

Introduction



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)

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



me at Harvard in 2011
(obviously need new photo)

Building a scatterometer

Camera for measuring parameters of scattering materials

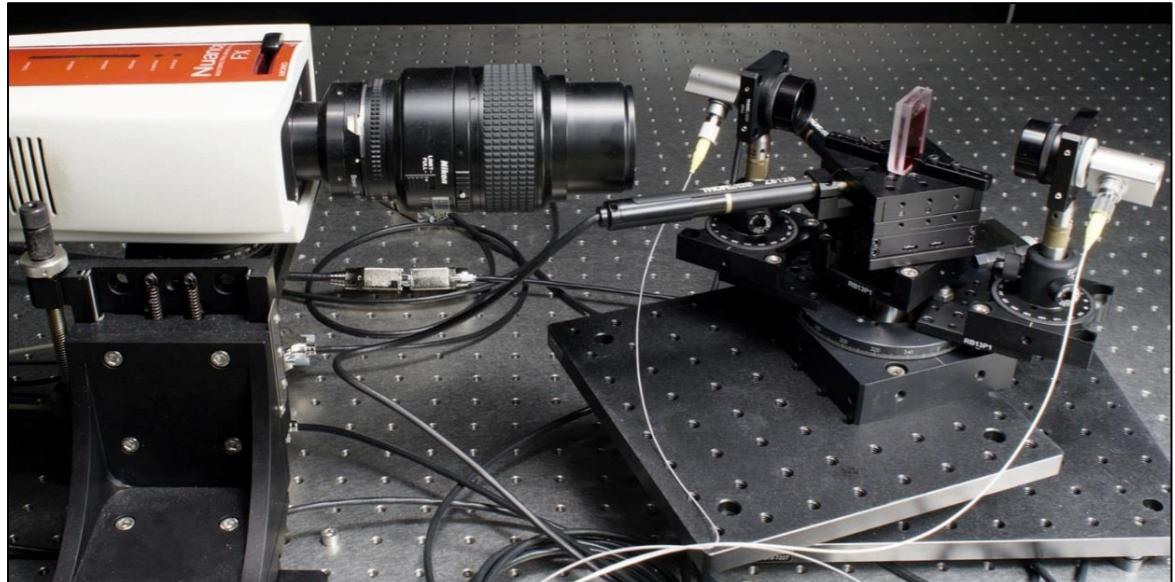
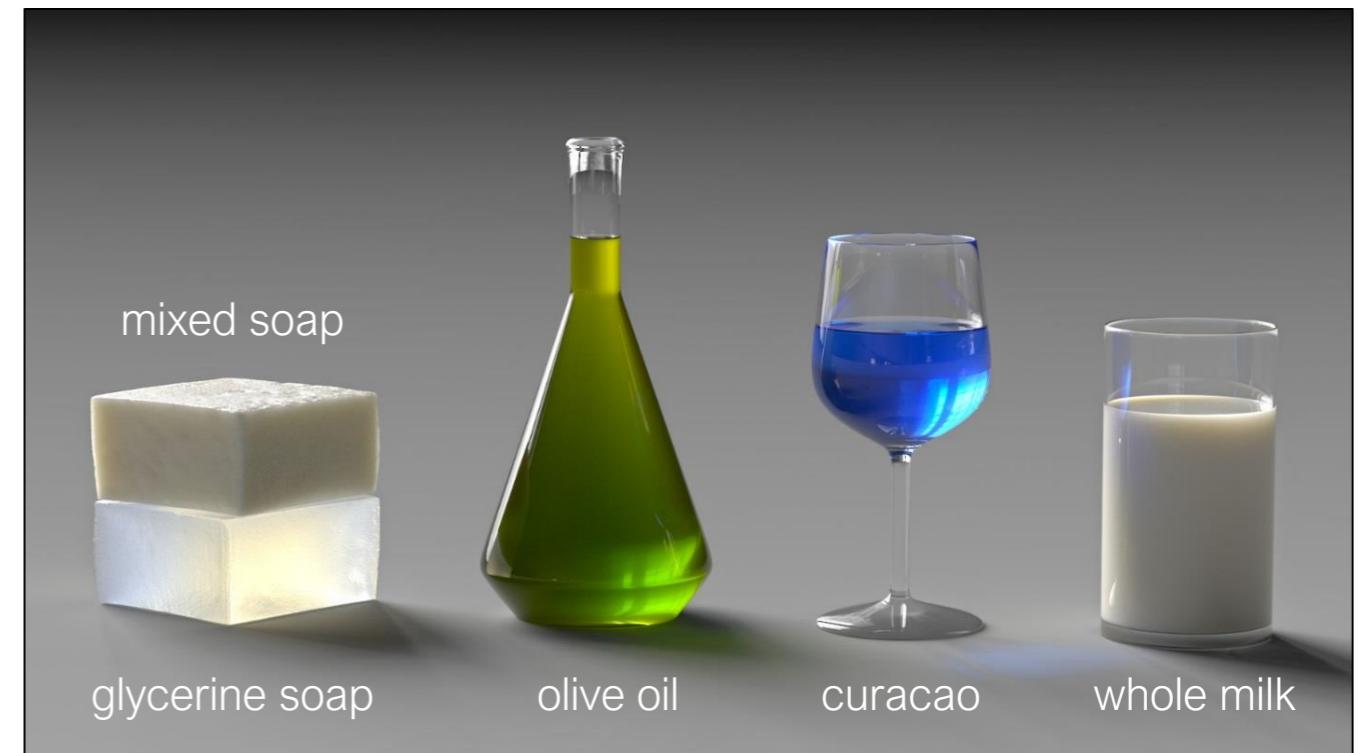
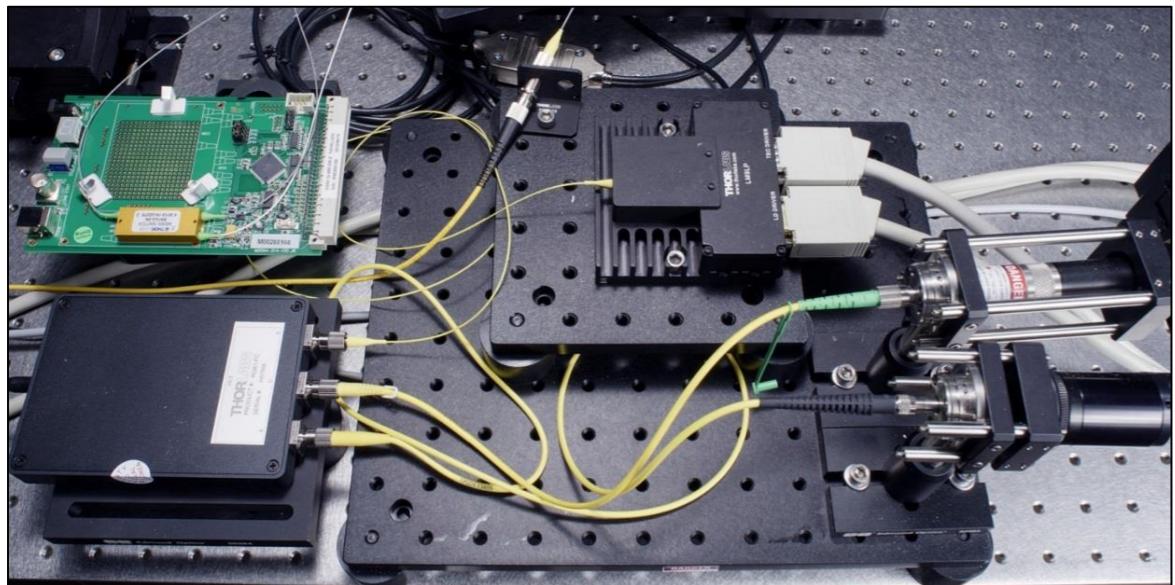
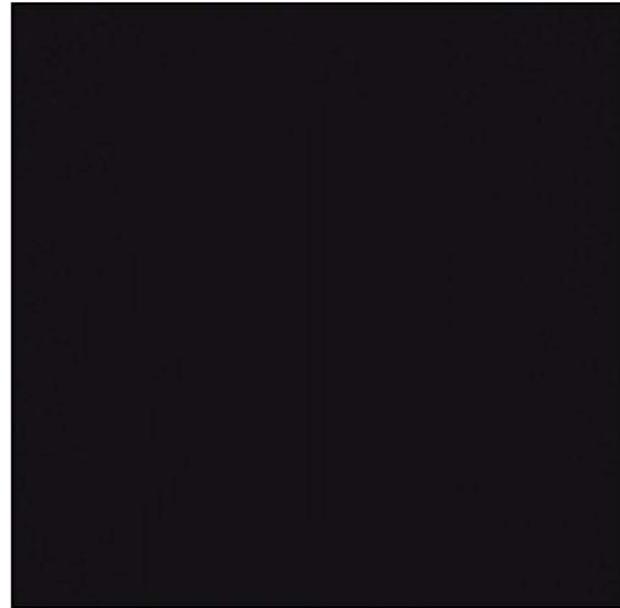
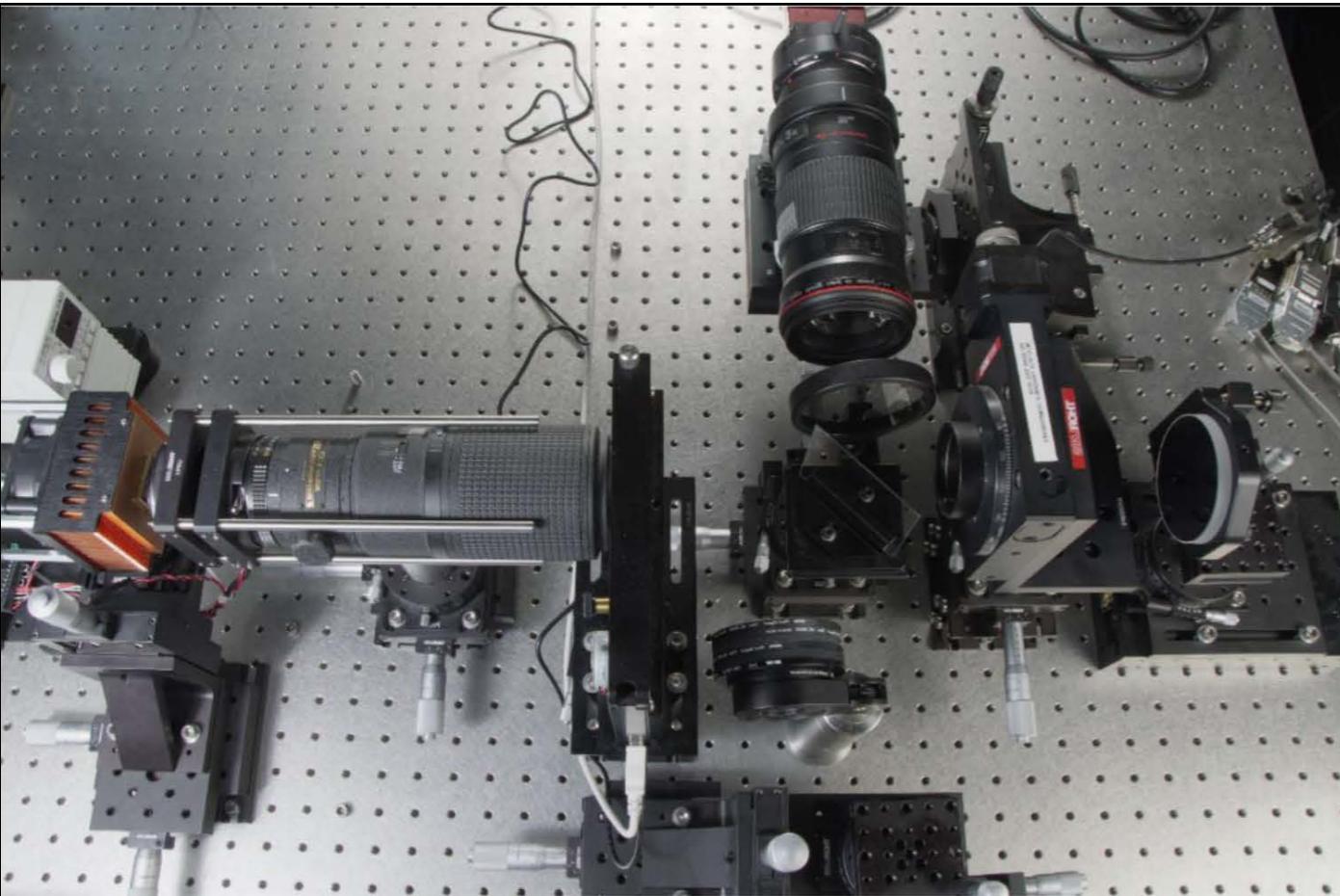


