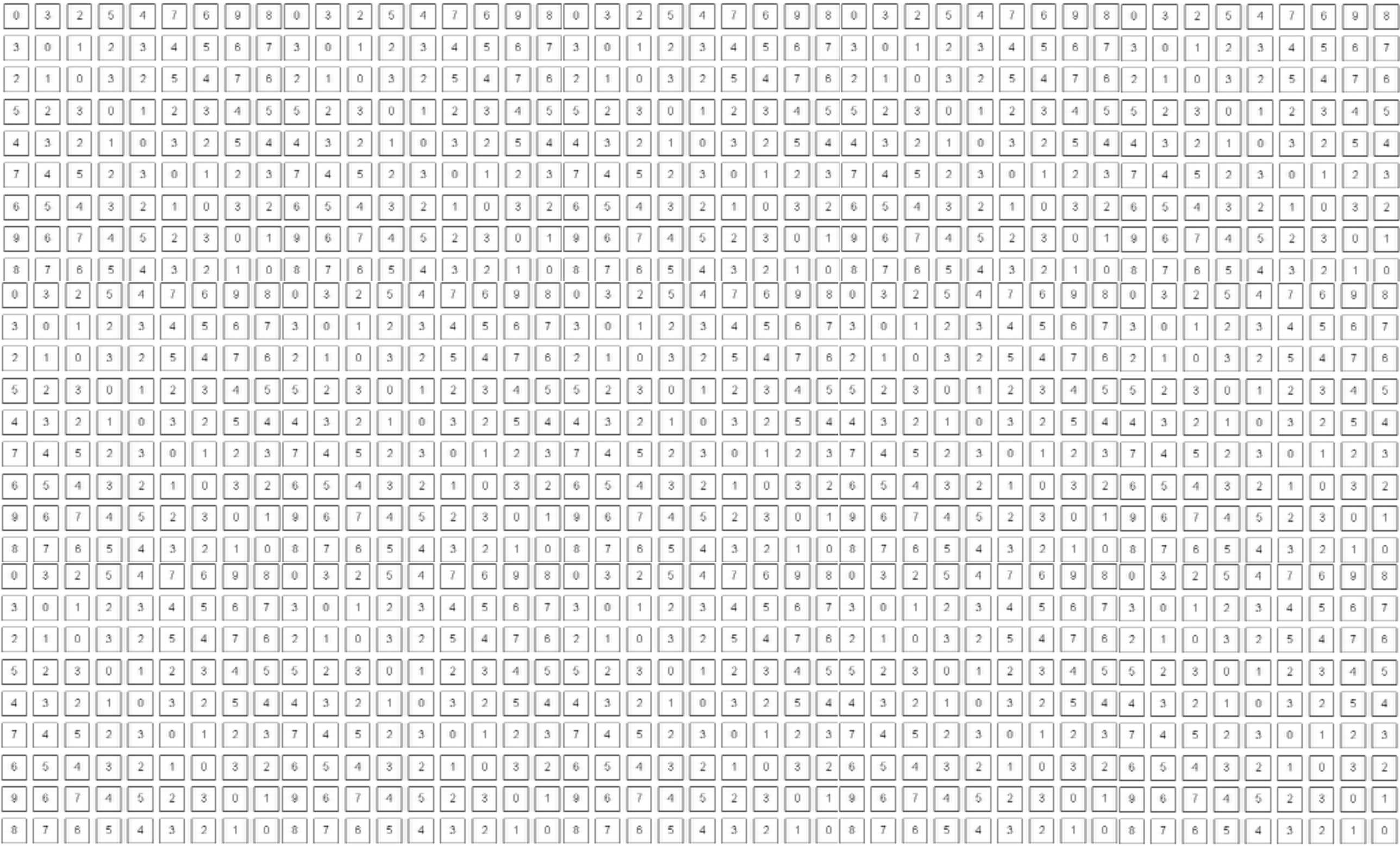
What is computer vision?

What a person sees



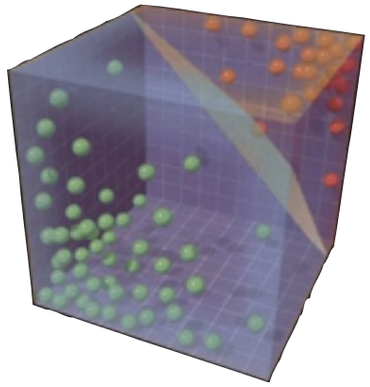
What a computer sees

Why are we able to interpret this image?

The goal of computer vision is to give computers perception

typical perception pipeline

representation

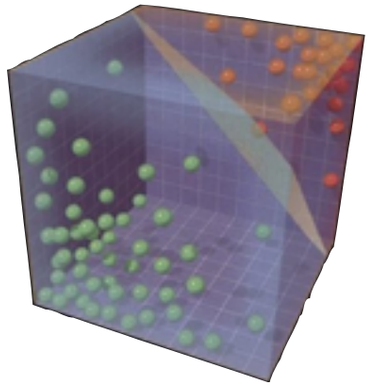


‘fancy math’

output

typical perception pipeline

representation



‘fancy math’

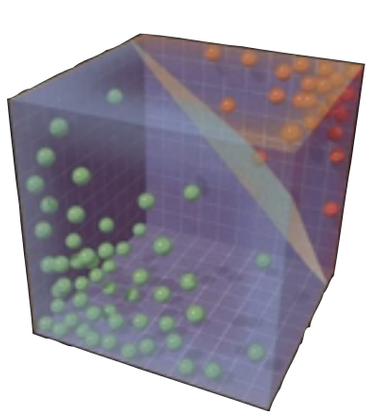
output

easy to get lost in the techniques

typical perception pipeline

representation

The parts that we are most interested in

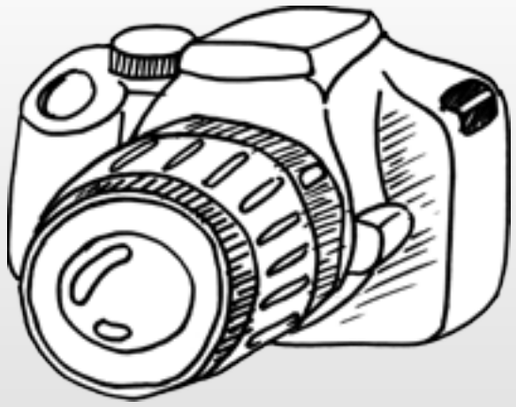


'fancy math'

