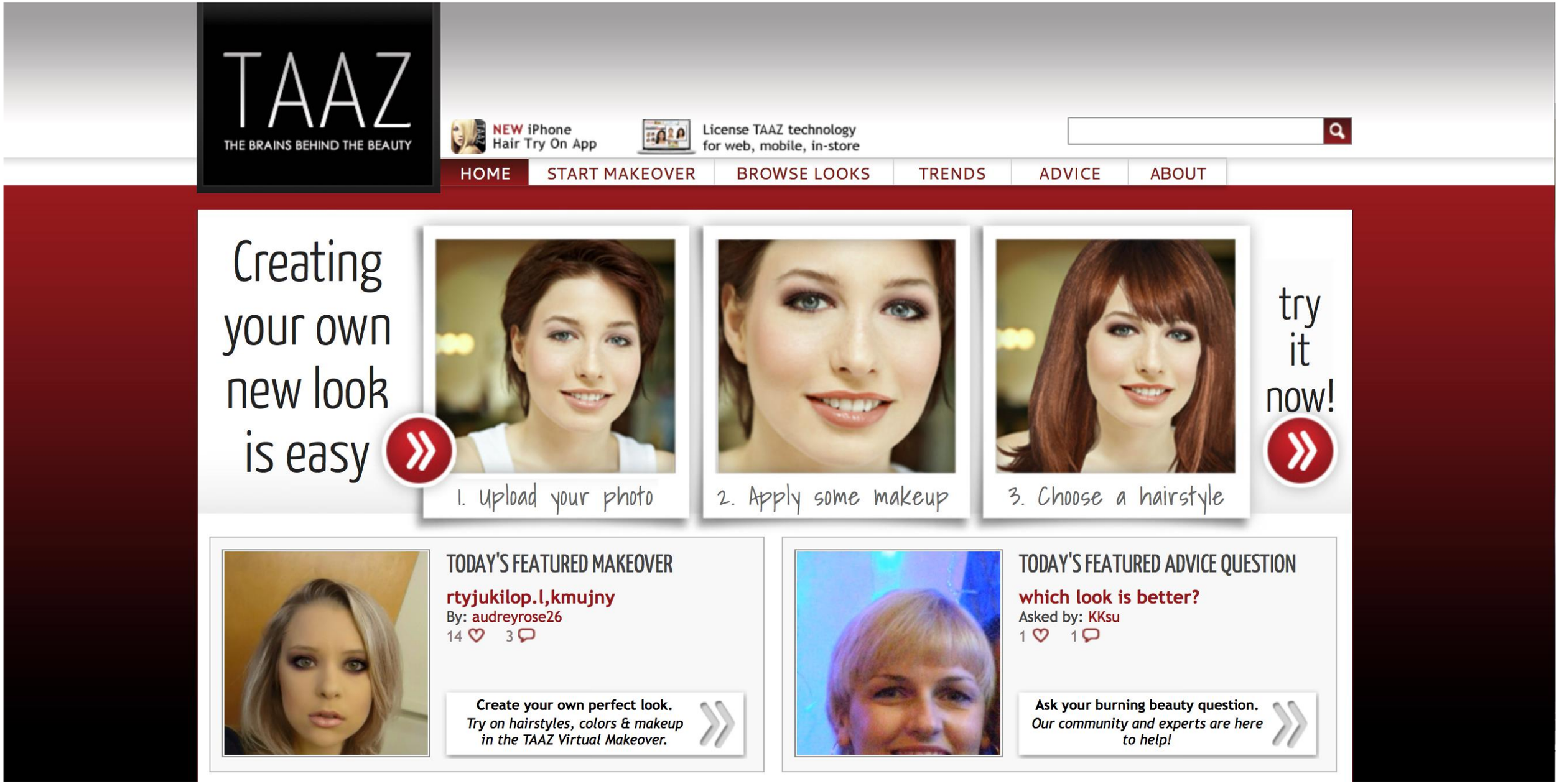


Age recognition



Smile recognition

Face makeovers



leafsnap

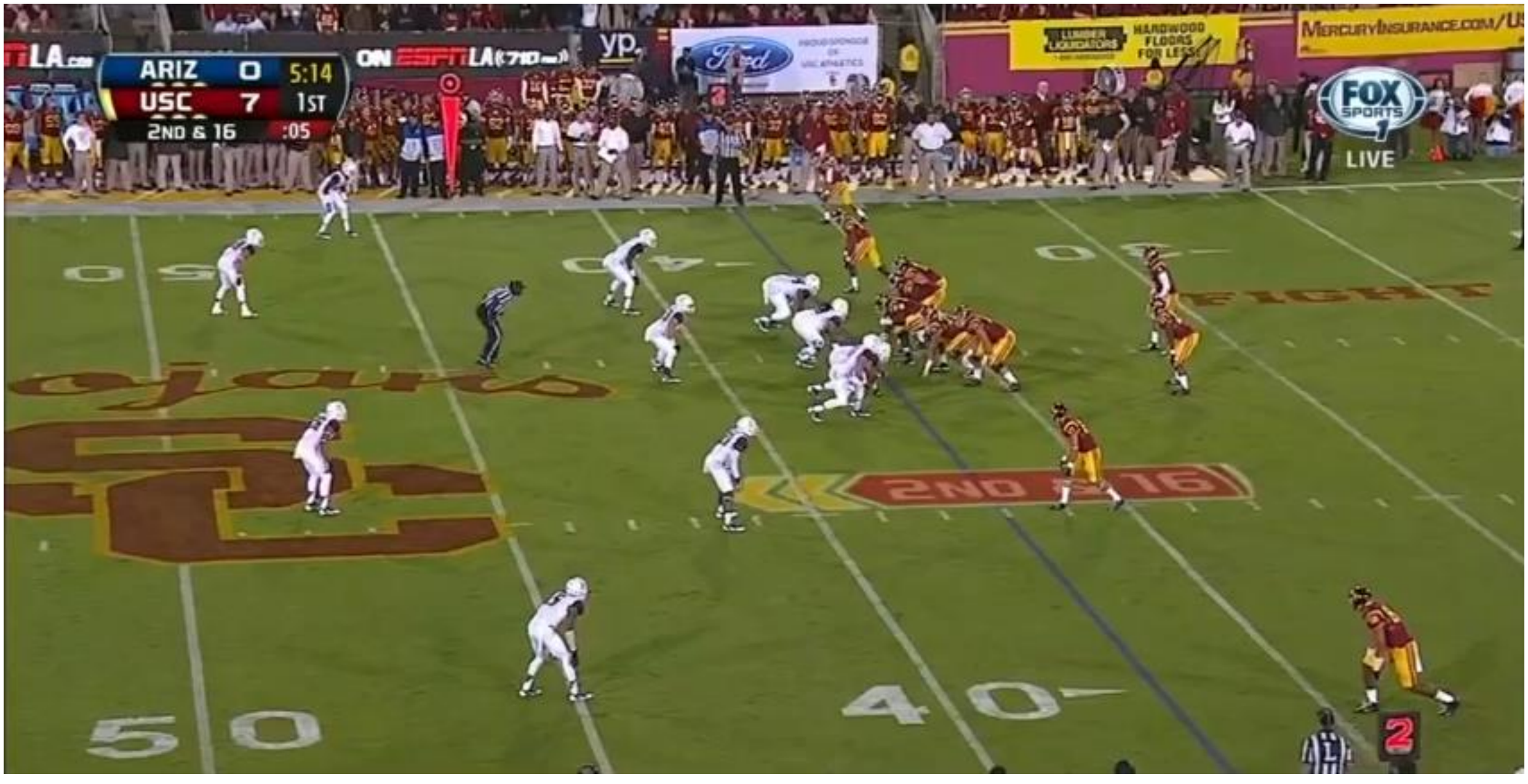

Verizon
12:38 PM
Back
Results
Map
Snap It! Results
1
Red Maple
Acer rubrum
2
Striped Maple
Acer pensylvanicum
3
Sycamore Maple
Acer pseudoplatanus
12:20 PM
100%
First
Last
Scientific
Ilex opaca
American Hornbeam
Carpinus caroliniana
American Linden
Tilia americana
American Sycamore
Platanus occidentalis
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