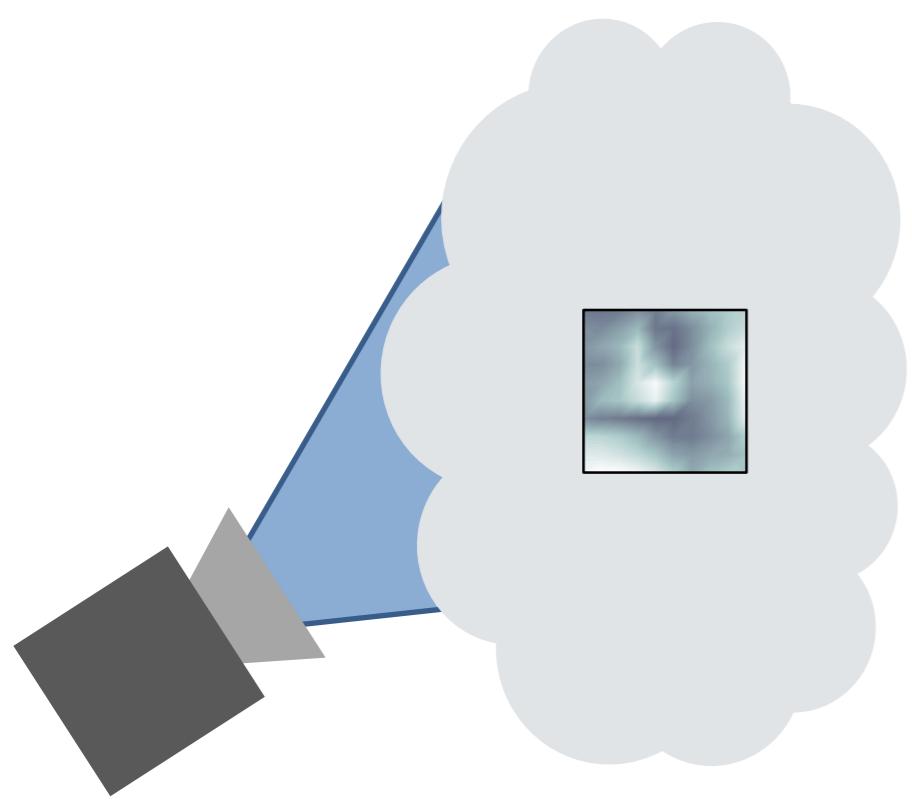
image synthesized from measurements



Quadrillion FPS video

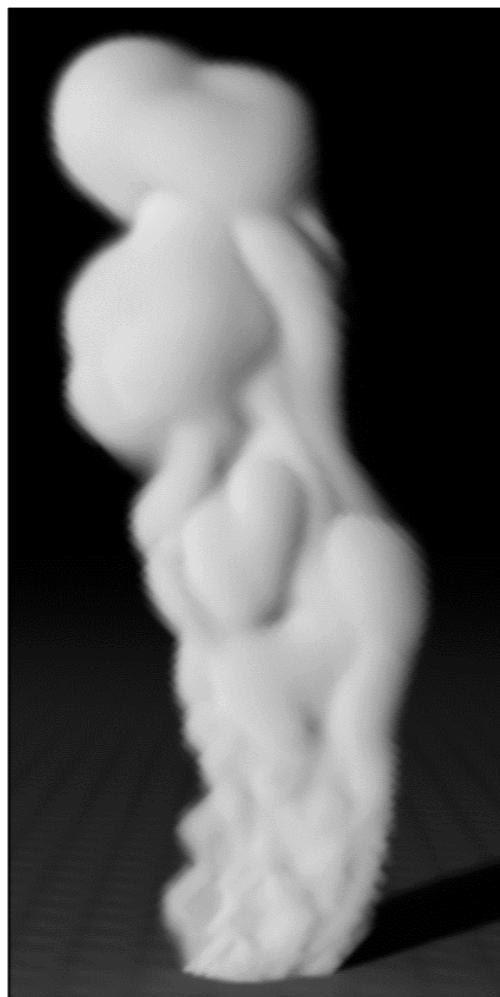


Seeing inside objects



camera

thick smoke
cloud



what a regular
camera sees

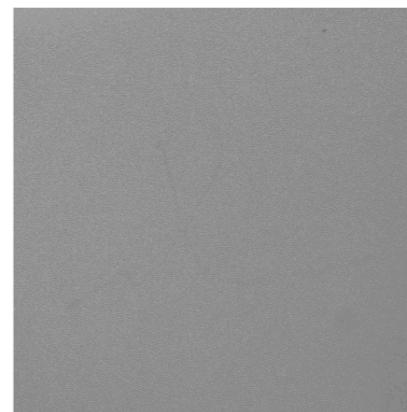
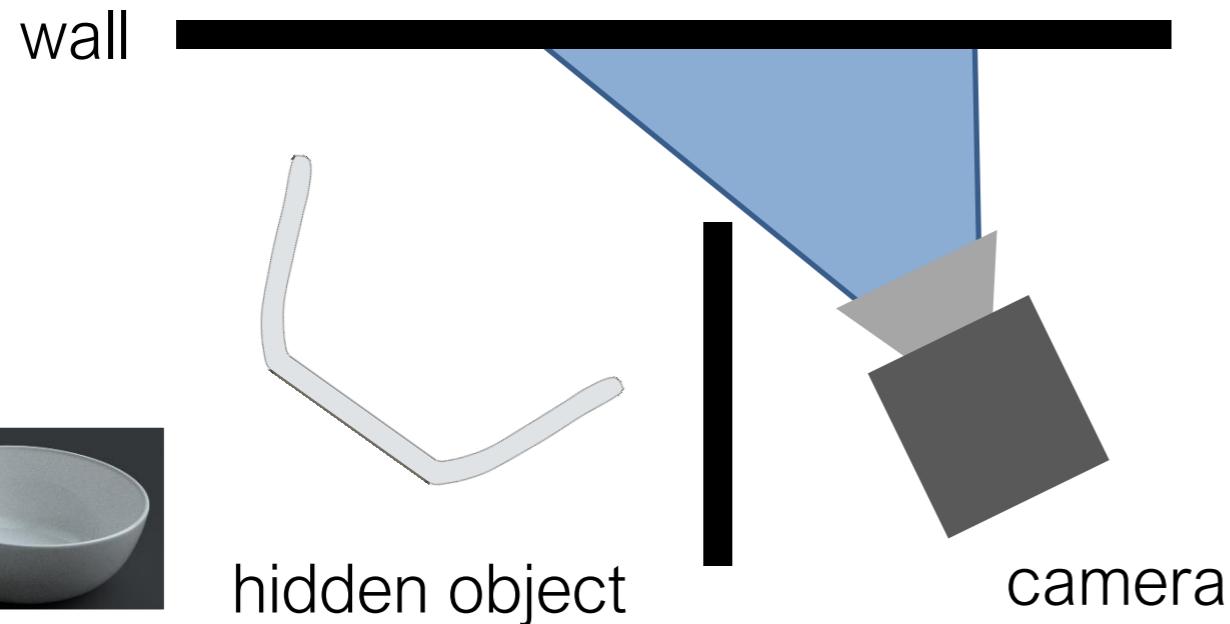