output

components of a computer vision system

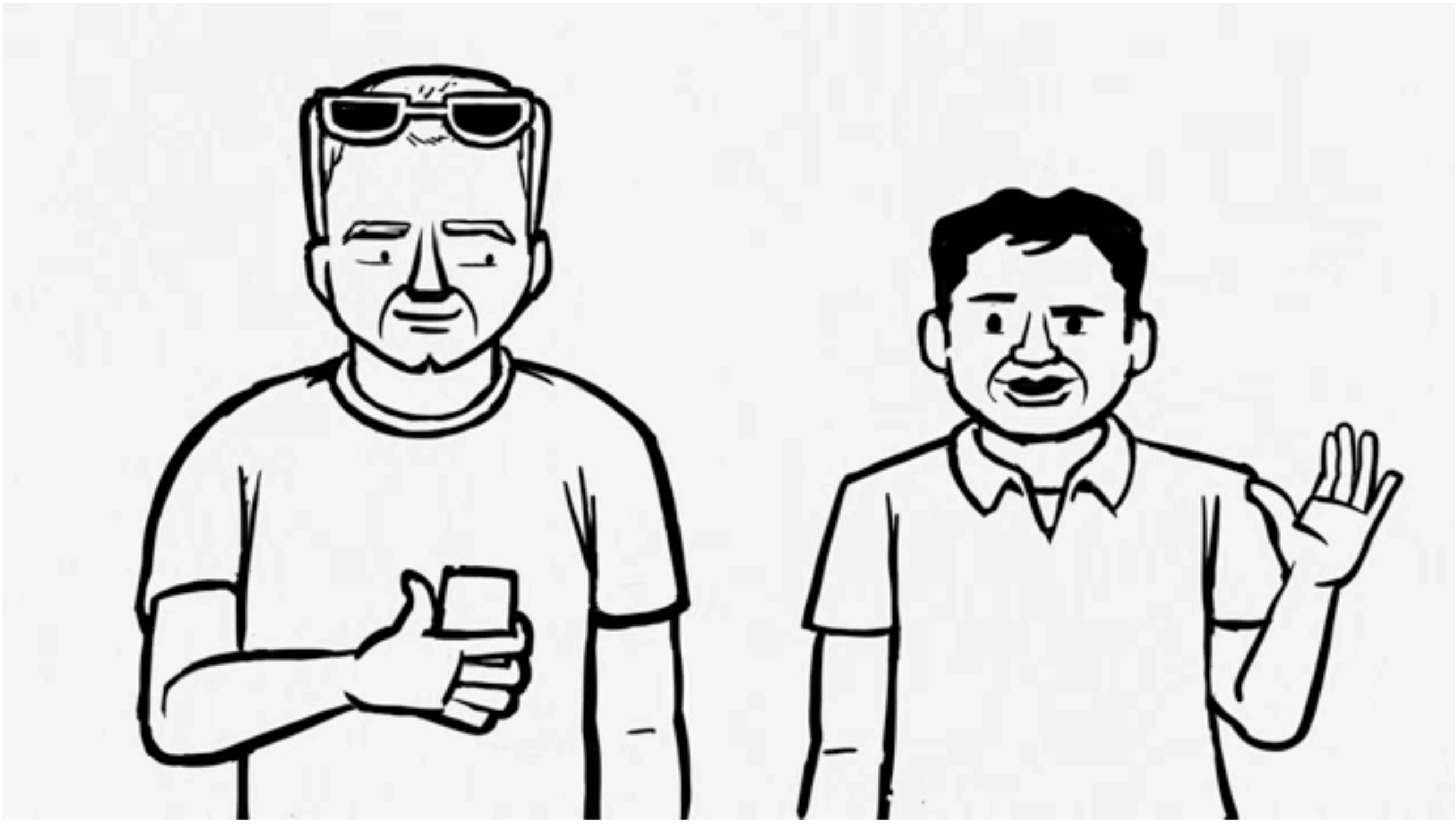
scene



camera

computer

Applications of computer vision



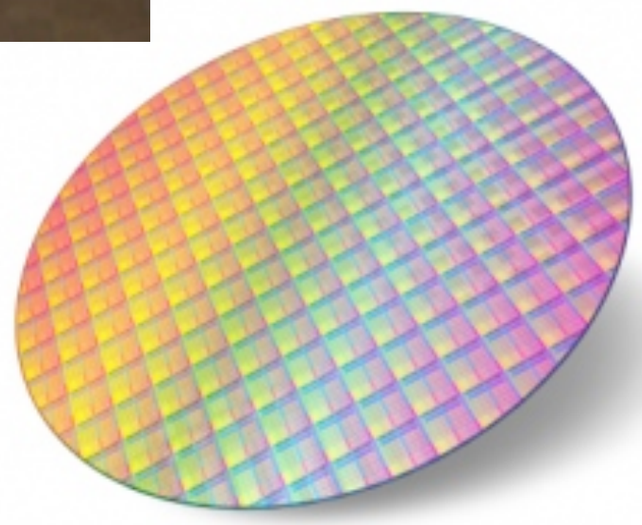
2009

Object Recognition

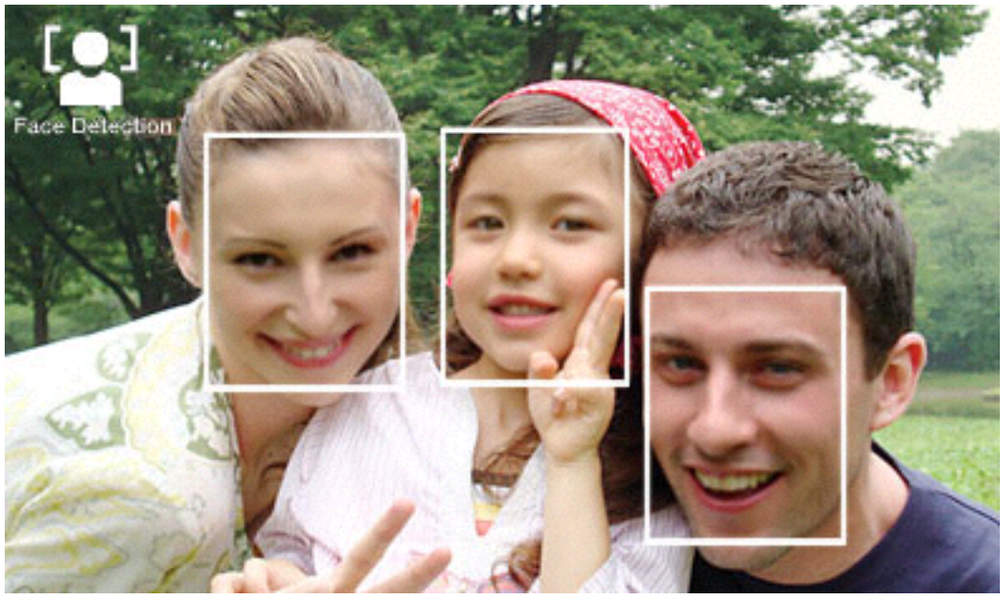
Toshiba Tech IS-910T 2013

DataLogic LaneHawk LH4000 2012

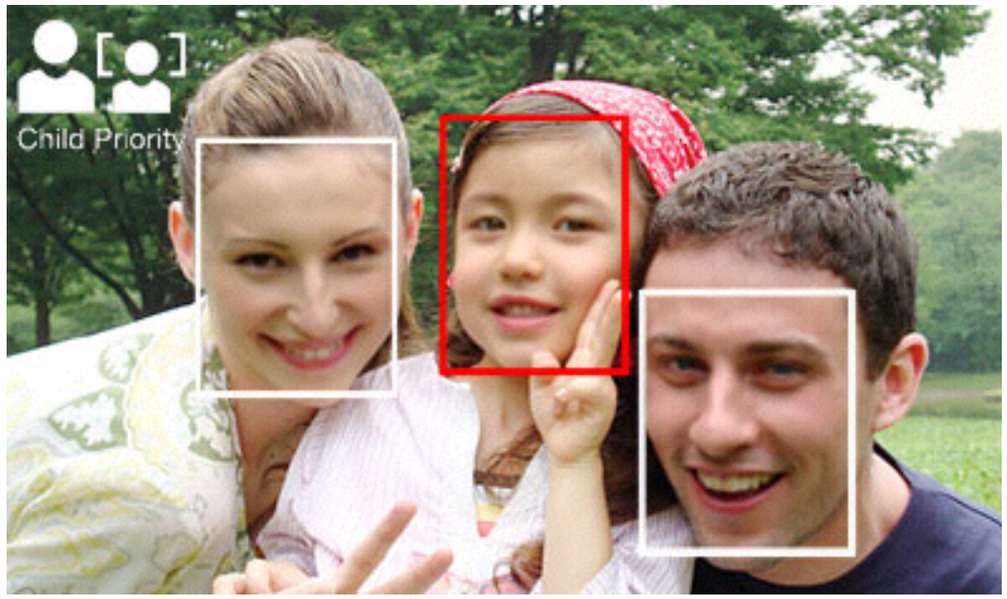