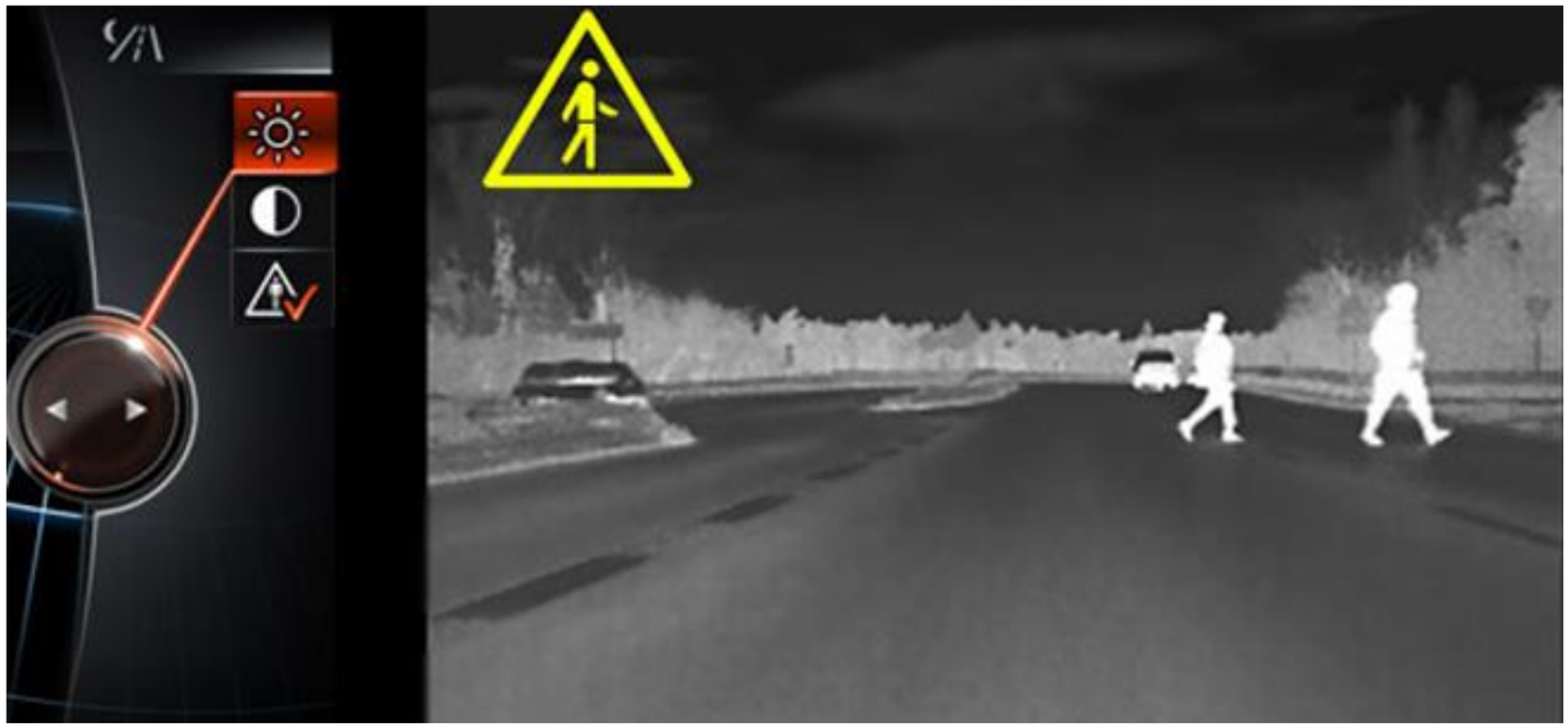
www.QuestVisual.com

First-down line



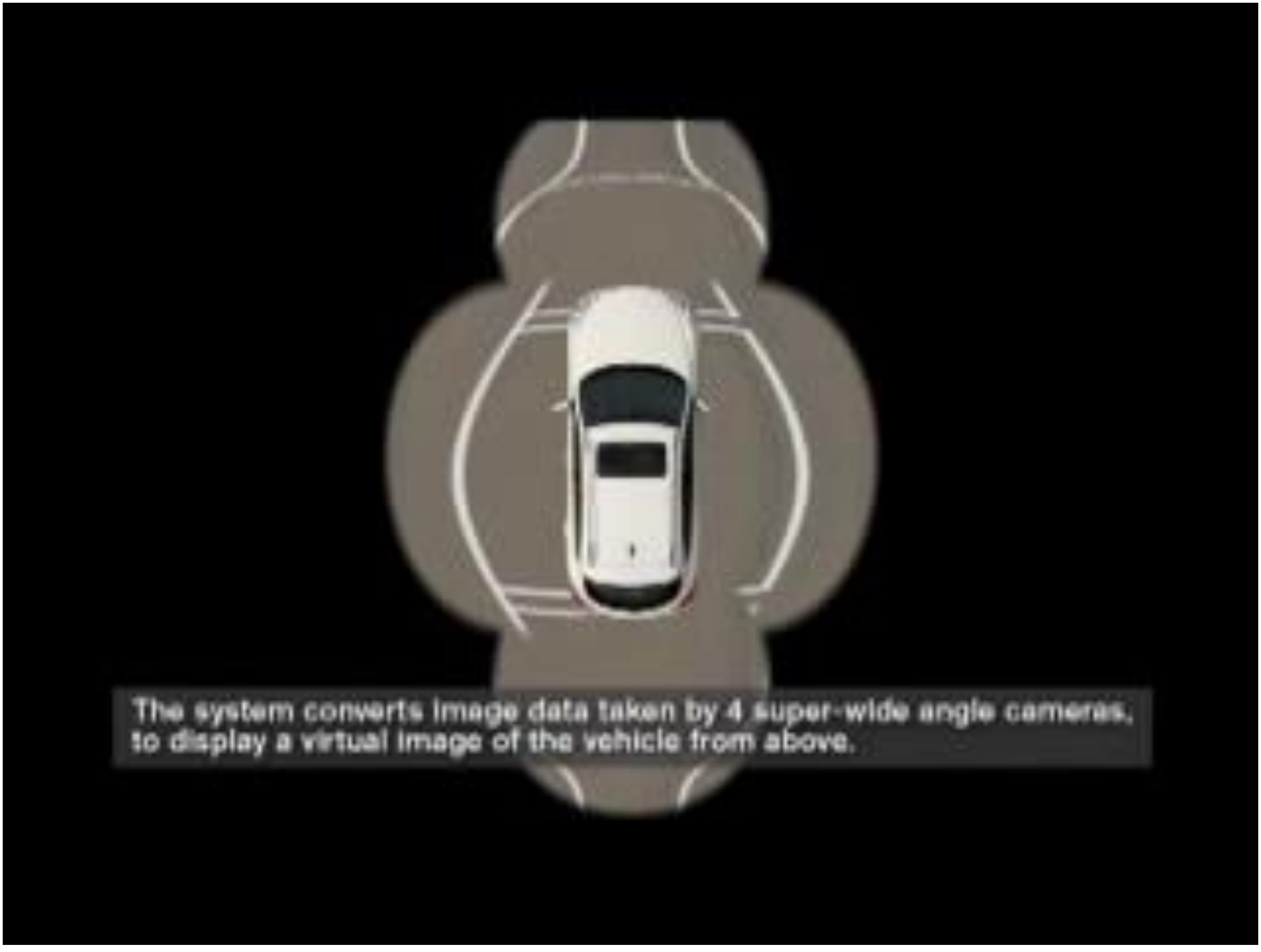
BMW 5 series

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.