what our camera sees



a slice through the
cloud

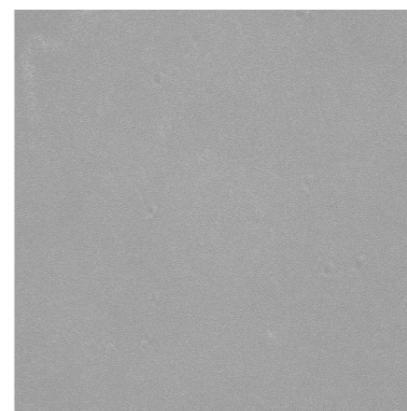
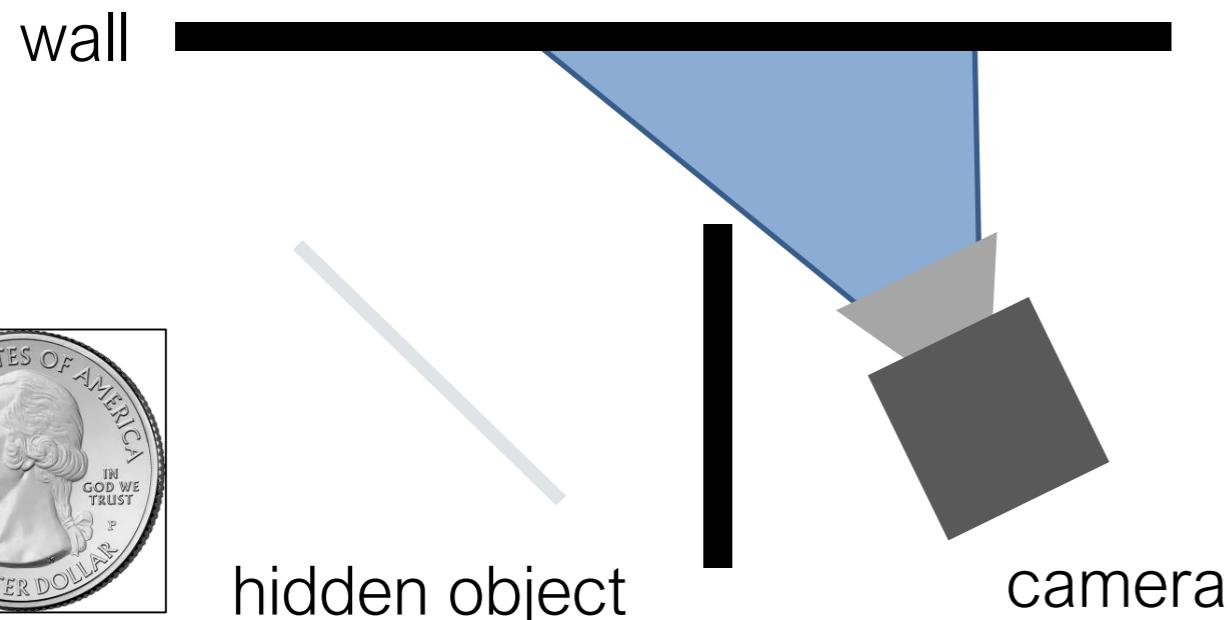
Seeing around walls



what a regular
camera sees



what shape our
camera sees



what a regular
camera sees



what depth our
camera sees

TA: Gaurav Mittal

Master of Science in Computer Vision (MSCV)

Research Interests

Image scene understanding/generation, deep learning, language and visual intelligence

Current Area of Research

Neural network compression using Reinforcement Learning (under Prof. Kris Kitani)

Past Research

- Video generation using captions with Variational Autoencoders
- Detection and coarse segmentation of garbage in images (SpotGarbage)



TA: Shashank Tripathi

Master of Science in Computer Vision (MSCV)

Research Interests

Object detection/tracking, Deep Learning, Medical Image Processing

Current Area of Research

Neural network compression, Reinforcement Learning for vision

Past Research

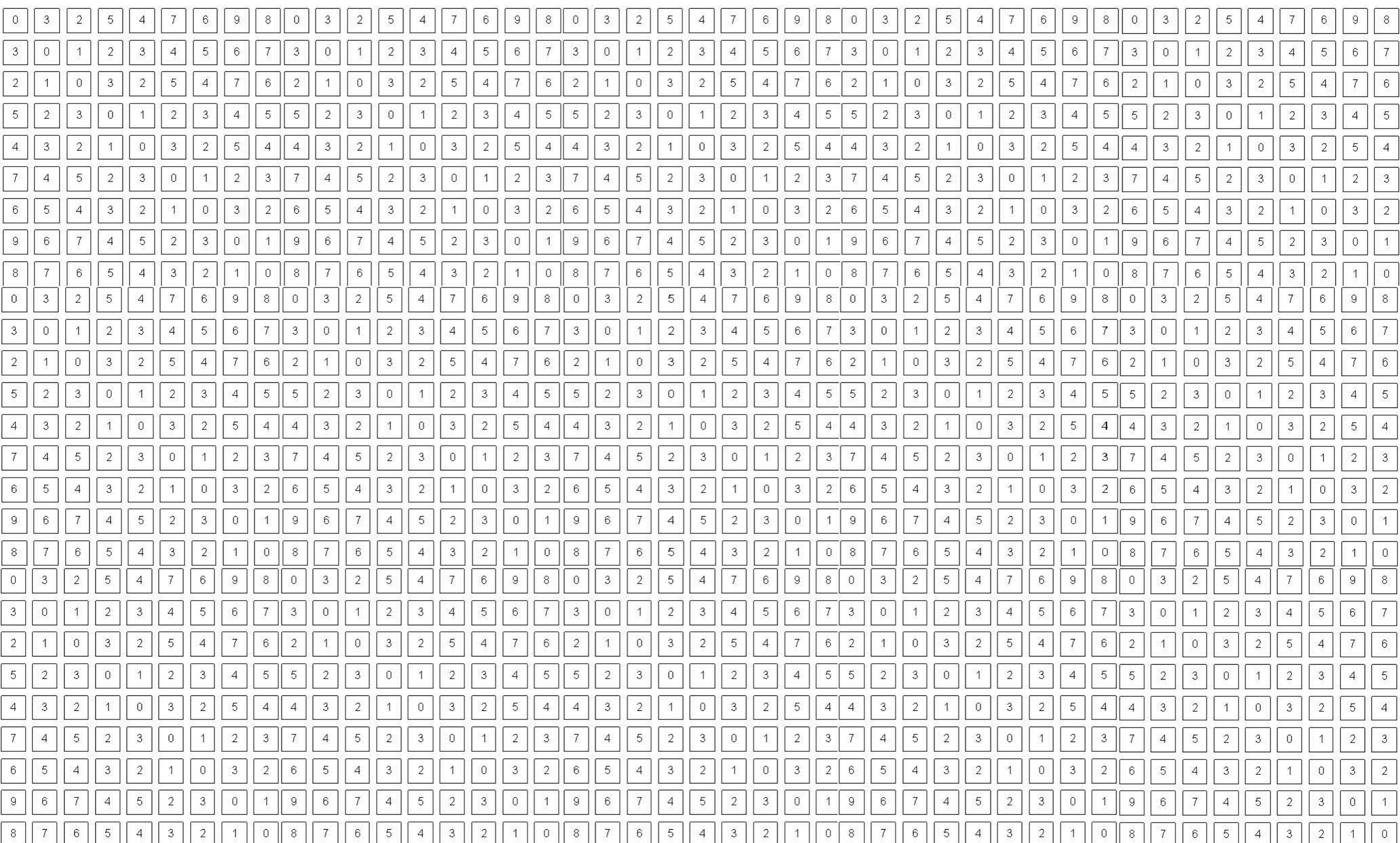
- Deep spectral-matching based shape features for efficient Alzheimer's disease classification
- Superpixel-augmented Convolutional Neural Networks
- Vision control system for automated micromanipulation



What is
computer vision?



What a person sees



What a computer sees

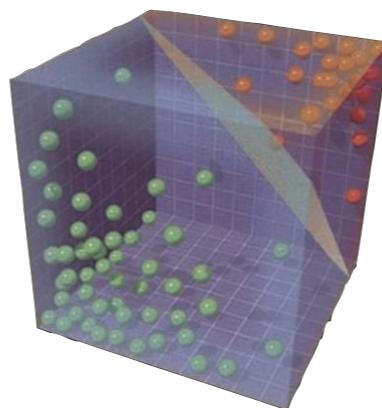


Why are we able to interpret this image?