Automated visual inspection



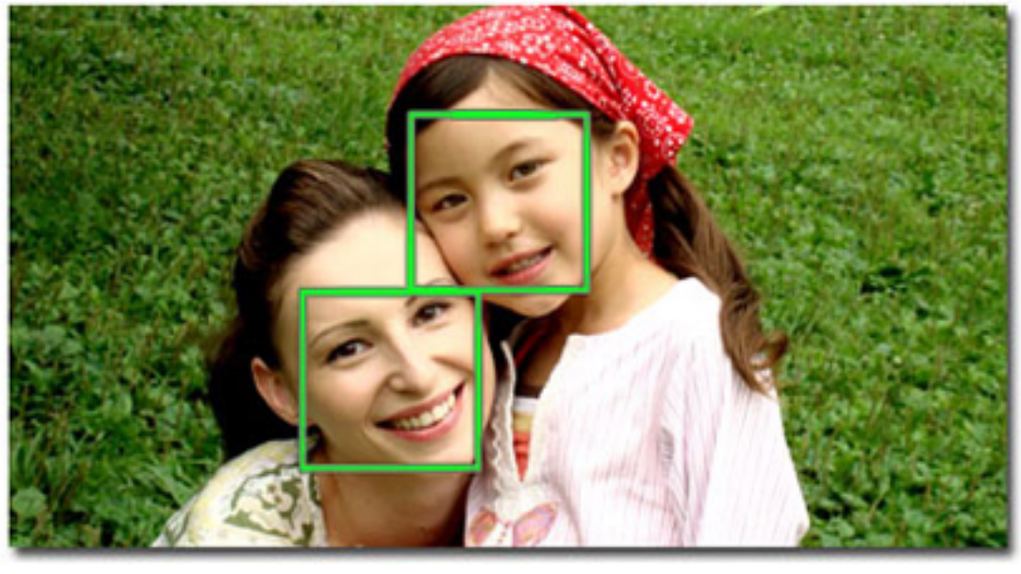
Face detection



Sony Cyber-shot



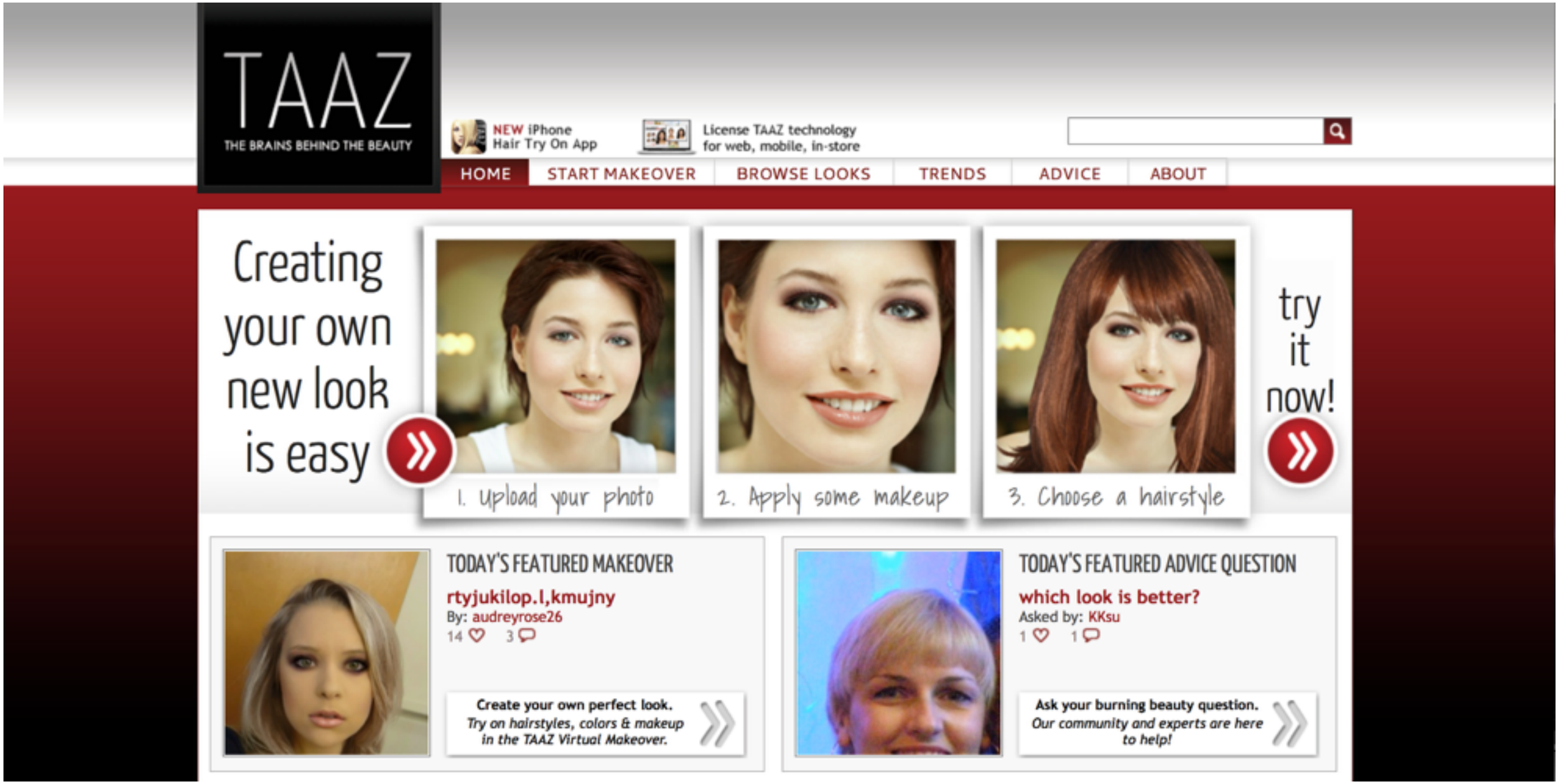
Age recognition



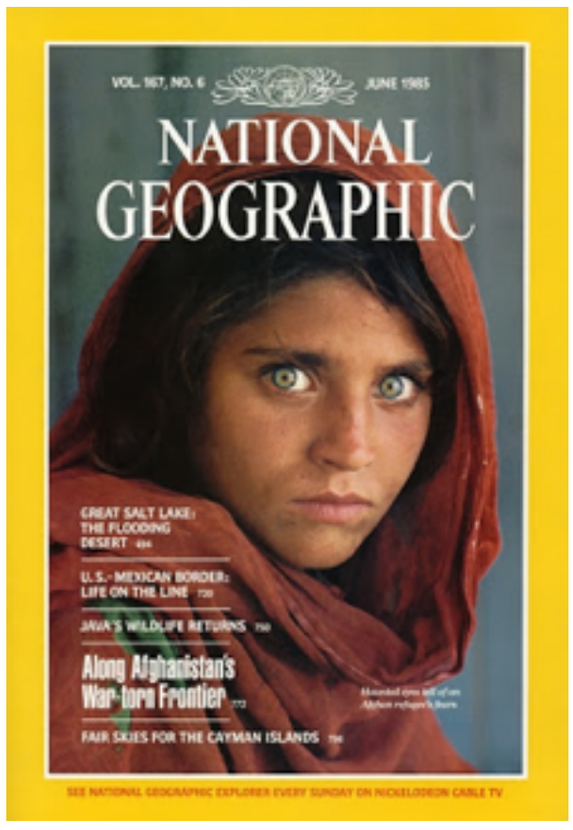
Smile recognition

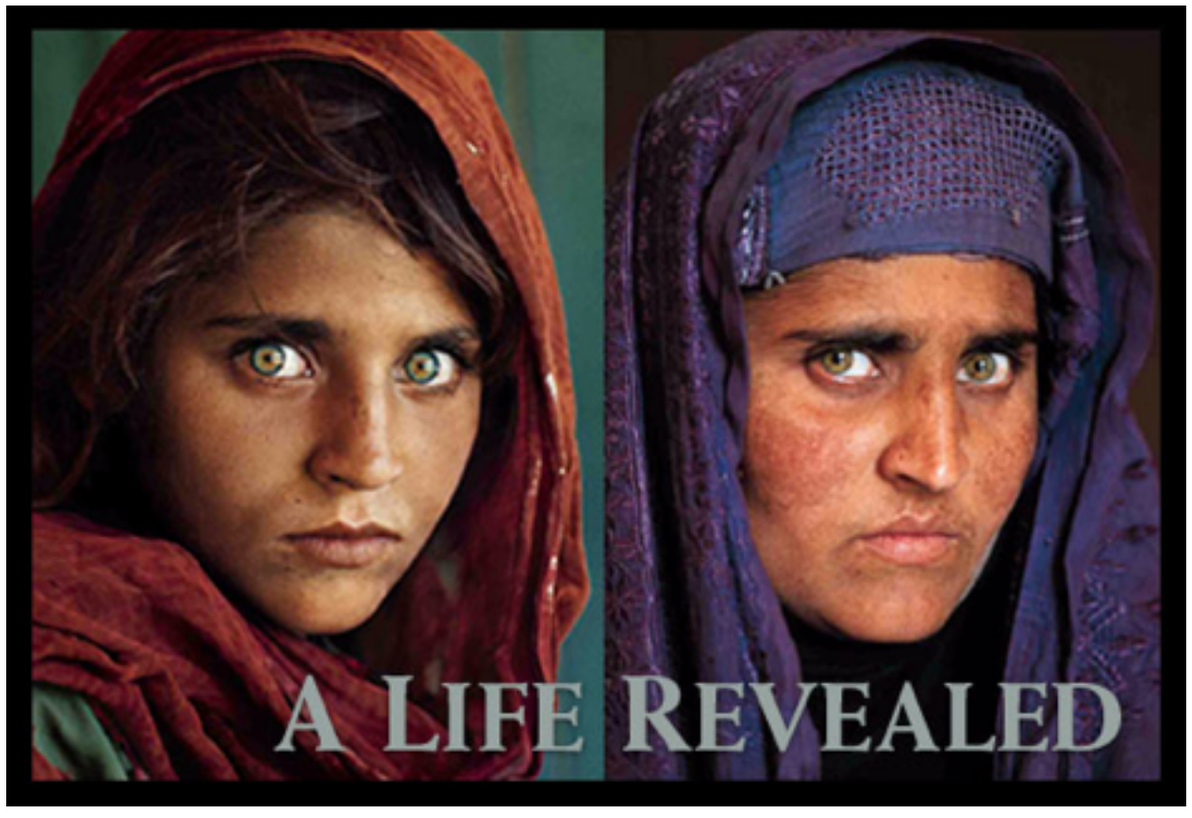
skin filter　　eye magnification　　eye lash density