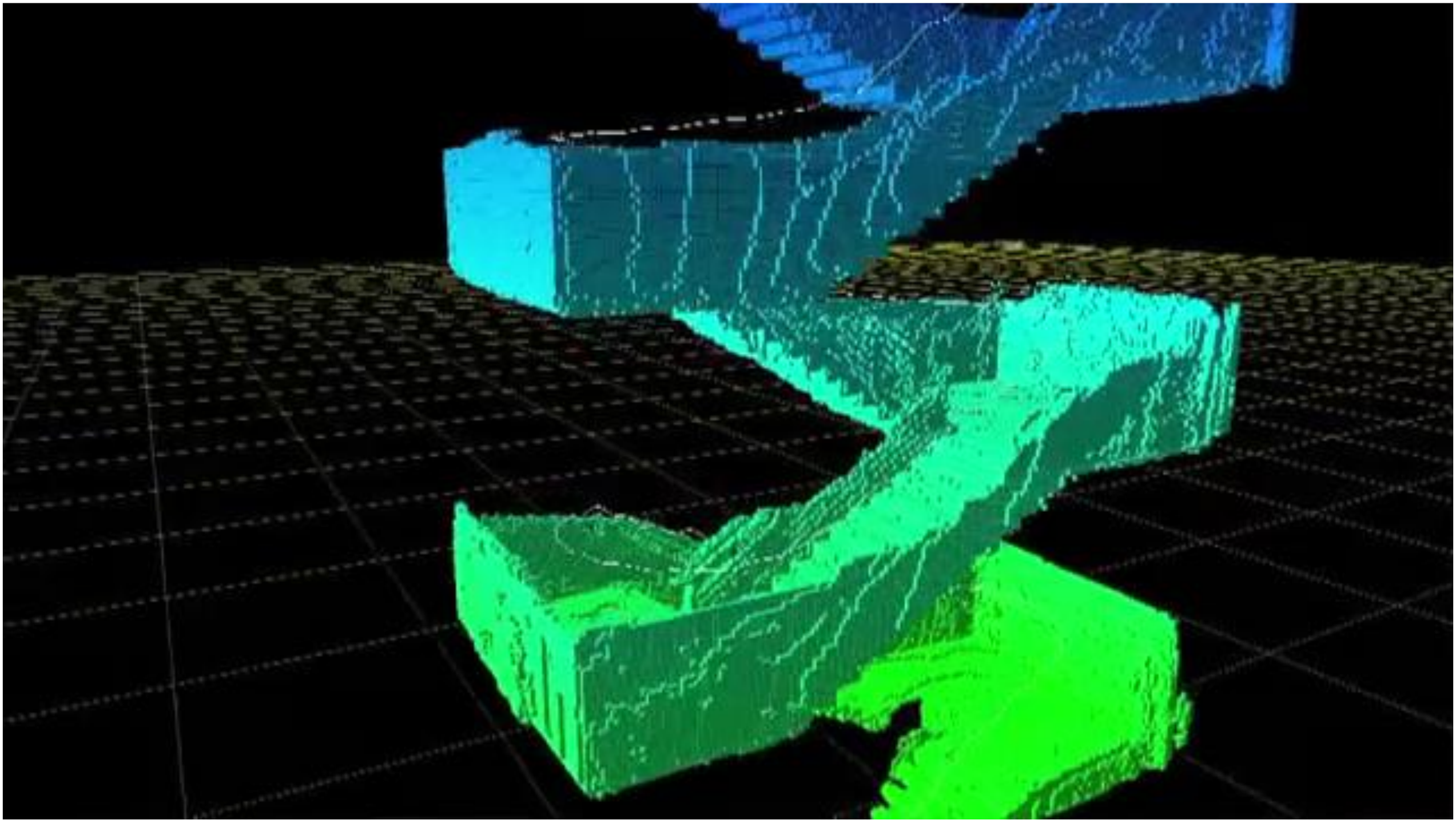
2015

Vision in Cars

Image stitching

Photosynth

Tango



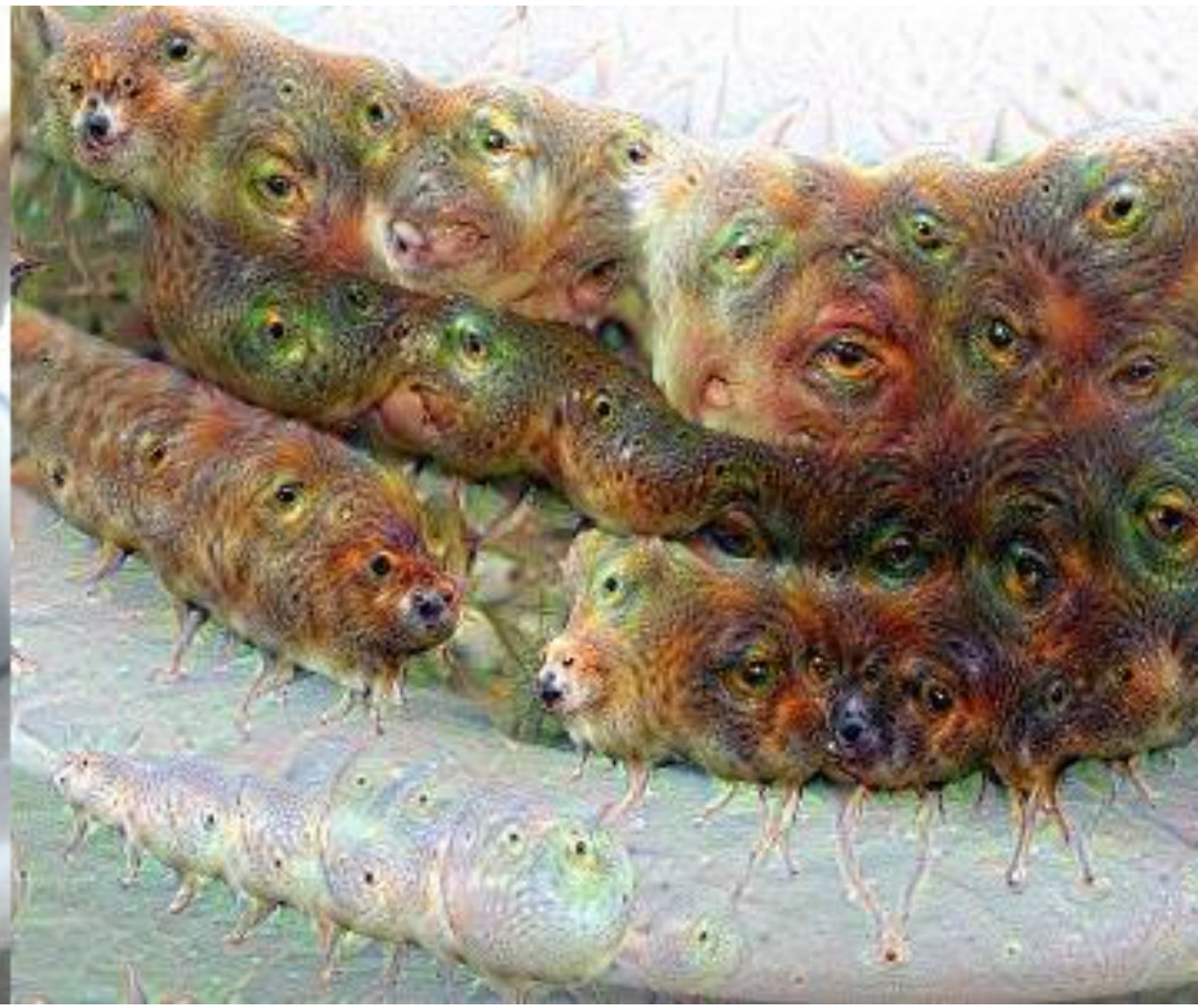
Virtual Fitting

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

(this slide is already out of date by at least 3 CMU faculty)