The goal of computer vision is
to give computers
(super) human-level perception

typical perception pipeline

representation



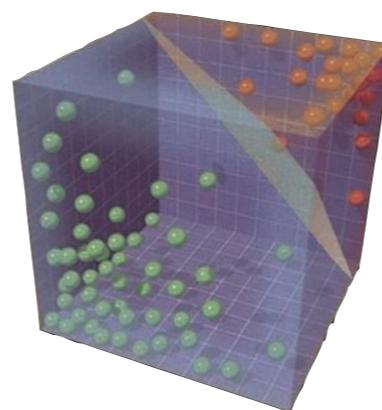
'fancy math'



output

typical perception pipeline

representation



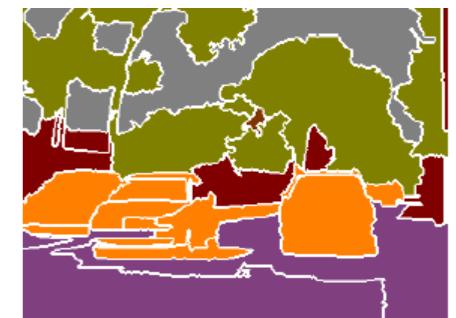
‘fancy math’



output

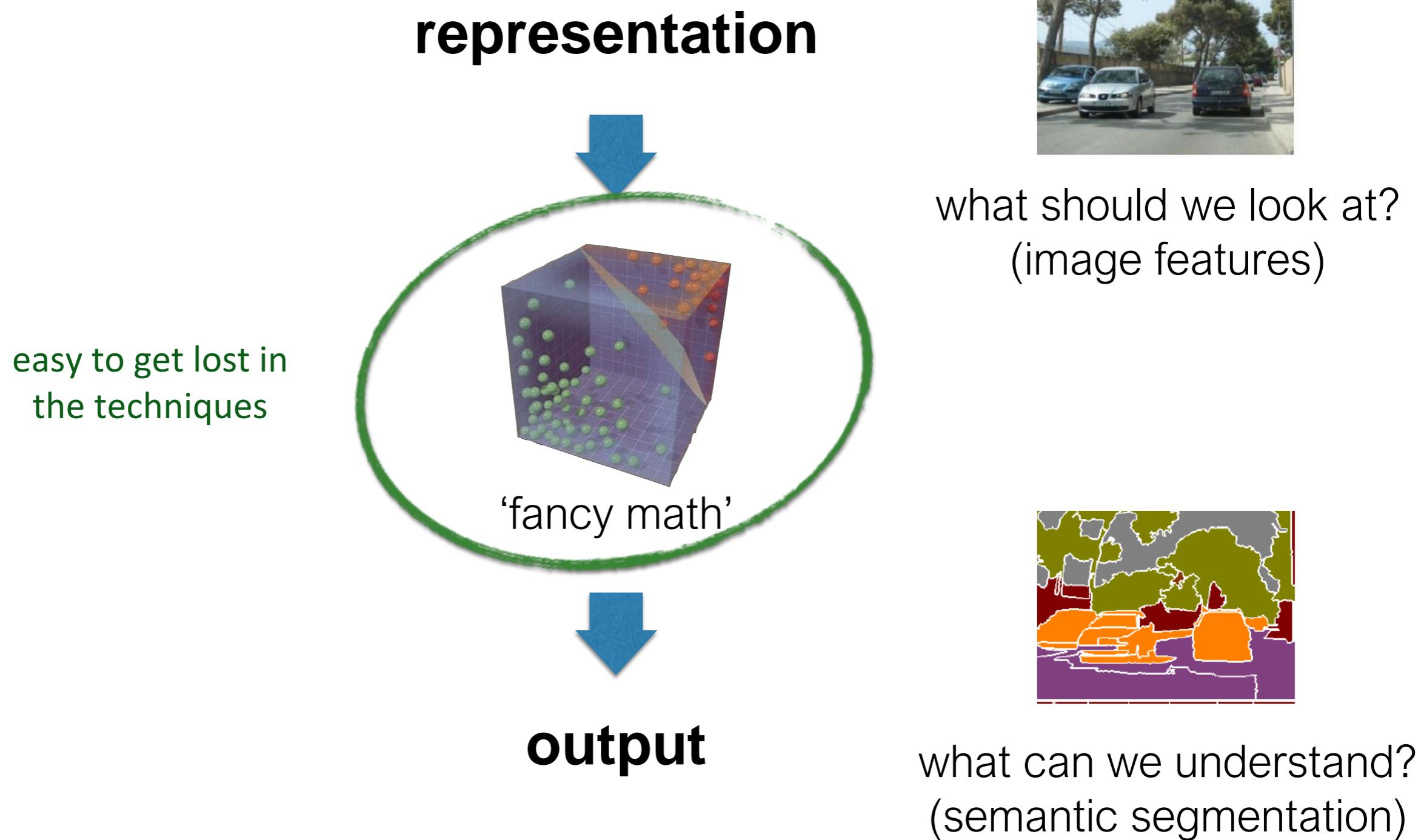


what should we look at?
(image features)

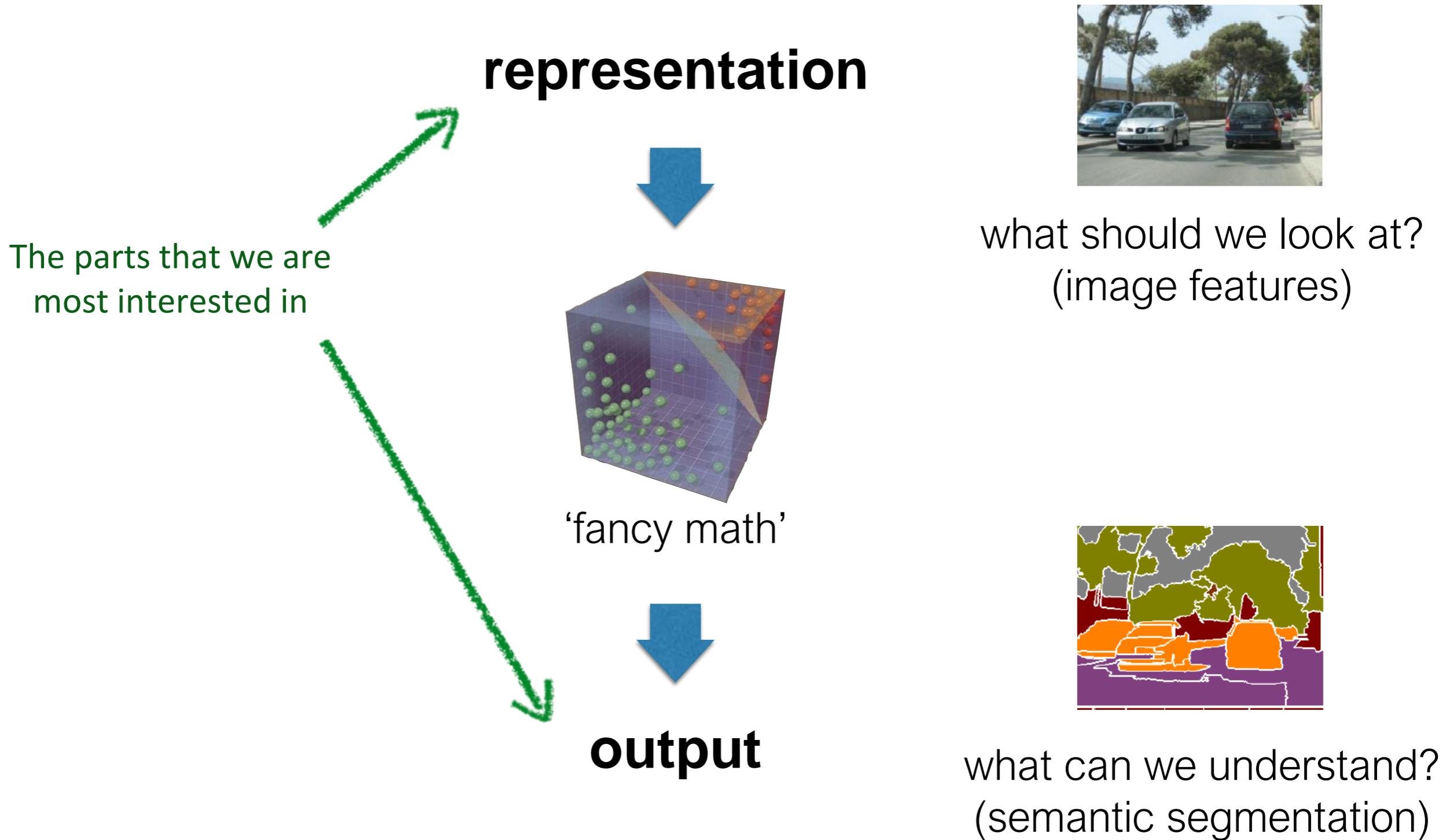


what can we understand?
(semantic segmentation)

typical perception pipeline



typical perception pipeline



Important note:

In general, computer vision does not work

Important note:

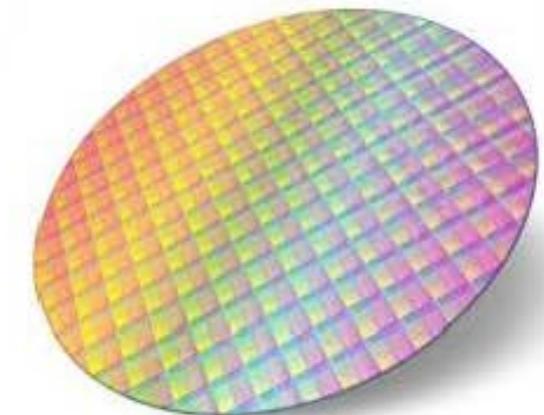
In general, computer vision does not work

(except in certain situations/conditions)