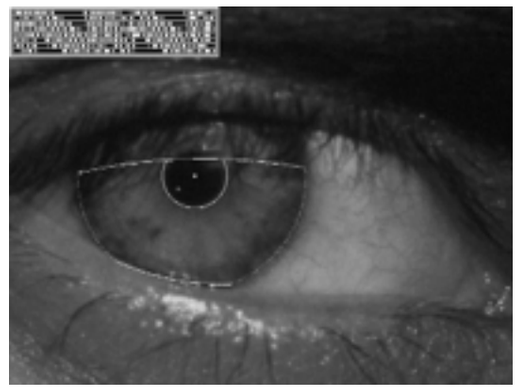
Face makeovers

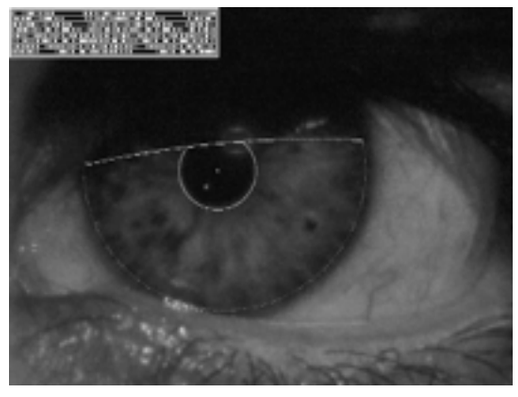


Forensics





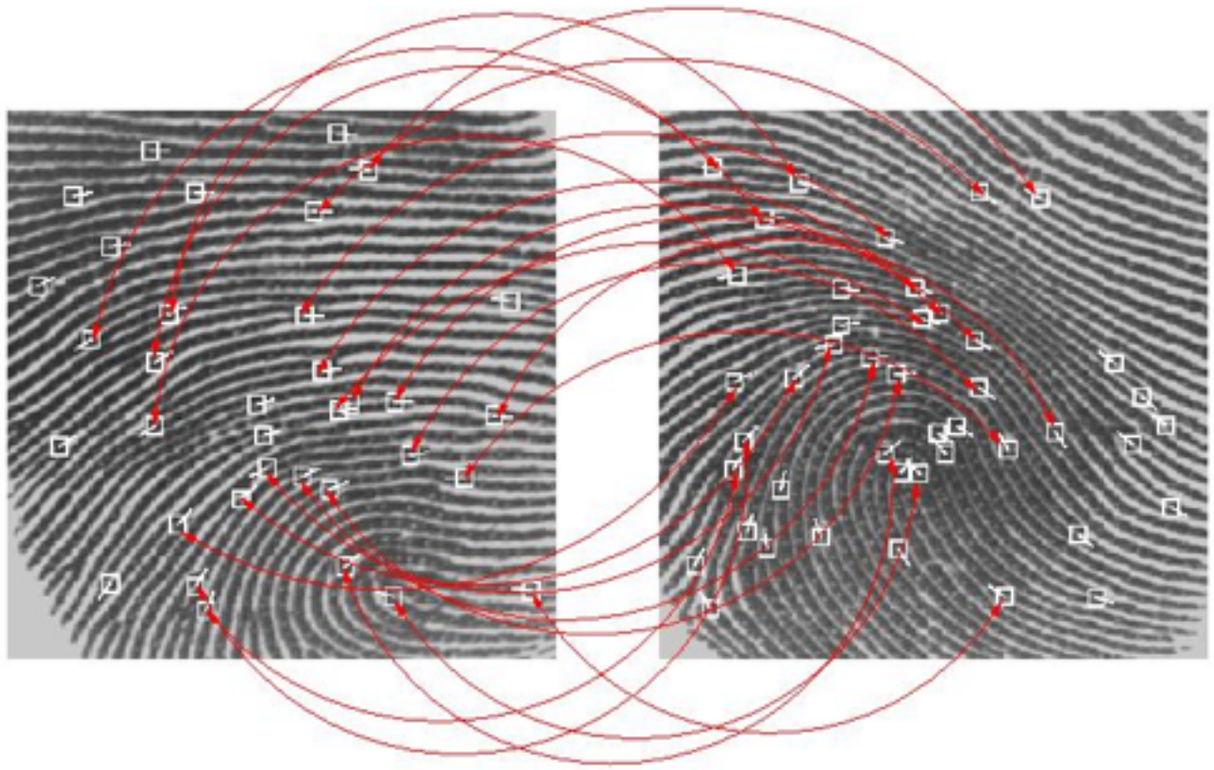




1984 2002

http://www.cl.cam.ac.uk/~jgd1000/afghan.html

fingerprint recognition



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!