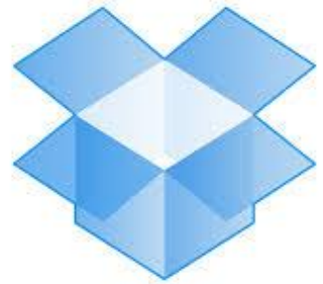
NYU

UW

NYU

USC

UW



UCSD

Columbia

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

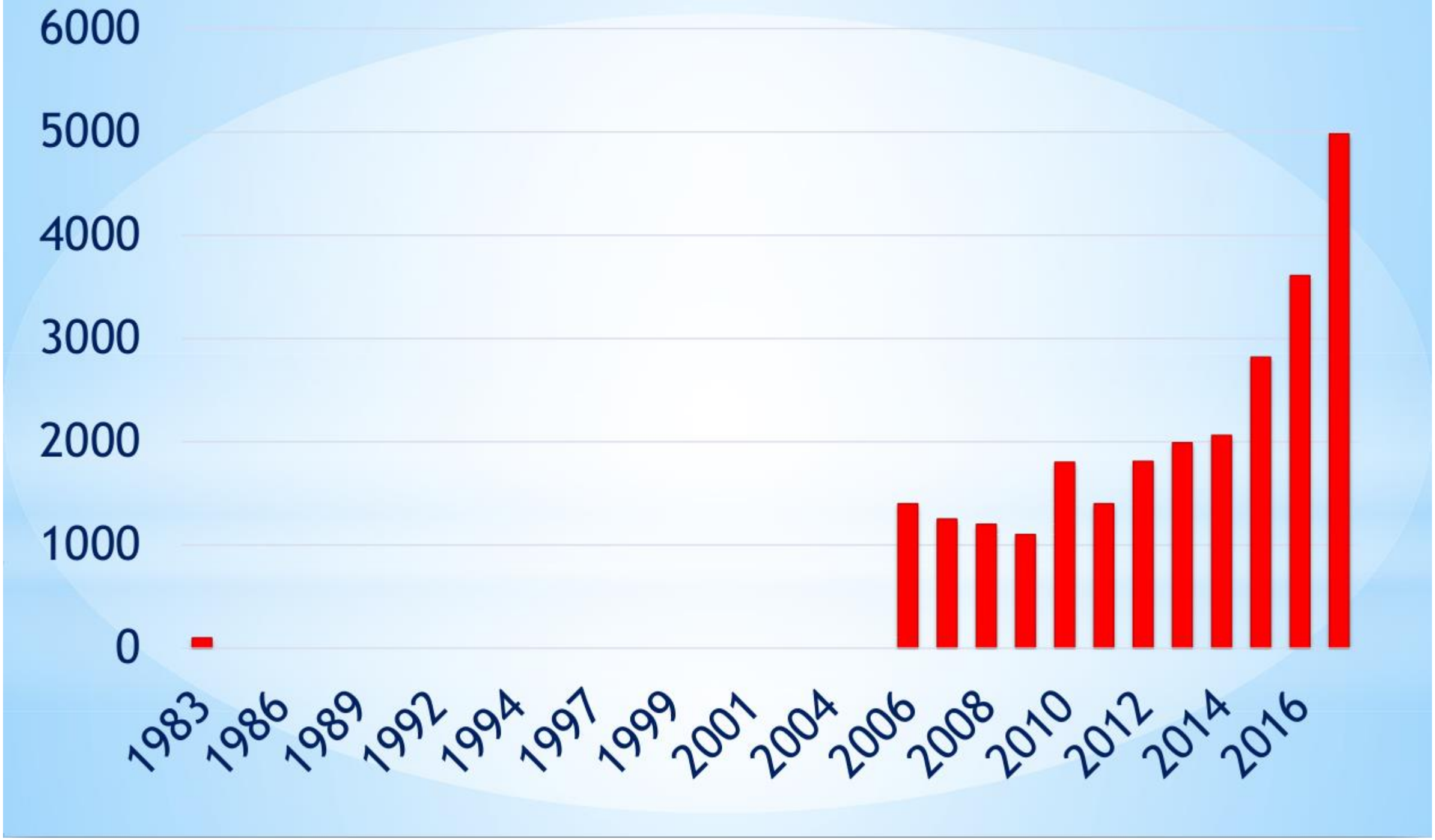
The latest news from Research at Google

Google at CVPR 2017