Applications of computer vision

Machine vision

Automated visual inspection



Object Recognition



Toshiba Tech IS-910T

2013



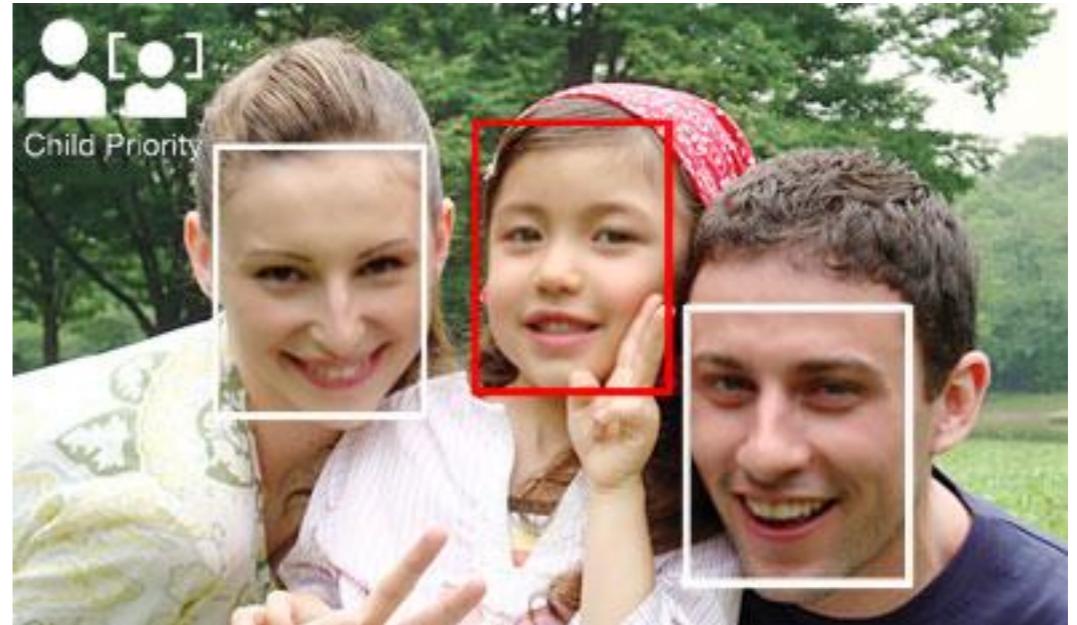
DataLogic LaneHawk LH4000

2012

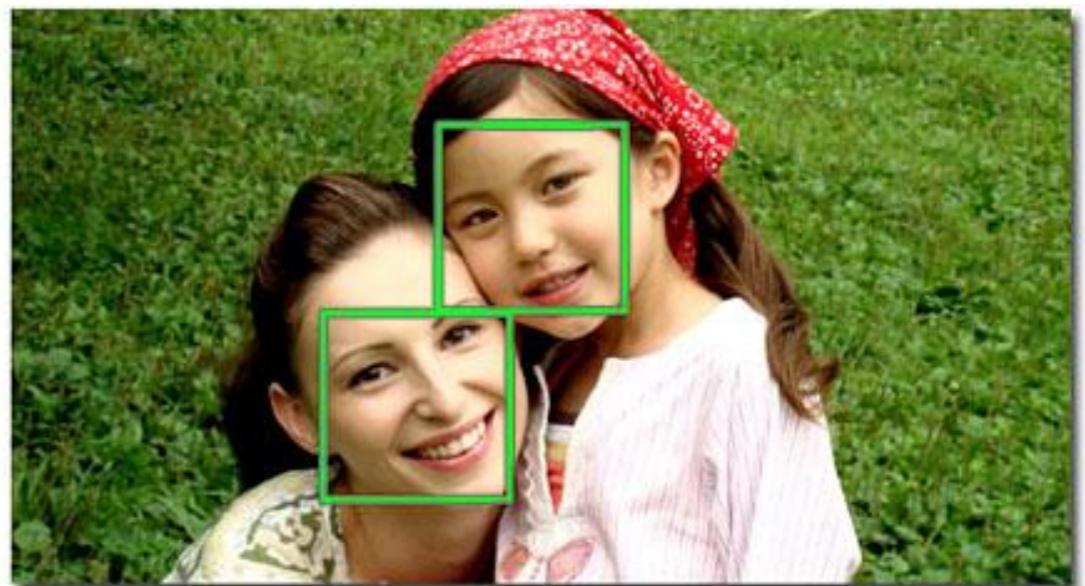
Face detection



Sony Cyber-shot



Age recognition



Smile recognition

Face makeovers

TAAZ
THE BRAINS BEHIND THE BEAUTY

 NEW iPhone Hair Try On App  License TAAZ technology for web, mobile, in-store

HOME START MAKEOVER BROWSE LOOKS TRENDS ADVICE ABOUT

Creating your own new look is easy 

try it now! 

1. Upload your photo 
2. Apply some makeup 
3. Choose a hairstyle 

TODAY'S FEATURED MAKEOVER
rtyjukilop.l,kmujny
By: audreyrose26
14  3 

Create your own perfect look.
Try on hairstyles, colors & makeup
in the TAAZ Virtual Makeover. 

TODAY'S FEATURED ADVICE QUESTION
which look is better?
Asked by: KKsu
1  1 

Ask your burning beauty question.
Our community and experts are here
to help! 

leafsnap

Verizon 12:38 PM 12:20 PM 100%

Back Results Map i

Snap It! Results

1 Red Maple
Acer rubrum

2 Striped Maple
Acer pensylvanicum

3 Sycamore Maple
Acer pseudoplatanus

First Last Scientific i

Ilex opaca

American Hornbeam
Carpinus caroliniana

American Linden
Tilia americana

American Sycamore
Platanus occidentalis

Amur Corktree
Phellodendron amurense

Home Browse Collection Options Snap It!