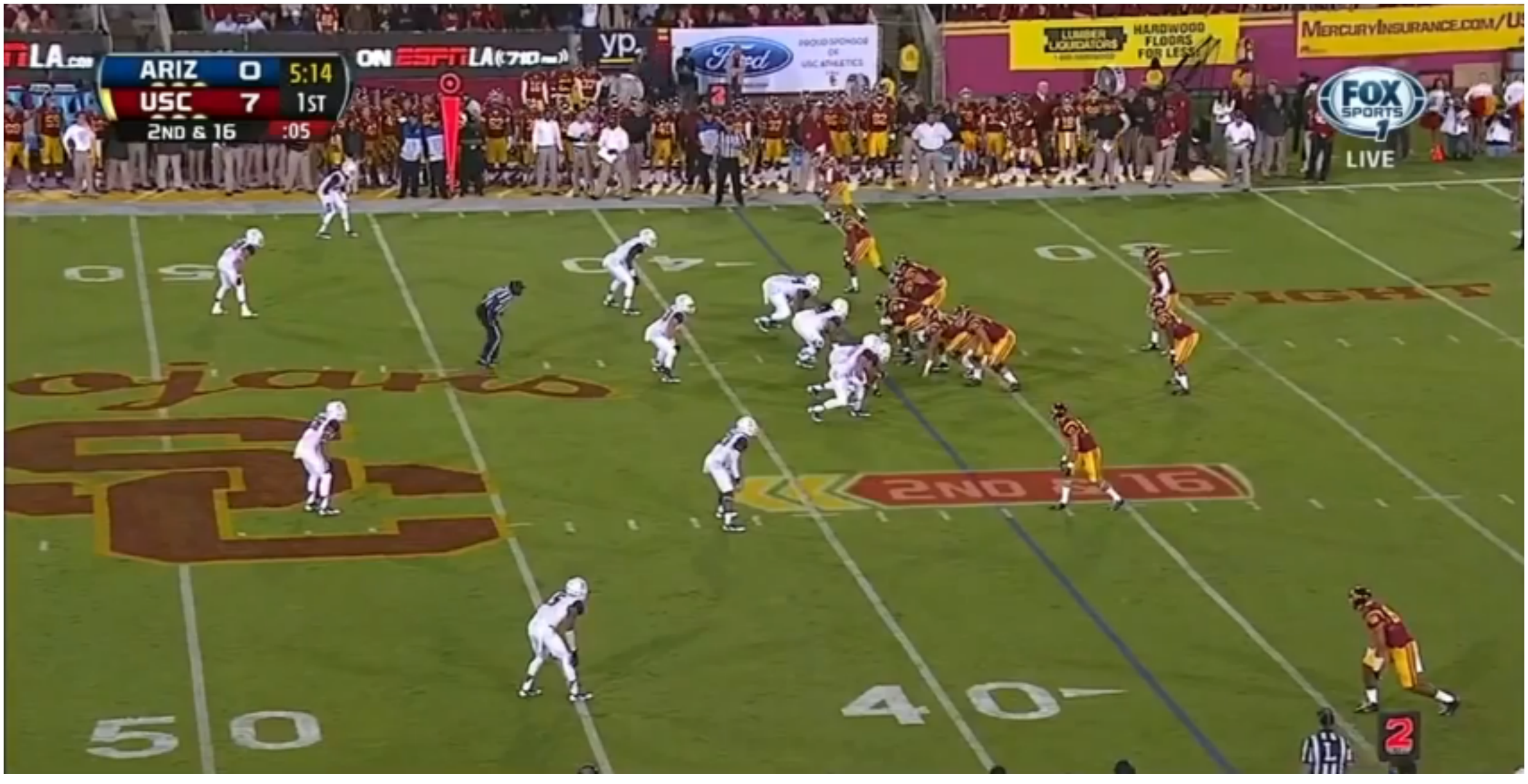

leaf snap

Word Lens

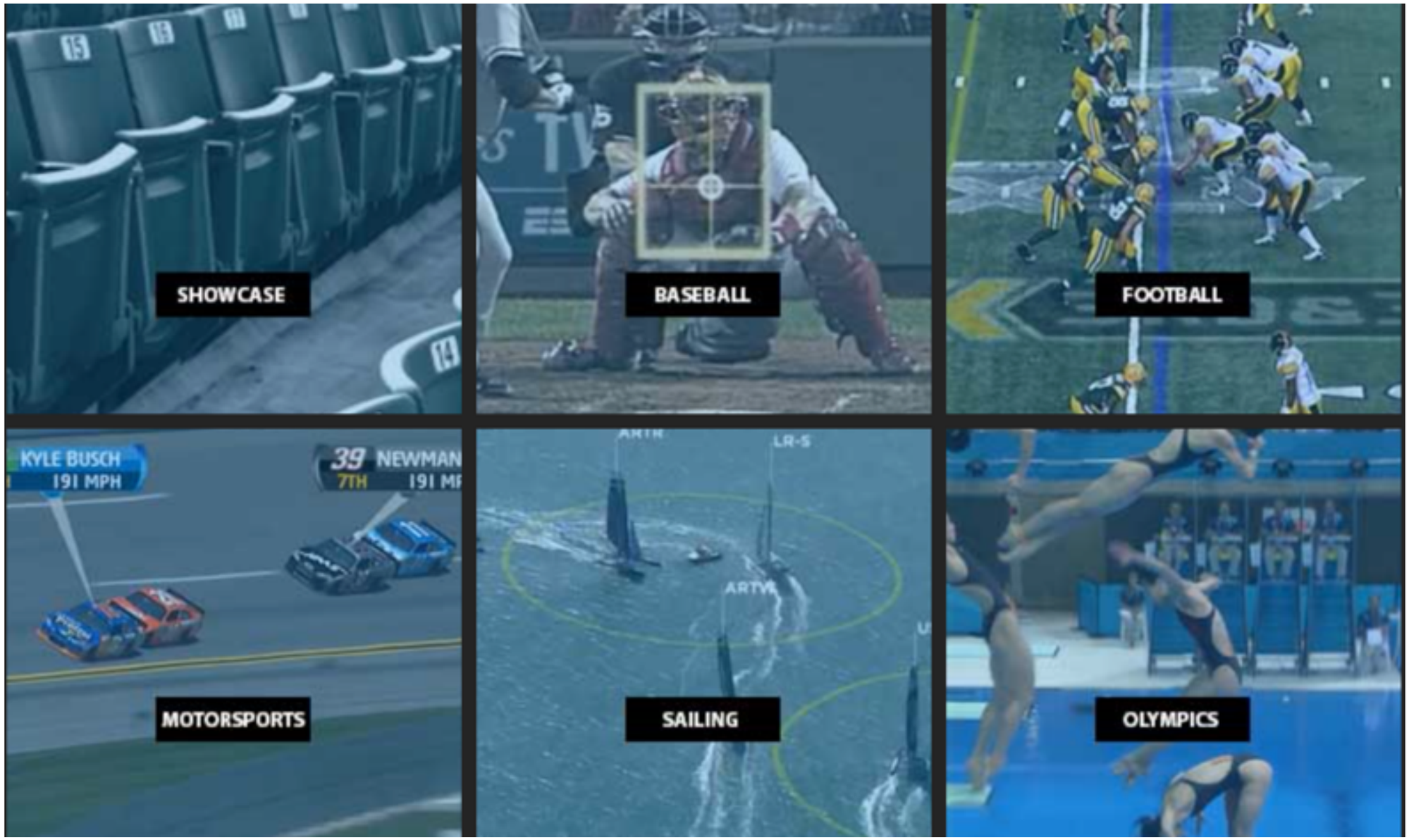
Word Lens

www.QuestVisual.com

First-down line



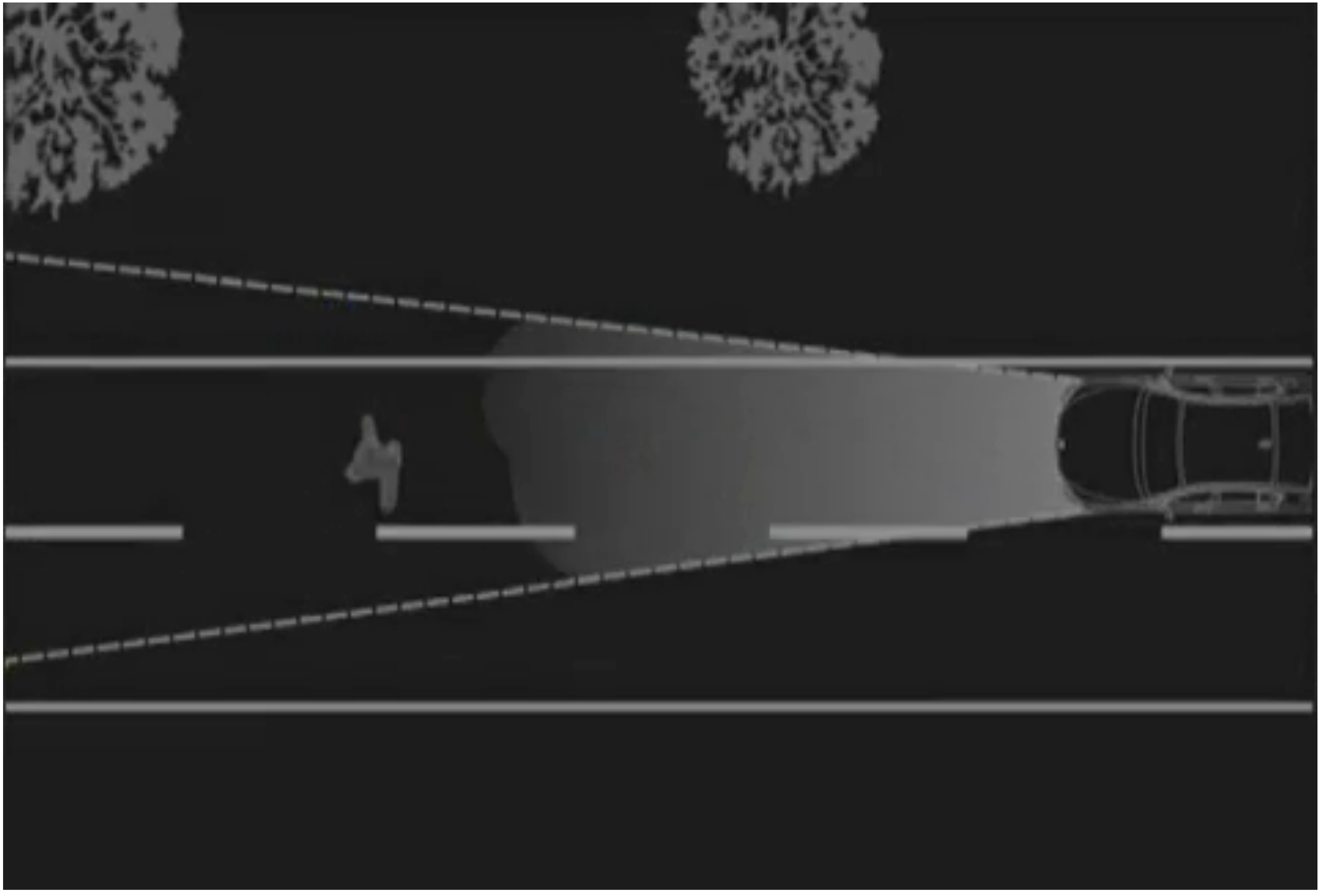
SportVision




HITACHI
Plasma HDTV
DVD Cam
GEICO
geico.com
DIRECT HIGHLIGHTS
JOE'S
FSN TRACER
92 MPH

BMW 5 series

BMW night vision



Infinity EX

“Around view” camera

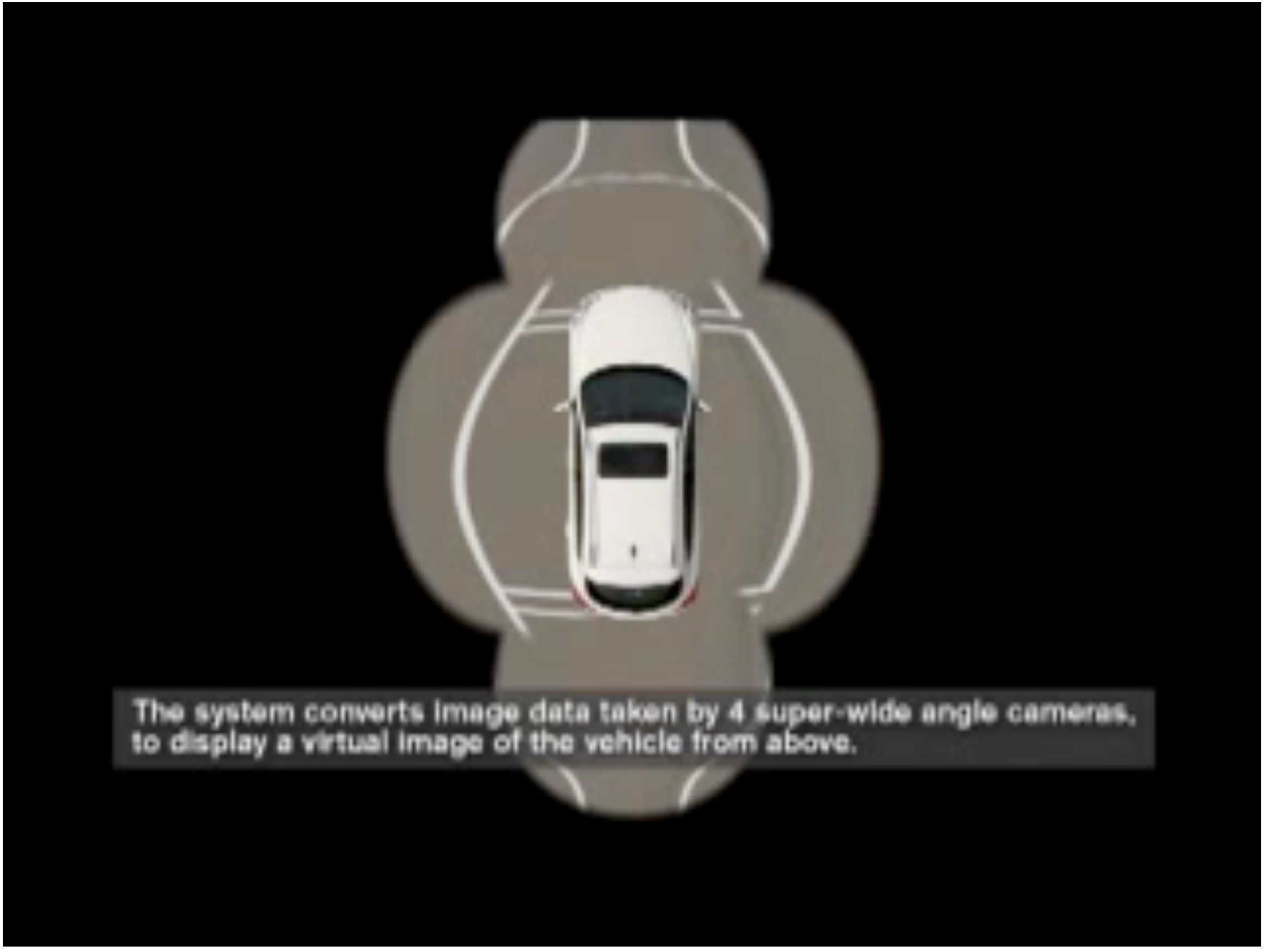

The system converts image data taken by 4 super-wide angle cameras,
to display a virtual image of the vehicle from above.