Friday, July 21, 2017

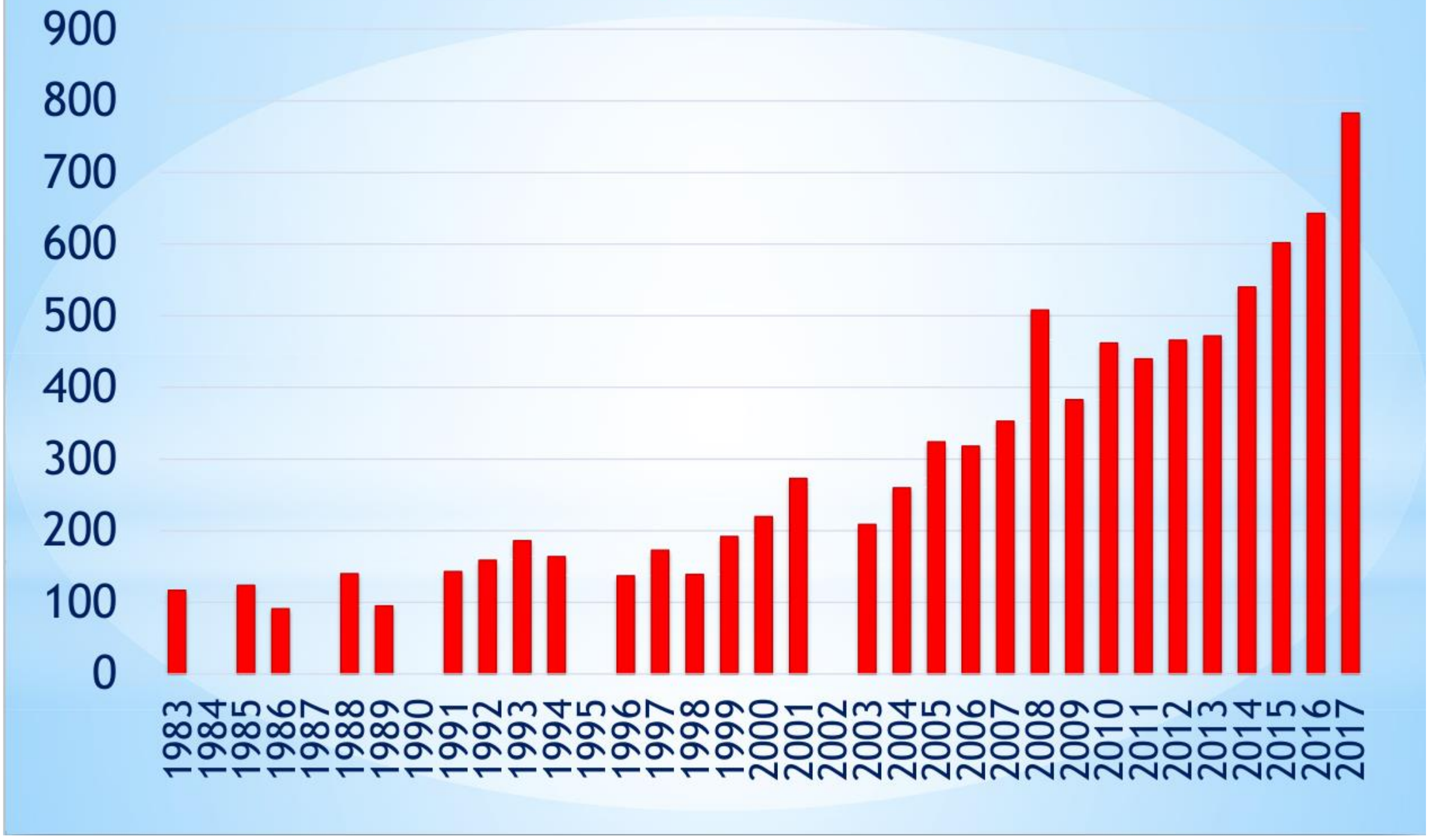
CVPR GROWTH

Original slide courtesy of CVPR 2016



CVPR GROWTH

Original slide courtesy of CVPR 2016



Computer vision at CMU

Dedicated courses for each subject we cover in this class:

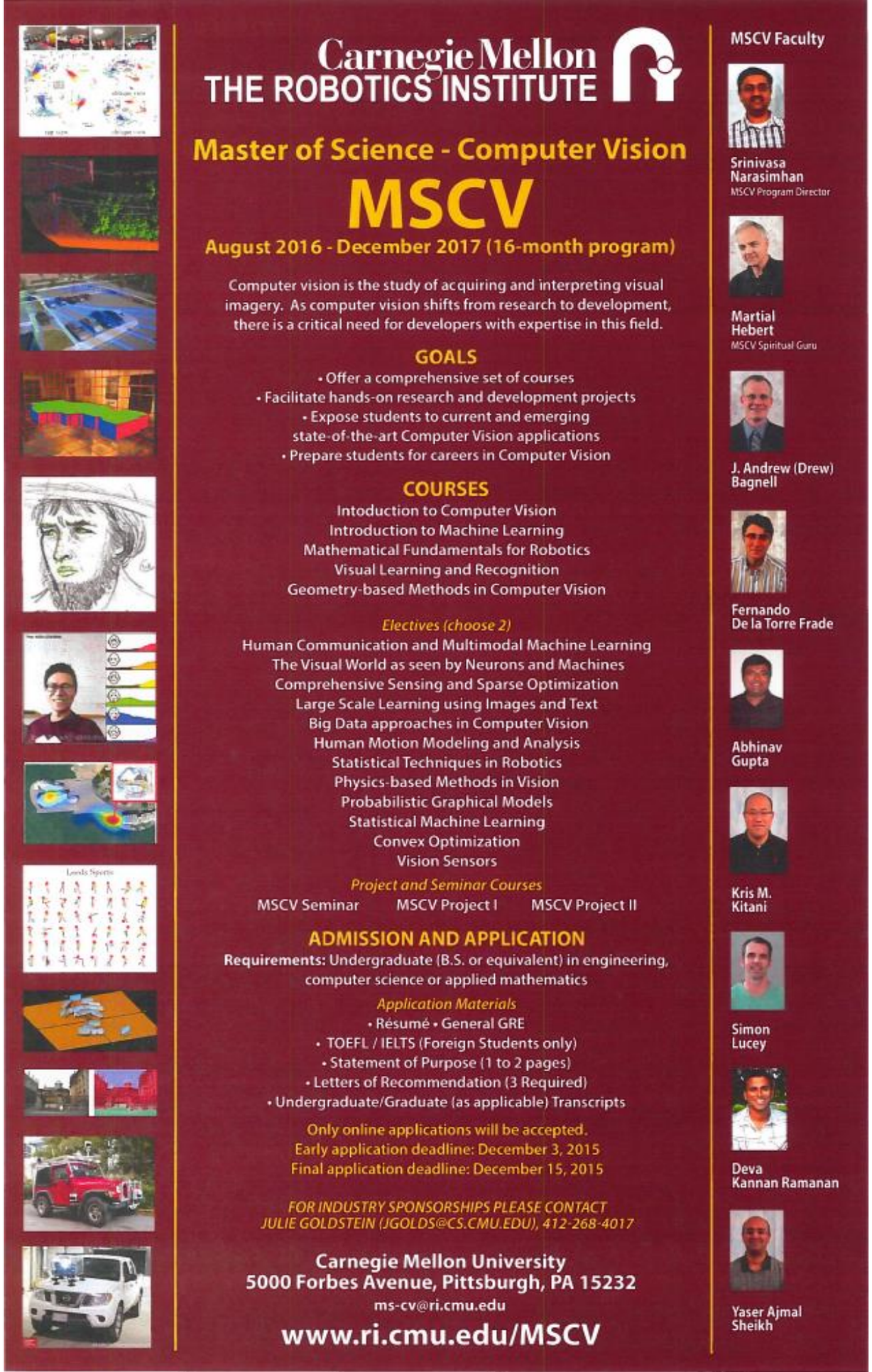
- Physics-based Methods in Vision
- Geometry-based Methods in Computer Vision
- Computational Photography
- Visual Learning and Recognition
- Statistical Techniques in Robotics
- Sensors and sensing

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

ICCV 2017: CMU was the second most common academic affiliation among authors

(can you guess the first?)

Master in Computer Vision at CMU



Course logistics

Website

http://www.cs.cmu.edu/~16385/

Assignments Canvas

https://canvas.cmu.edu/courses/8880

Discussion&notes piazza

https://piazza.com/class/jqmfa1yz38v2oc

(you should sign up here on your own)

Topics to be covered

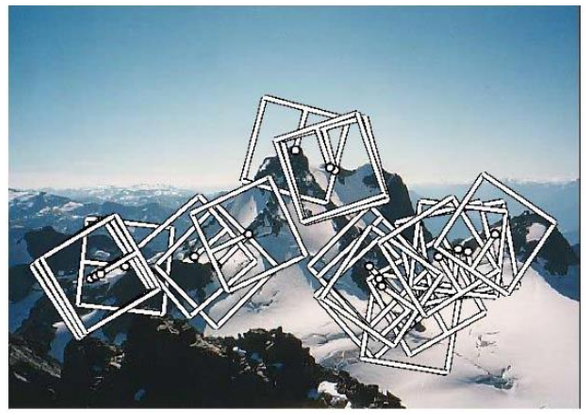
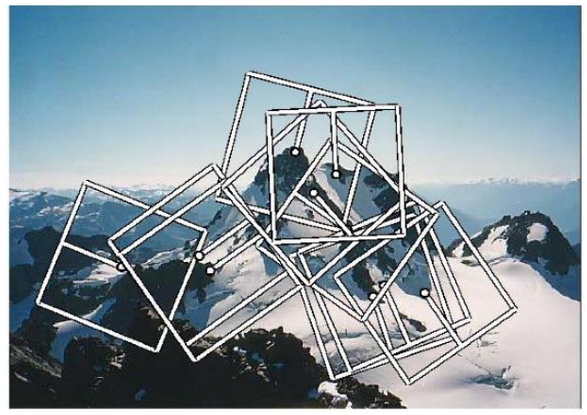
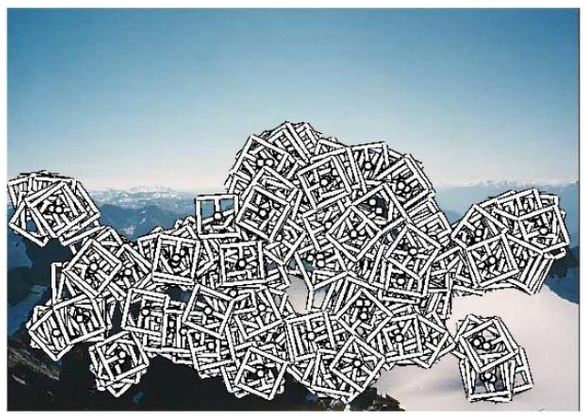
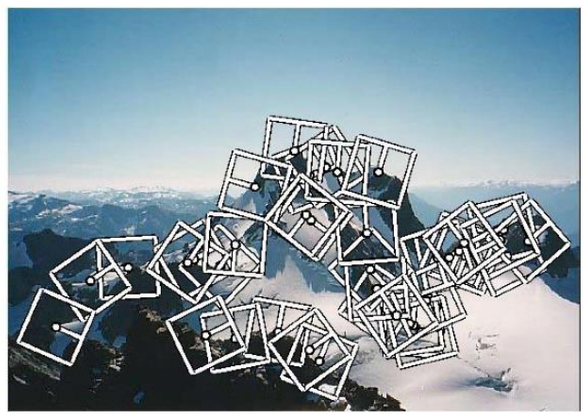
Image processing:

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

Topics to be covered

Feature detection and correspondences:

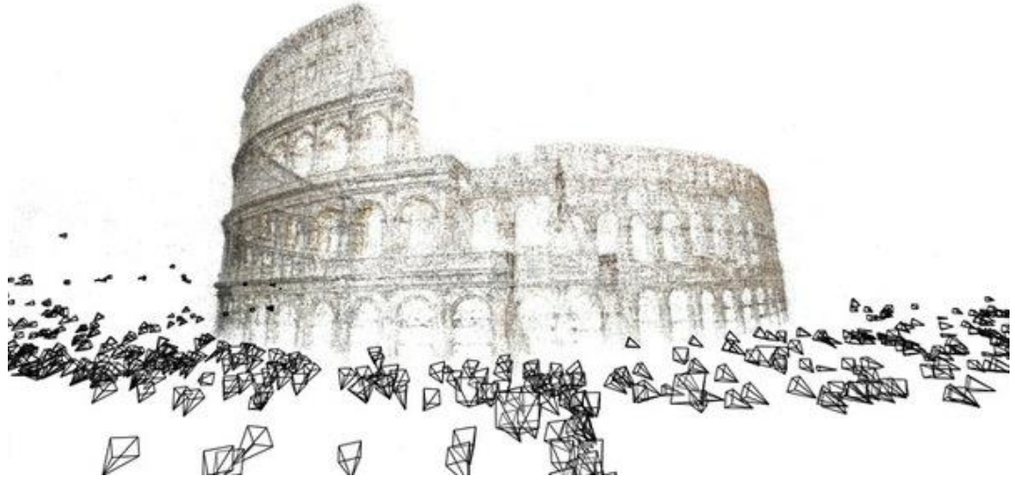
- Corner detection.
- SIFT et al.
- Feature descriptors.
- RANSAC.

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

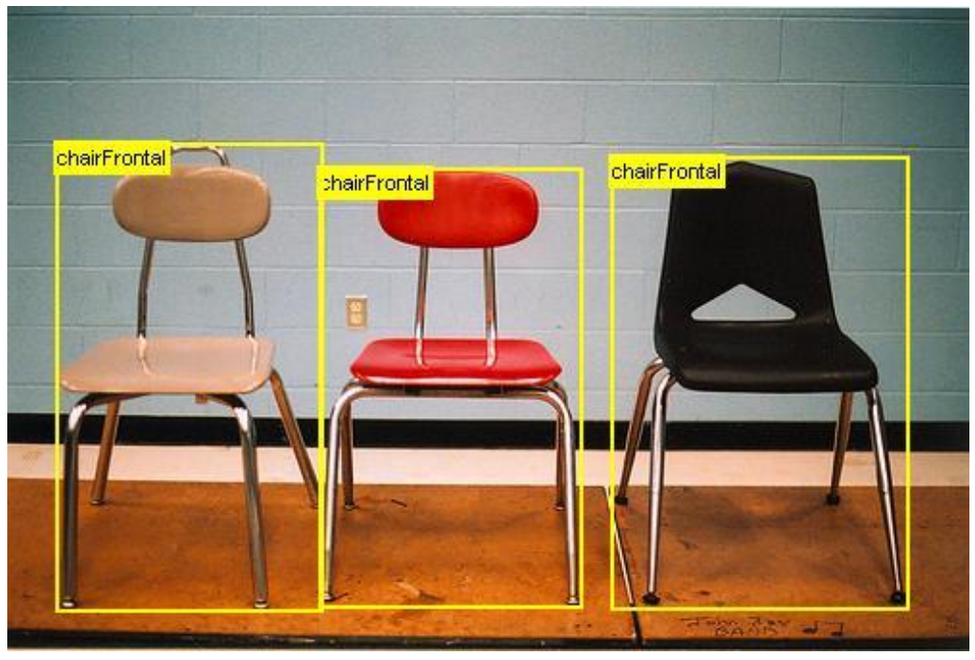
Physics-based vision:

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

Topics to be covered

Objects, faces, and learning:

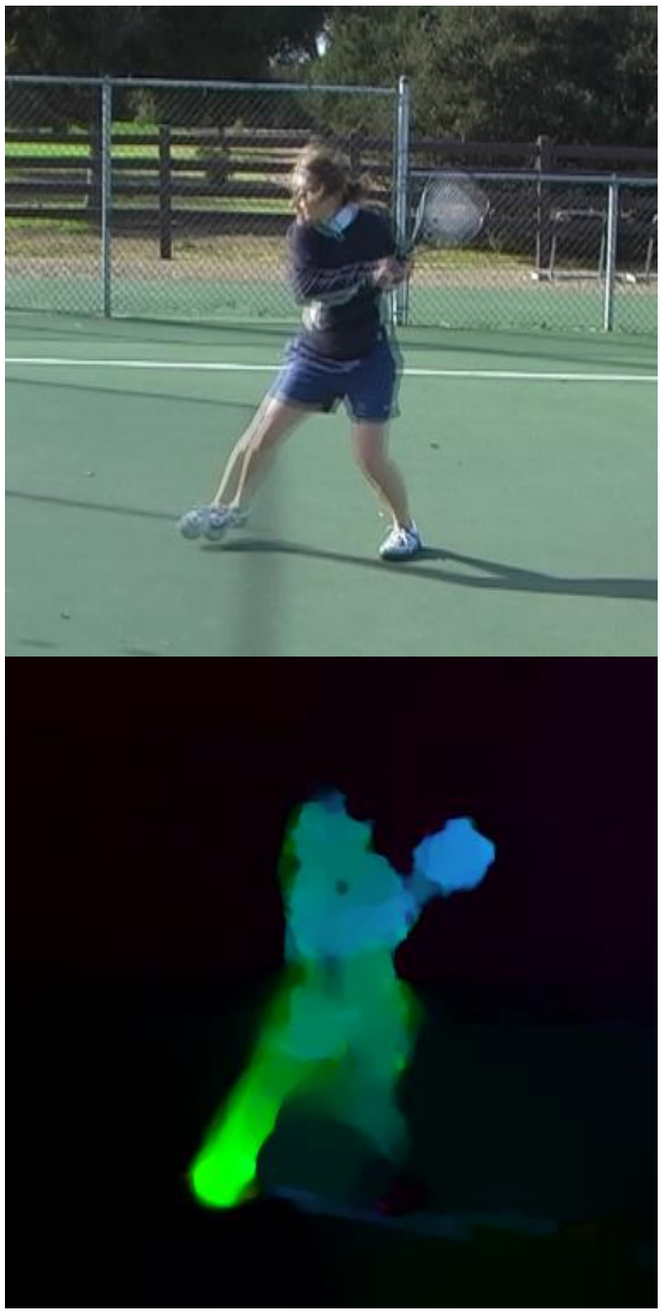
- Basics of probability.
- K-means, KNN, PCA, SVM.
- Bag of words.
- Viola-Jones face detection.
- Perceptron, backpropagation.
- Convolutional neural networks.