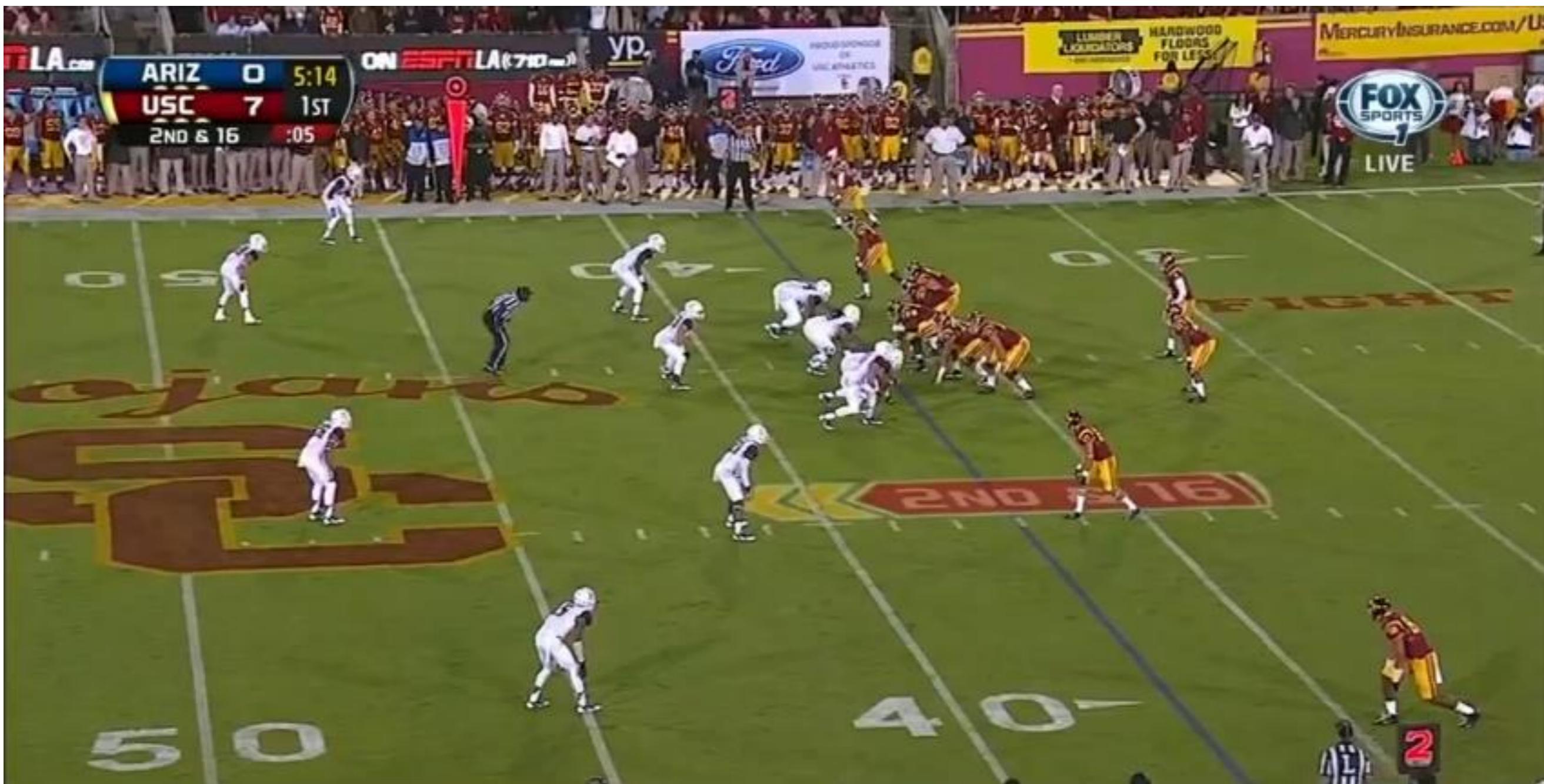
Word Lens



Word Lens

www.QuestVisual.com

First-down line





BMW 5 series

BMW night vision



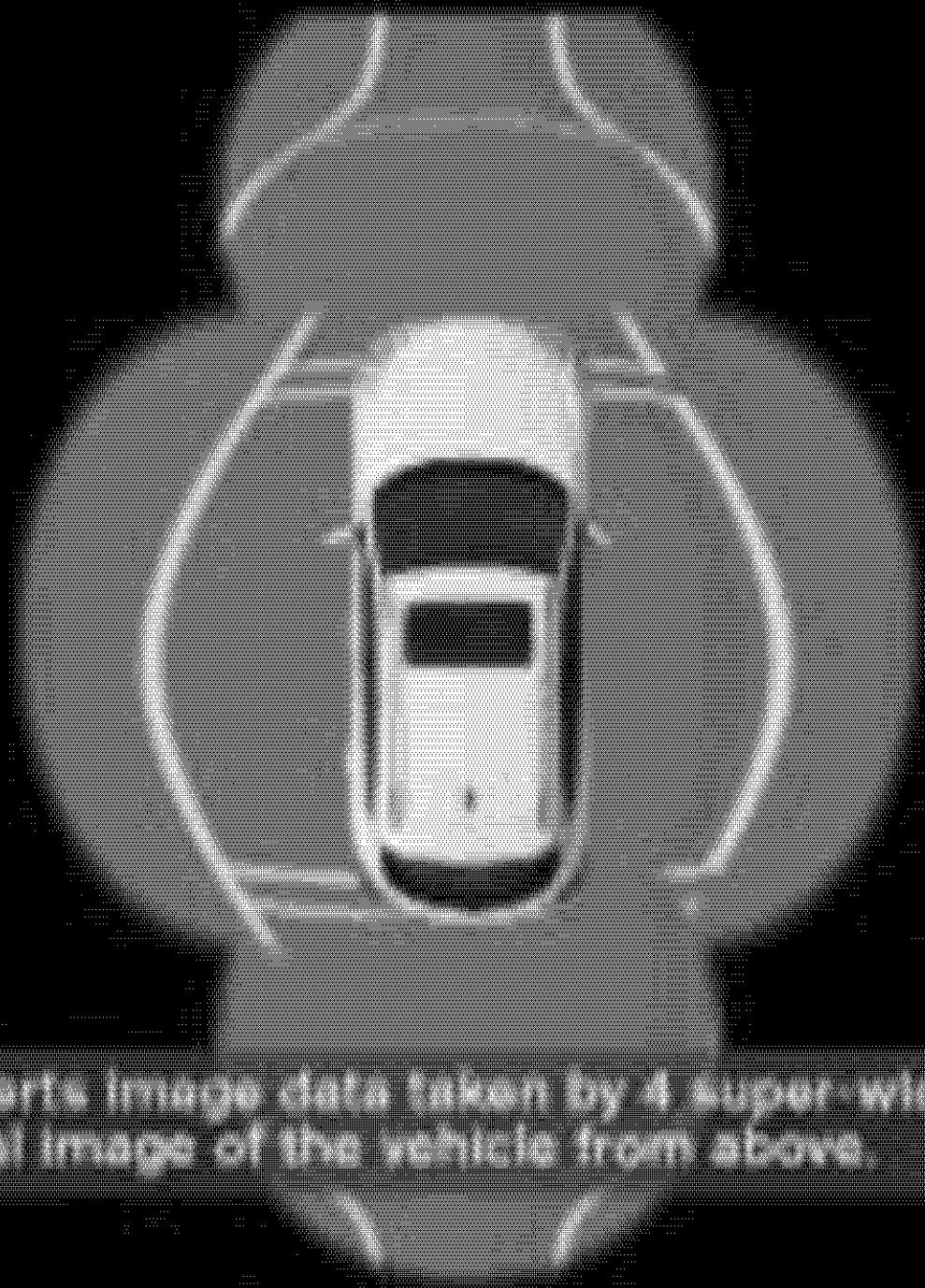


Infinity EX

“Around view” camera



OVERHEAD IMAGE



This 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



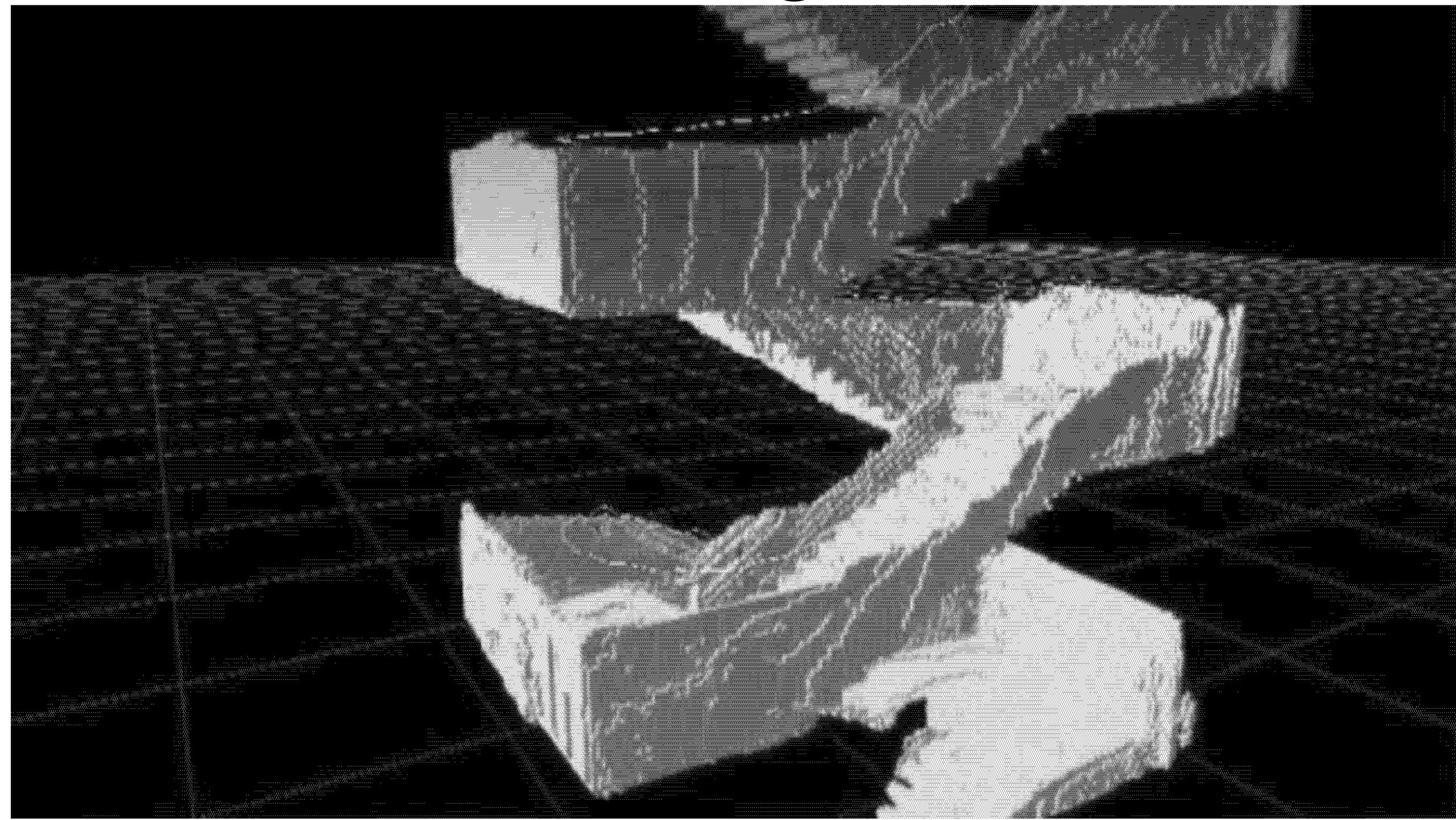
Image stitching



Photosynth



Tango



Virtual Fitting



2015

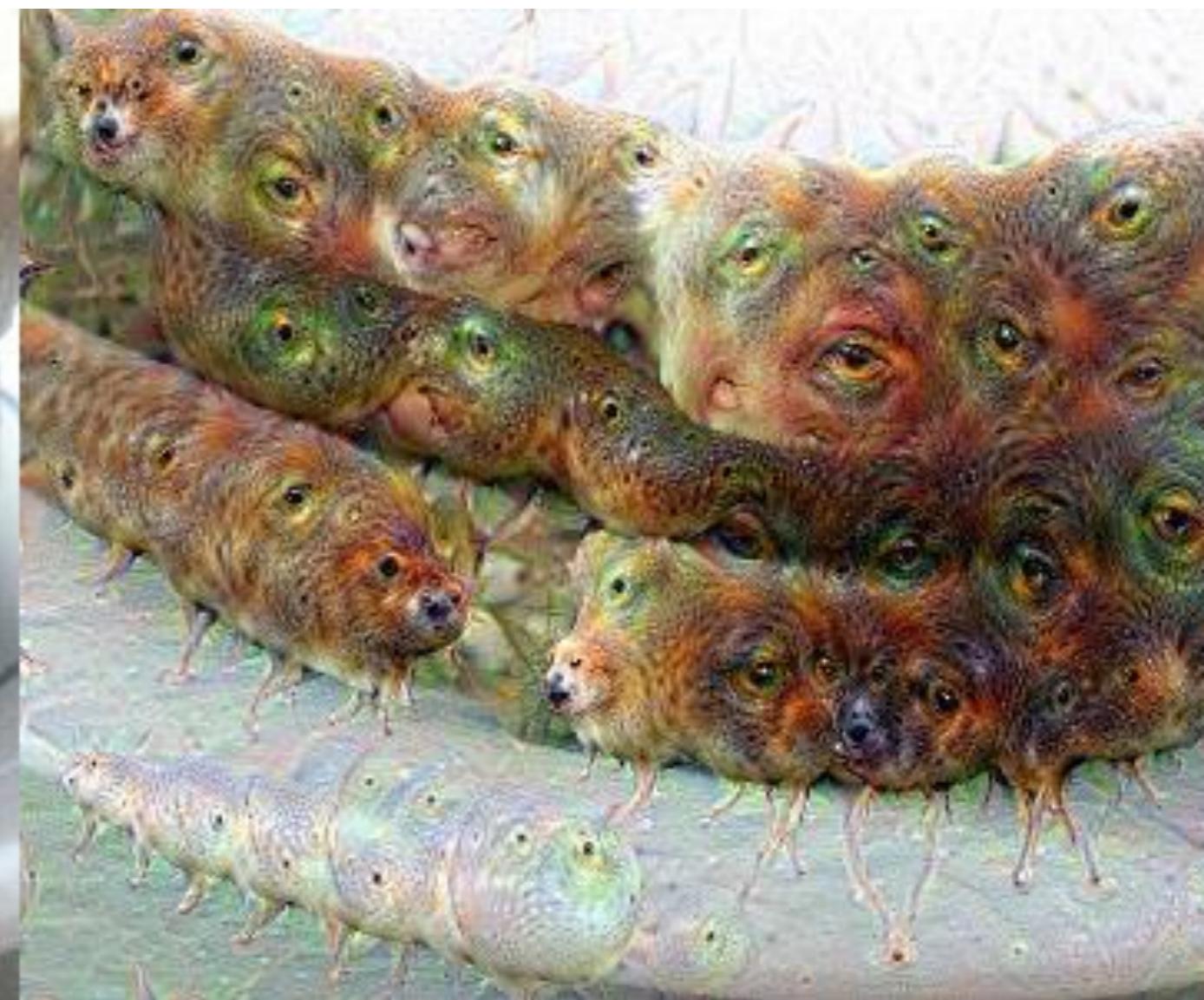
Computer Vision for VR



Deep Face



Deep Dream





Facebook video style transfer 2016

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

*Justus Thies¹, Michael Zollhöfer²,
Marc Stamminger¹, Christian Theobalt²,
Matthias Nießner³*