Image stitching

Photosynth

FLUTTER

CONTROL MUSIC & MOVIES WITH GESTURES

1 HOLD YOUR HAND TO THE WEBCAM

2 WEBCAM DETECTS IT

3 FLUTTER CONTROLS YOUR COMPUTER

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FOR MAC OS X 10.6+

AVAILABLE ON
MAC APP STORE
AND
WINDOWS

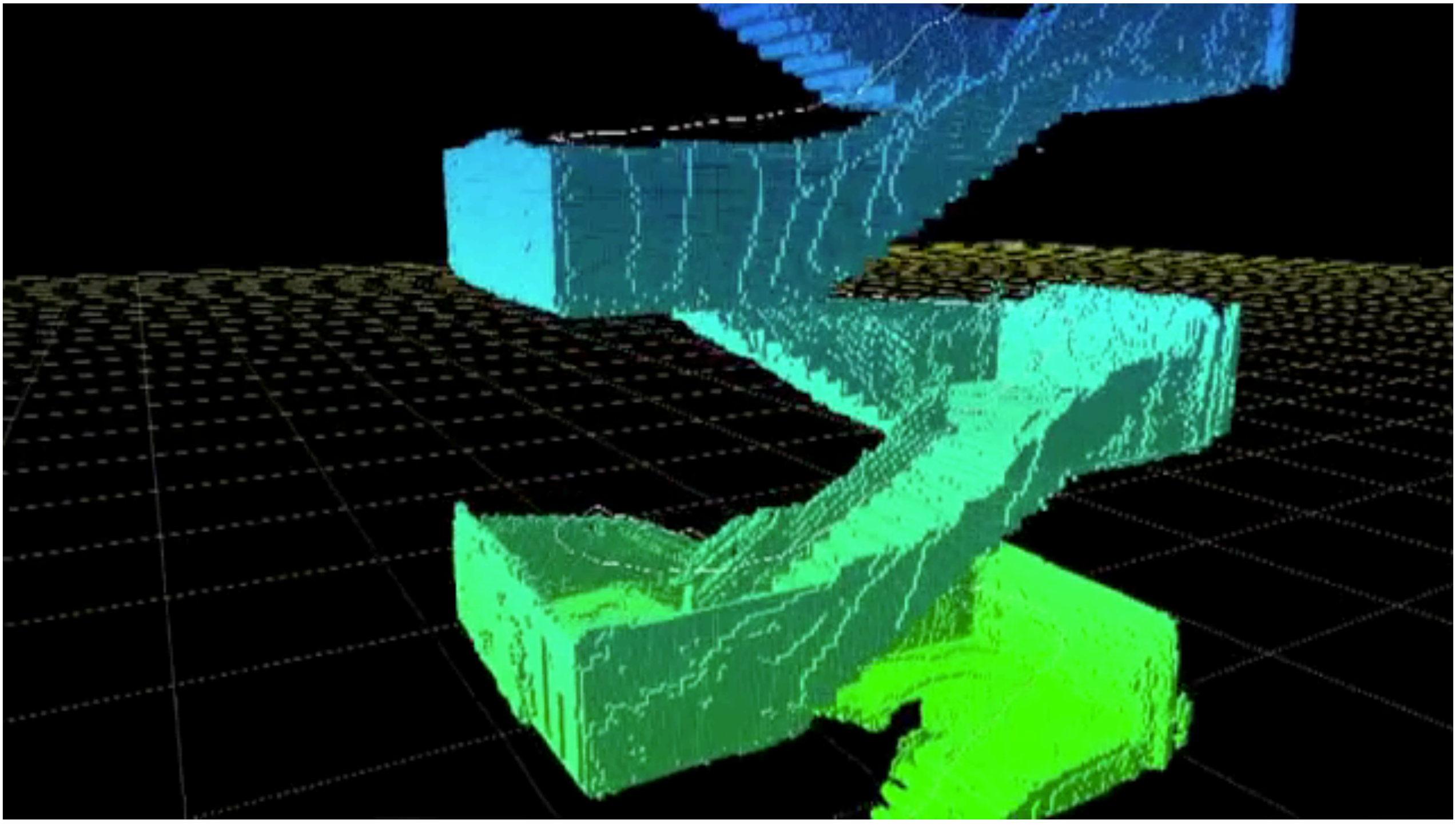
ABOUT
BLOG
PRIVACY

TWITTER
FACEBOOK
PRESS

WINDOWS

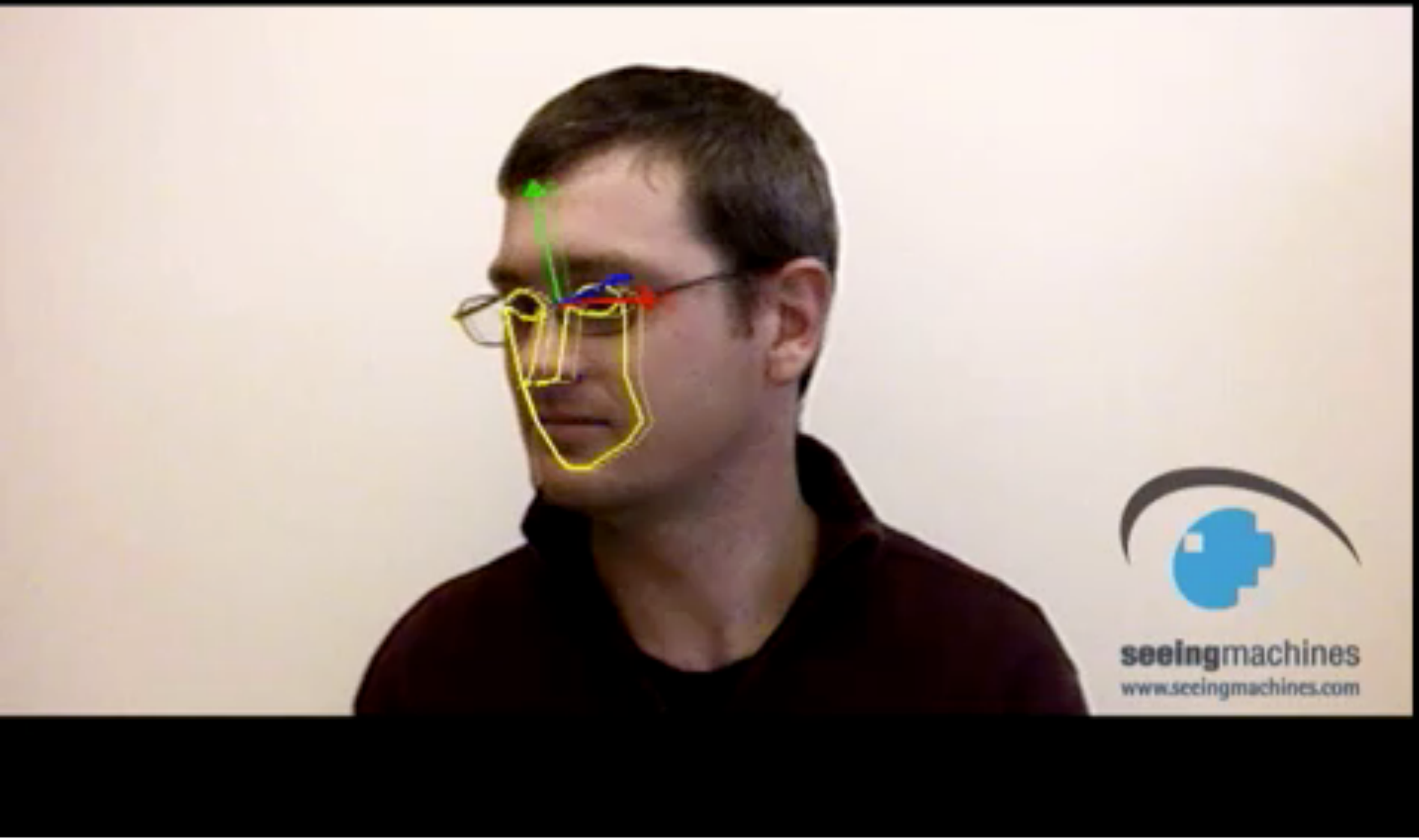
FLUTTER HAS BEEN ACQUIRED BY Google


Flutter




XBOX ONE
Y
X
B
A

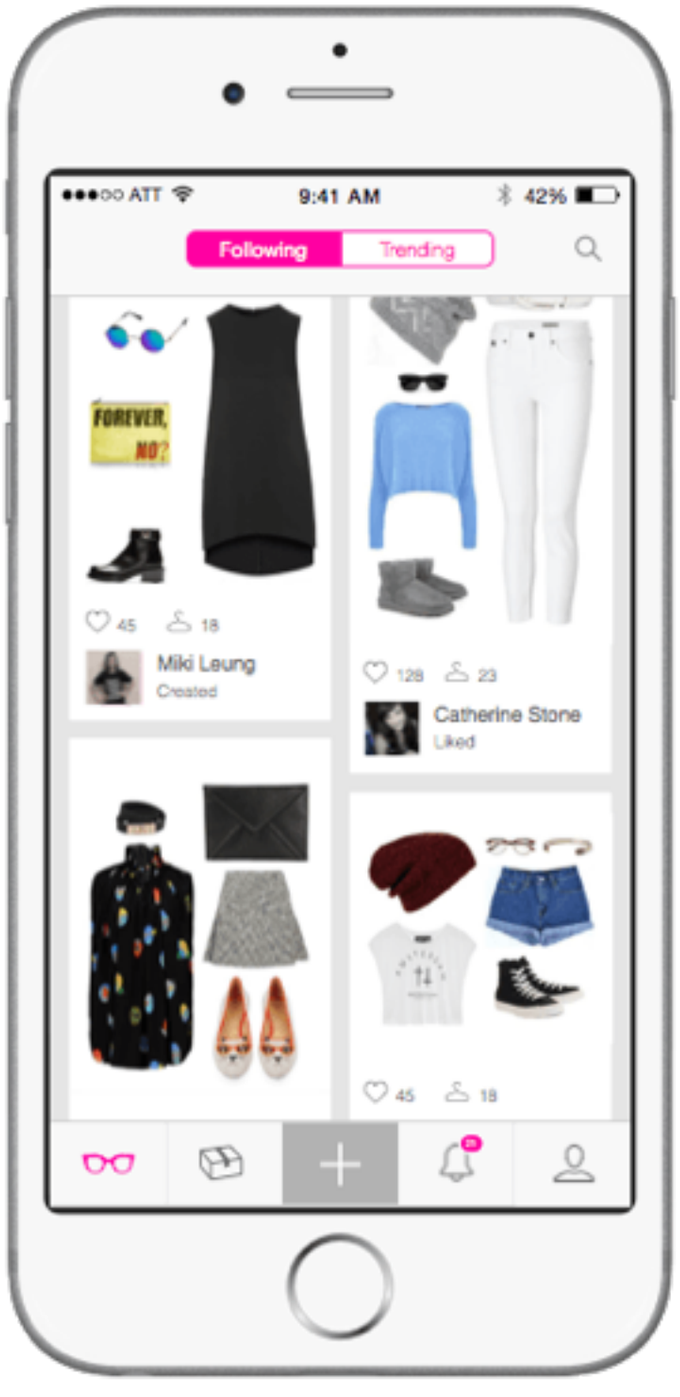
Augmented Reality


seeingmachines
www.seeingmachines.com

Virtual Fitting

2015

STYLE IT



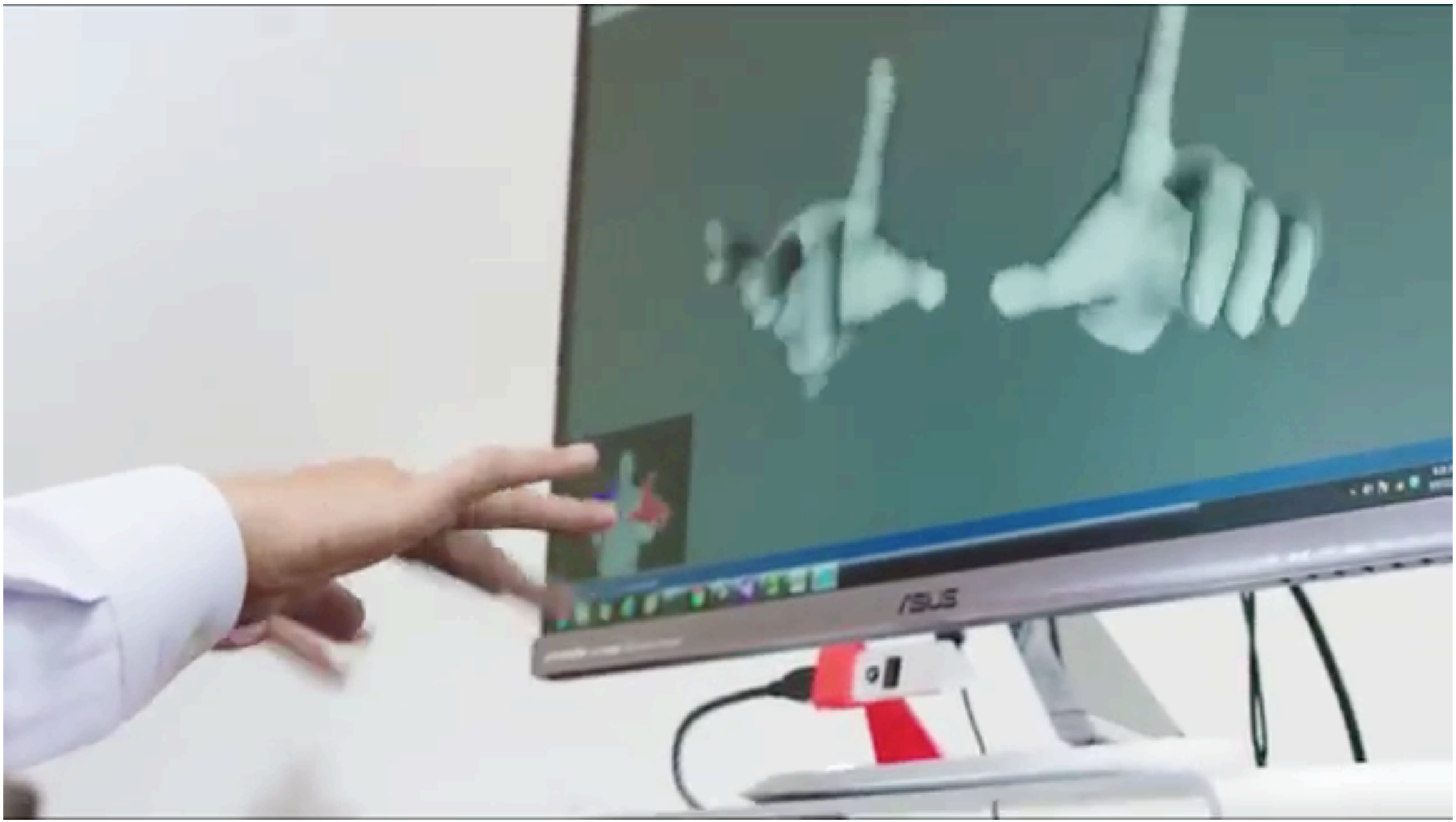
Max
Fashionista dog

CMU alum start up

take a picture of one item

app recommends other clothing that go with it

Computer Vision for VR



2014

Deep Face

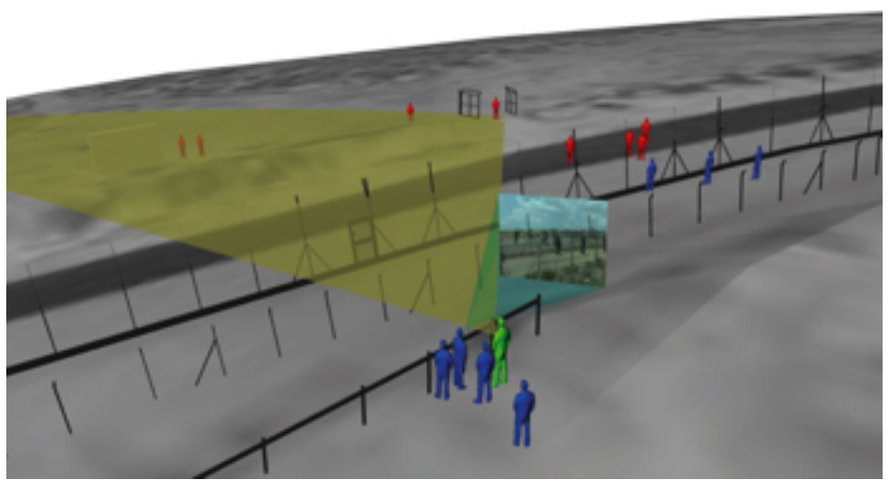
2015

Vision in Cars

Social Justice

Human Trafficking

Human Rights
Video Forensics



Industry Aggressively Hiring from Universities

amazon.com

Google

Dropbox

Spring 2015 Carnegie Mellon University

Computer Vision

16-385

- Lecturer: Kris Kitani
- TAs: Wei-Chiu Ma, Minghuang Ma
- Class: Tuesday, Thursday 12 to 1:20
- Room: NSH 3002

Website

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

Assignments

Blackboard

https://blackboard.andrew.cmu.edu

Discussion&notes

piazza

https://piazza.com/cmu/spring2015/16385/home

Project-based

a lot of programming

hours and hours of programming