Topics to be covered

Dealing with motion:

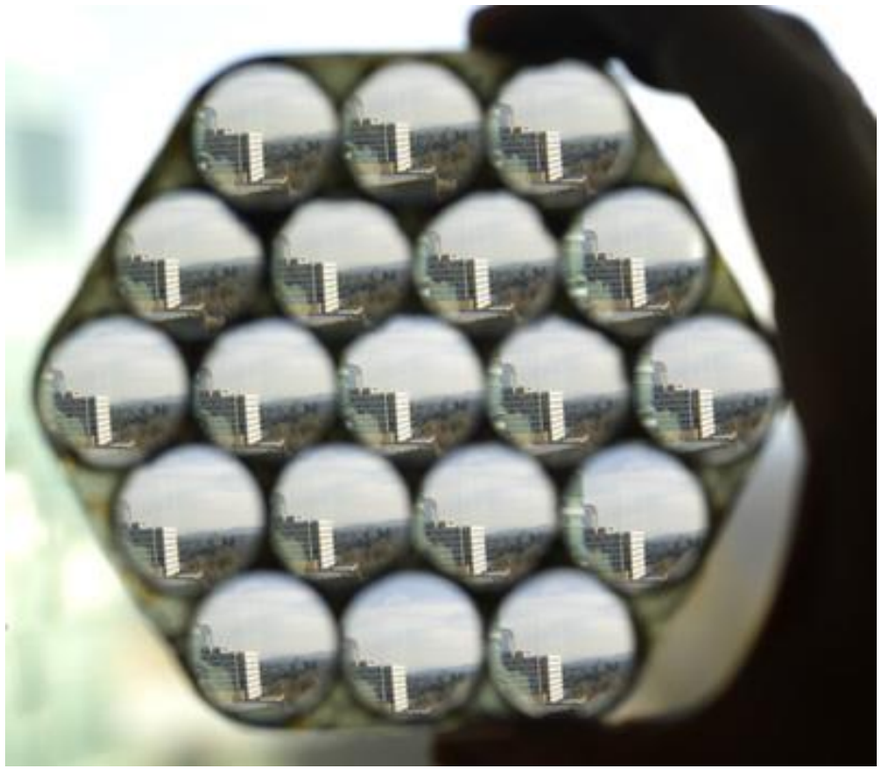
- Optical flow (LK, HS).
- Image registration.
- Kalman Filtering.
- Tracking (KLT, Mean-Shift).



Topics to be covered

Special topics:

- Computational photography.
- ???



Grading: Project-based

- Seven two-week projects: 95%
- Class and Piazza participation: 5%

Projects:

- a lot of programming in Matlab.
- hours and hours of programming.
- days and days of debugging.

Participation:

- Be around for lectures.
- Post on Piazza discussions.
- Ask and answer questions.

Tentative project schedule

Projects
Project 0 Matlab (optional, no credit)
Project 1 Hough Transform
Project 2 Homography
Project 3 Stereo
Project 4 Photometric Stereo
Project 5 Bag of Words
Project 6 Convolutional Neural Nets
Project 7 Lucas-Kanade Tracking

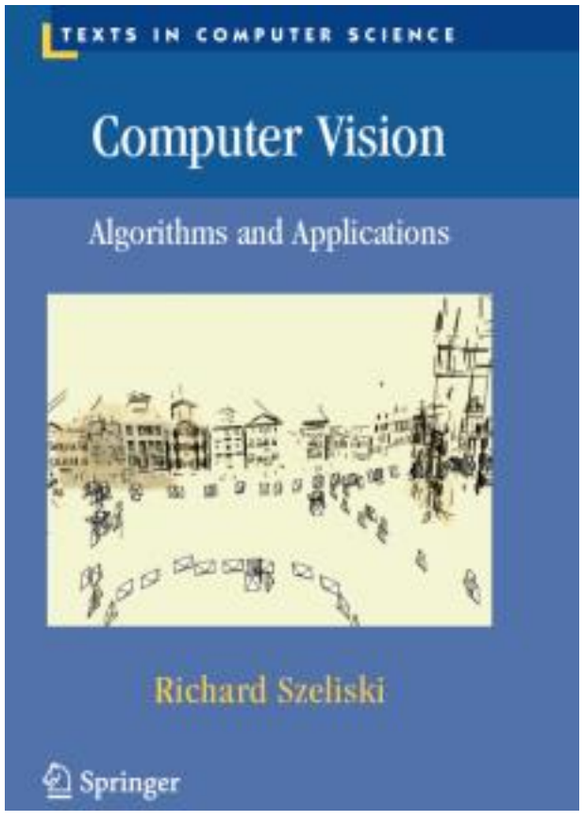
- Generous grading policy (like grad school)
- Getting an A vs. mastering the material
- Build your CV
- Take advantage of extra credit

Late days

- 10% reduction of points per late day
- 5 free late days total (not per project)
- use them wisely…

Book

We will be posting readings after each lecture



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 and office hours

- 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 Yannis about additional office hours.
  - you can also just drop by Yannis' office (Smith Hall (EDSH) Rm 225).

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

Please take the course survey before the next lecture!

(posted on Piazza)