¹University of Erlangen-Nuremberg

²Max-Planck-Institute for Informatics

³Stanford 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



Oculus VR™

CMU



CMU



CMU



UBER

CMU



CMU



CMU



CMU



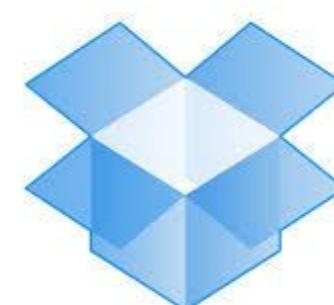
Stanford



Toronto



UW



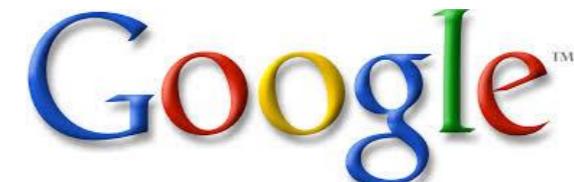
Dropbox



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](#)
[Q](#)

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

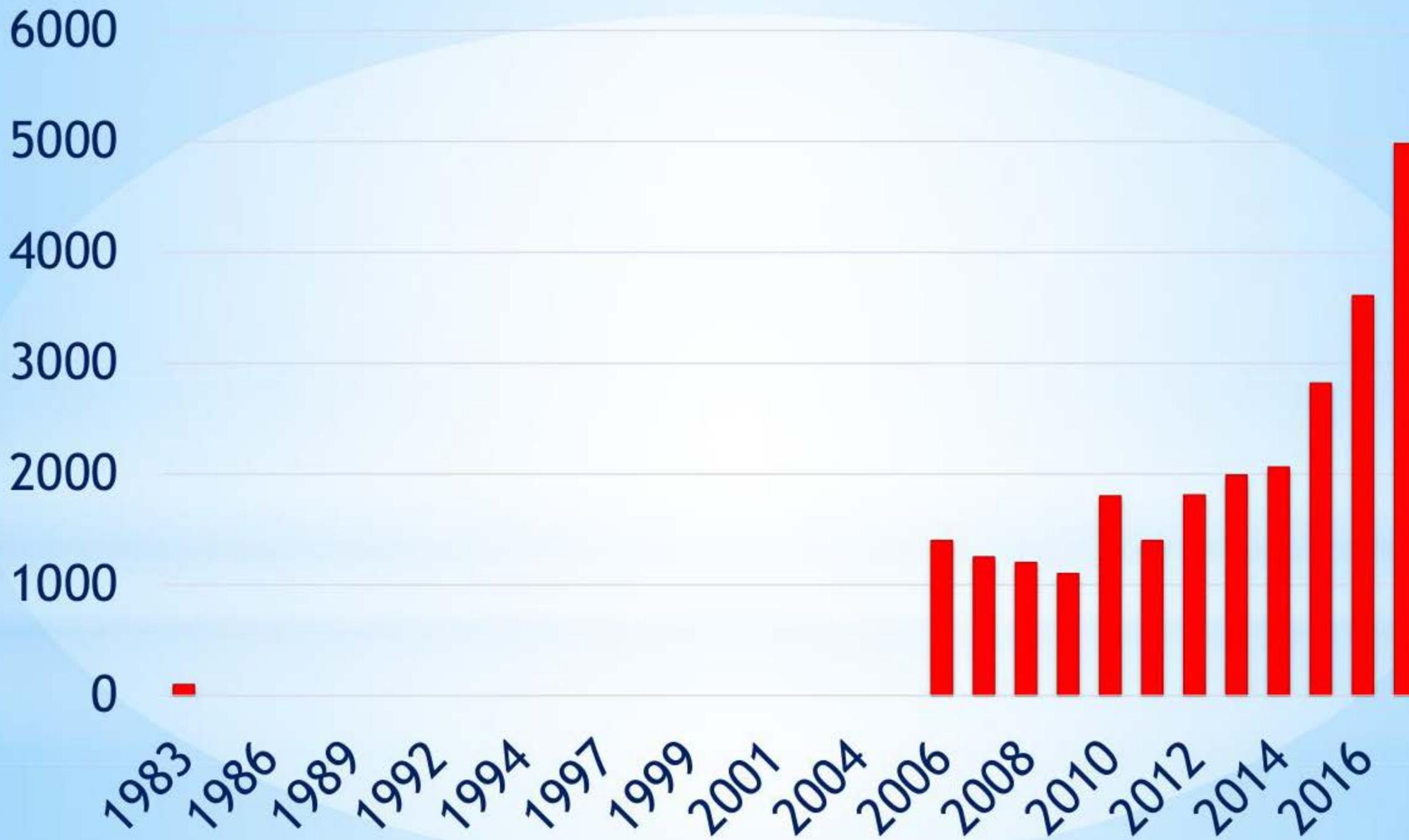


Microsoft Research @ CVPR 2017

CVPR GROWTH

Number of **attendees** at CVPR

*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



Carnegie Mellon THE ROBOTICS INSTITUTE

Master of Science - Computer Vision MSCV

August 2016 - December 2017 (16-month program)

Computer vision is the study of acquiring and interpreting visual imagery. As computer vision shifts from research to development, there is a critical need for developers with expertise in this field.

GOALS

- Offer a comprehensive set of courses
- Facilitate hands-on research and development projects
 - Expose students to current and emerging state-of-the-art Computer Vision applications
 - Prepare students for careers in Computer Vision

COURSES

- Introduction to Computer Vision
Introduction to Machine Learning
Mathematical Fundamentals for Robotics
Visual Learning and Recognition
Geometry-based Methods in Computer Vision

Electives (choose 2)

- Human Communication and Multimodal Machine Learning
The Visual World as seen by Neurons and Machines
Comprehensive Sensing and Sparse Optimization
Large Scale Learning using Images and Text
Big Data approaches in Computer Vision
Human Motion Modeling and Analysis
Statistical Techniques in Robotics
Physics-based Methods in Vision
Probabilistic Graphical Models
Statistical Machine Learning
Convex Optimization
Vision Sensors

Project and Seminar Courses

MSCV Seminar MSCV Project I MSCV Project II

ADMISSION AND APPLICATION

Requirements: Undergraduate (B.S. or equivalent) in engineering, computer science or applied mathematics

Application Materials

- Résumé • General GRE
- TOEFL / IELTS (Foreign Students only)
 - Statement of Purpose (1 to 2 pages)
 - Letters of Recommendation (3 Required)
- Undergraduate/Graduate (as applicable) Transcripts

Only online applications will be accepted.

Early application deadline: December 3, 2015

Final application deadline: December 15, 2015

FOR INDUSTRY SPONSORSHIPS PLEASE CONTACT
JULIE GOLDSTEIN (JGOLDS@CS.CMU.EDU), 412-268-4017

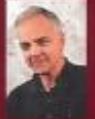
Carnegie Mellon University
5000 Forbes Avenue, Pittsburgh, PA 15232
ms-cv@ri.cmu.edu

www.ri.cmu.edu/MSCV

MSCV Faculty



Srinivasa
Narasimhan
MSCV Program Director



Martial
Hebert
MSCV Spiritual Guru



J. Andrew (Drew)
Bagnell



Fernando
De la Torre Frade



Abhinav
Gupta



Kris M.
Kitani



Simon
Lucey



Deva
Kannan Ramanan



Yaser Ajmal
Sheikh

Course logistics



Website

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

Assignments

Canvas

<https://canvas.cmu.edu/courses/3561>

Discussion¬es

piazza

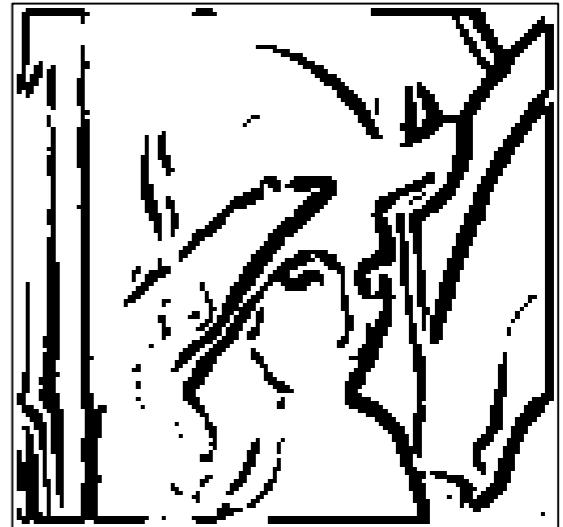
<https://piazza.com/class/jbfezjo9yao2jj>

(you should sign up here on your own)

Topics to be covered

Image processing:

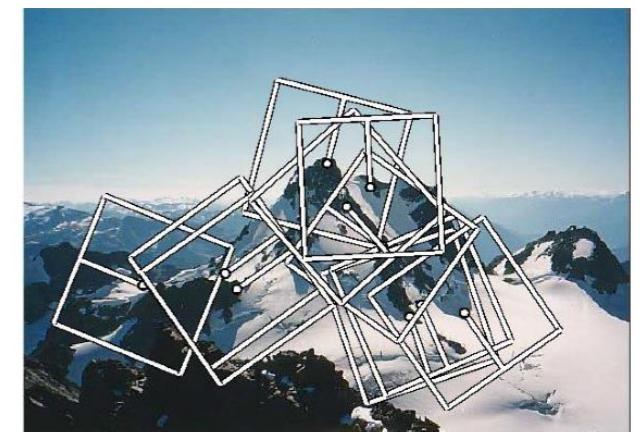
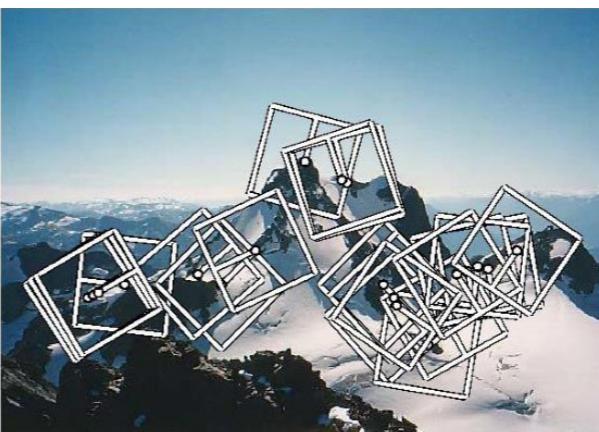
- Basics of filtering.
- Image pyramids.
- Gradients and lines.
- Hough transforms.