days and days of debugging

Grading

- Projects: 90%
- Mid-term exam: 10%

Late days

- 3 late days total (not per project)

- use them wisely

Grading

There are five individual projects and one midterm exam. There is no final exam.

Project 1	Hough Transform	15%
Project 2	Bag of Words	15%
Project 3	Homography	20%
Project 4	Structure from Motion	20%
Project 5	Tracking	20%
Midterm Exam		10%

Image Processing

Jan 13	Introduction
Jan 15	Filtering
Jan 20	Programming Tutorial
Jan 22	Fourier Analysis
Jan 27	Edge Detection
Jan 29	Hough Transform
Feb 03	Generalized Hough Transform

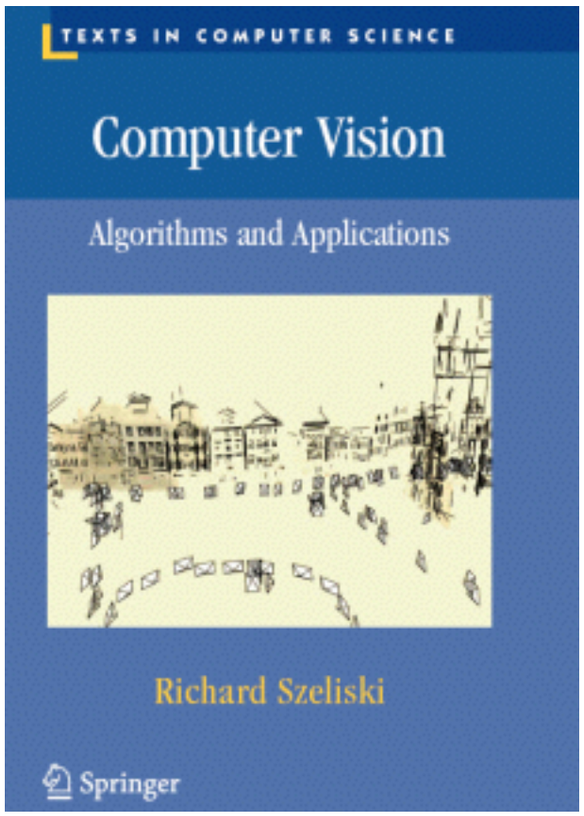
Recognition

Feb 05	Feature Detection
Feb 10	Feature Detection
Feb 12	Feature Descriptors
Feb 17	Feature Descriptors
Feb 19	Object Recognition
Feb 24	Bag of Words
Feb 26	Bag of Words
Mar 03	Midterm Review
Mar 05	Midterm Exam
Mar 10	Spring Break; No Class.
Mar 12	Spring Break; No Class.

Image Transformations(2D)	
Mar 17	2D Transforms
Mar 19	2D Alignment, RANSAC
Multi-view Geometry(3D)	
Mar 24	Pose Estimation, Triangularization
Mar 26	Epipolar Geometry
Mar 31	Essential and Fundamental Matrix, 8 Point Algorithm
Apr 02	Reconstruction, Stereo Vision
Apr 07	Applications of N-view Geometry
Video Analysis	
Apr 09	Optical Flow(Horn-Schunck)
Apr 14	Image Registration(Lucas-Kanade)
Apr 16	No Class.
Apr 21	Image Registration(Lucas-Kanade)
Apr 23	KLT Tracking
Apr 28	Mean-shift Tracking
Apr 30	Guest Lecture

Book

(optional)