Topics to be covered

Feature detection and correspondences:

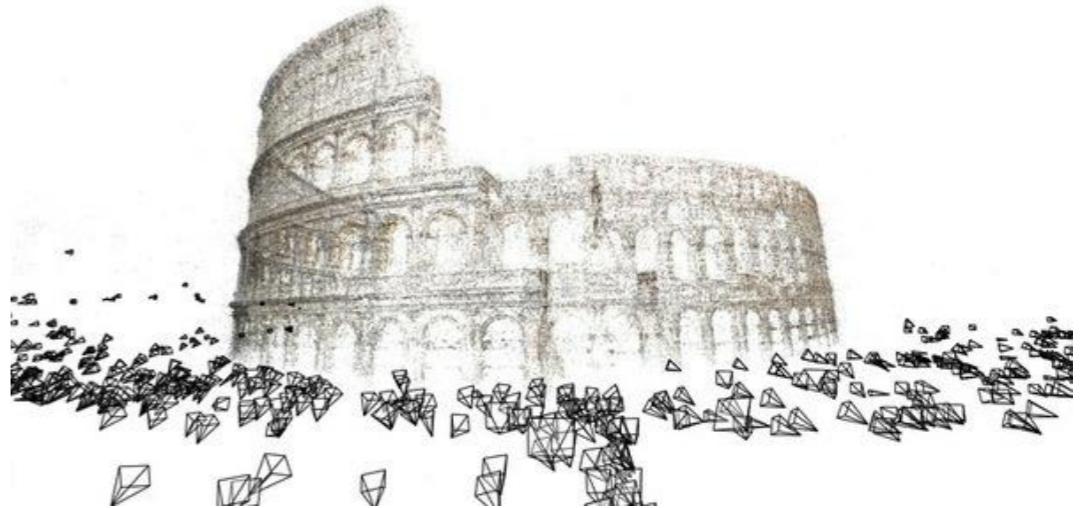
- Corner detection.
- SIFT et al.
- Feature descriptors.
- RANSAC.



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:

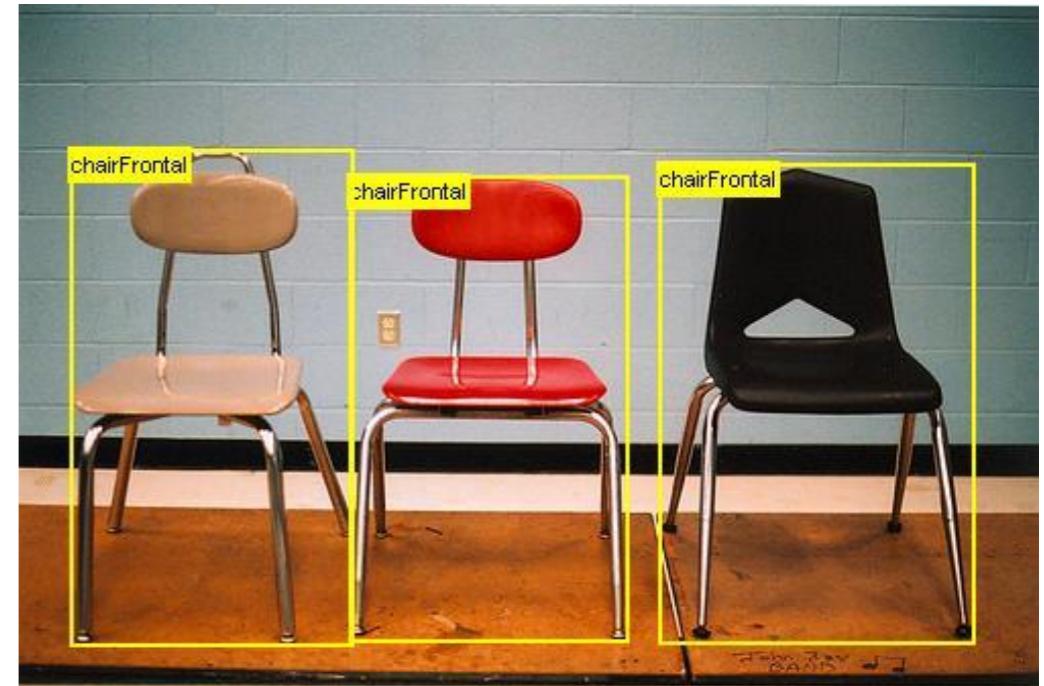
- Reflectance and image formation.
- Radiometry.
- Shape from shading.
- Photometric stereo.
- Color.



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:

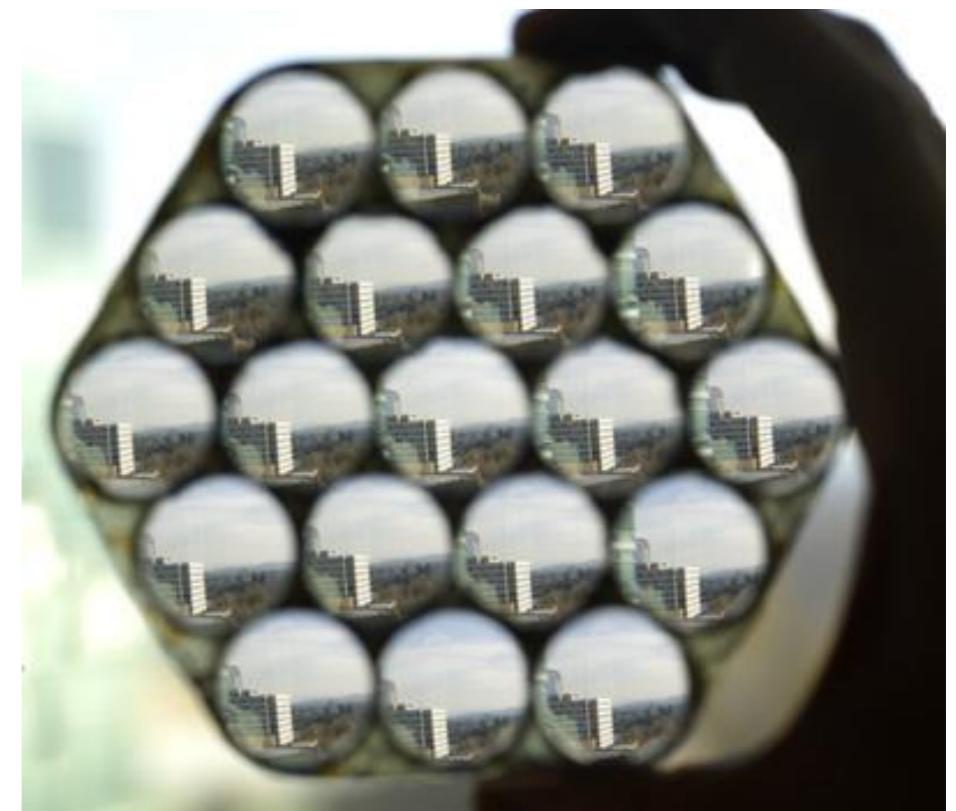
- Optical flow (LK, HS).
- Image registration.
- Kalman Filtering.
- Tracking (KLT, Mean-Shift).



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
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

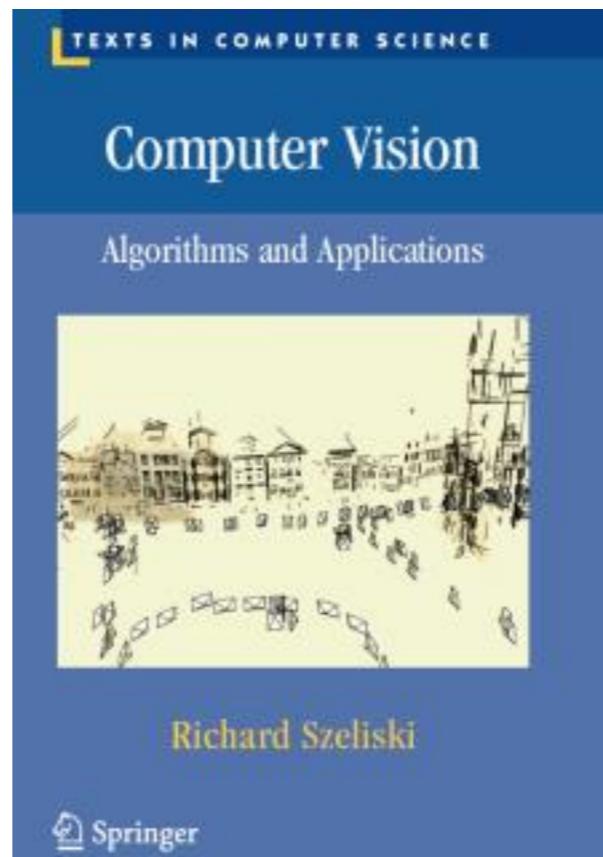
- Generous grading policy (like grad school)
- Getting an A vs. mastering the material
- Build your CV
- Take advantage of extra credit

Late days

- 10% reduction of points per late day
- 3 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).

For this week, Yannis will have office hours on Friday, 2-4 pm.

Please take the course survey
before the next lecture!

<https://goo.gl/forms/AEOBv1lnR7Js62Jx2>

(also posted on Piazza)