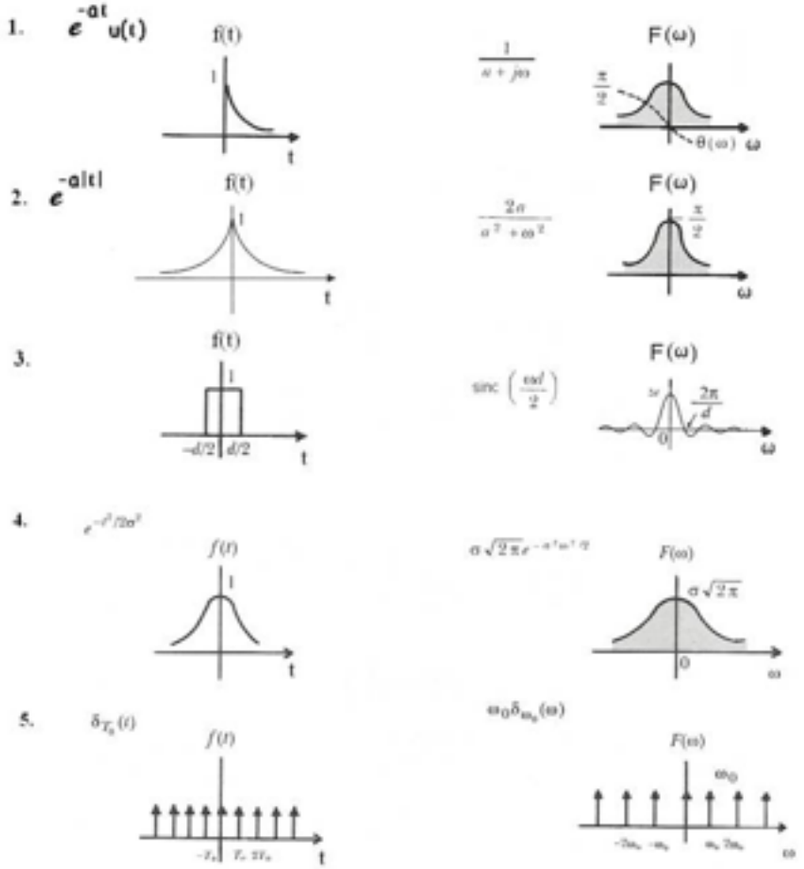
PDF online

http://szeliski.org/Book/

No screens
(smartphone, tablet, laptop, etc.)
*unless for taking notes

Class Overview

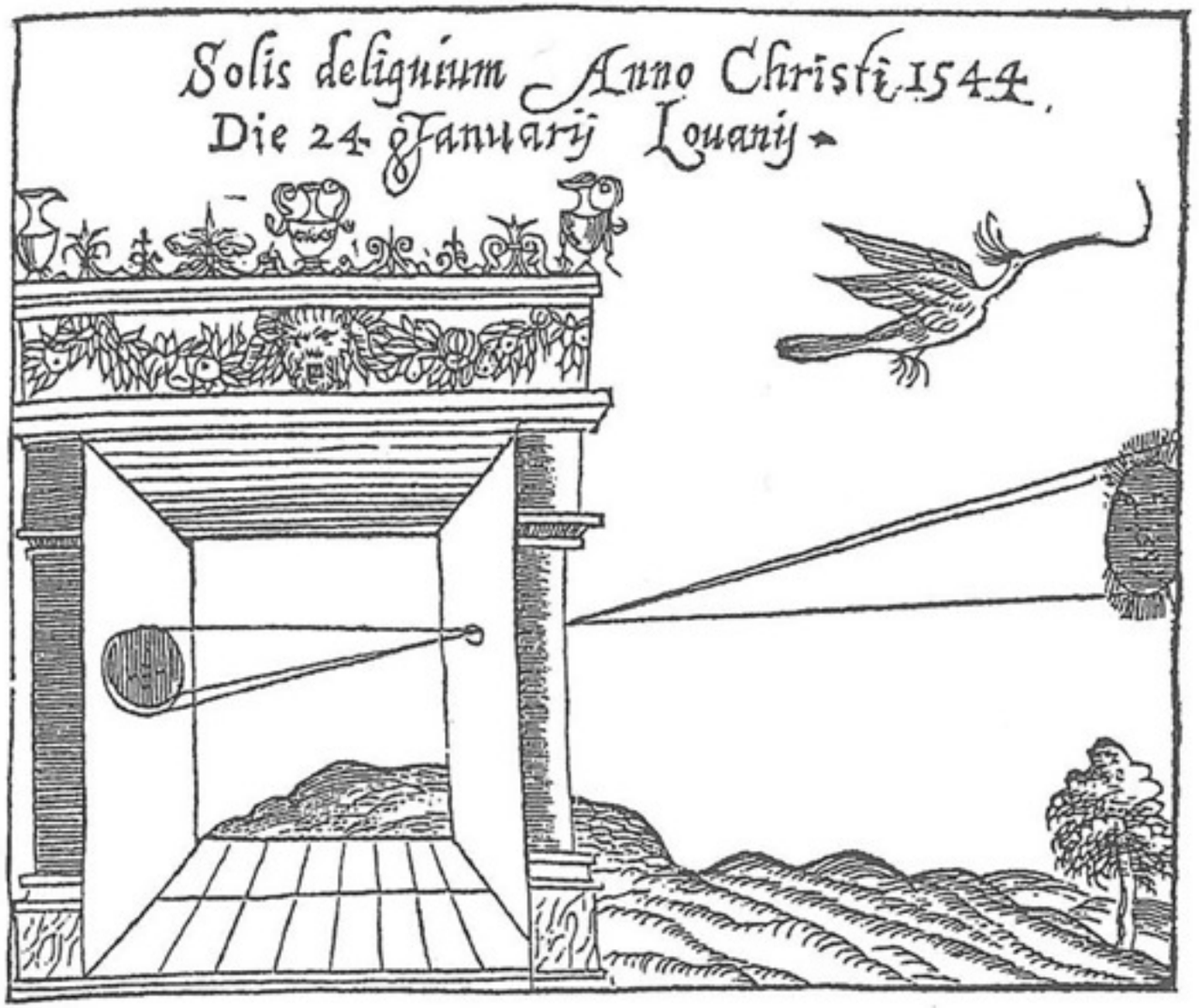
Image processing



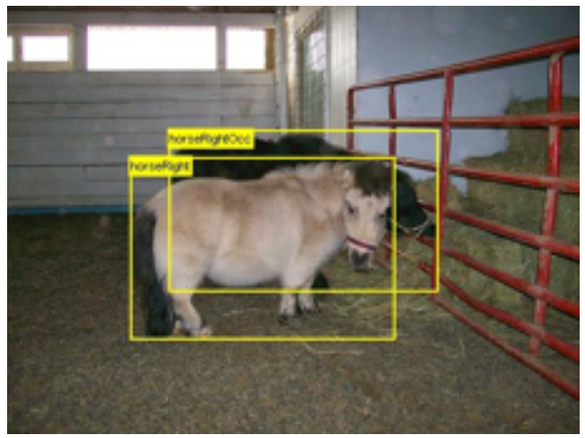
Fourier Transform
Sampling, Convolution

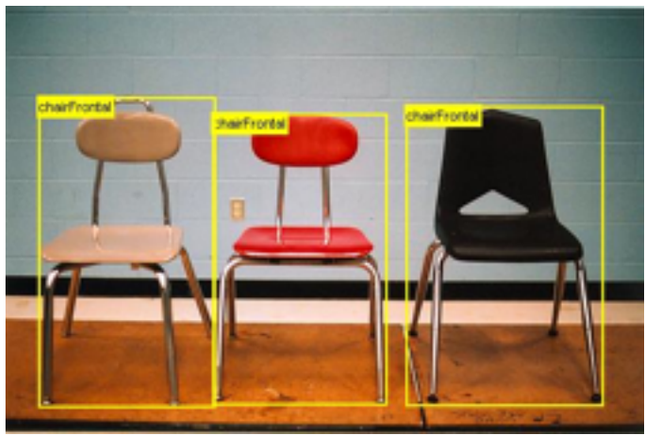
Image enhancement
Feature detection

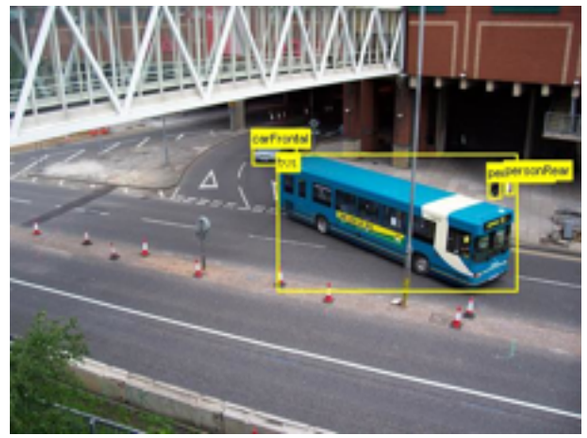
Camera optics

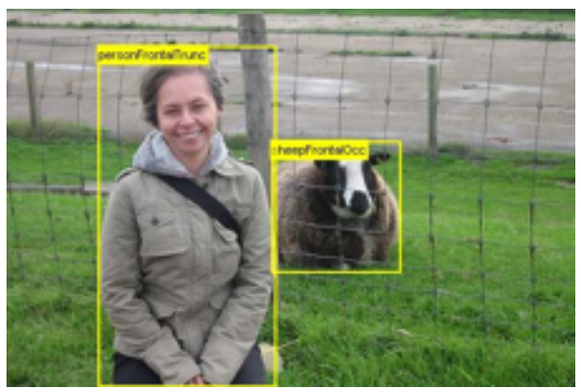


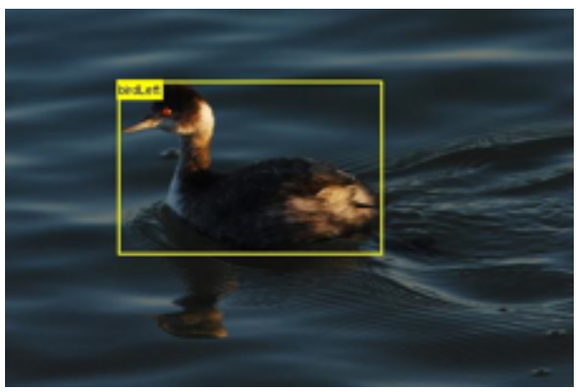
Object detection











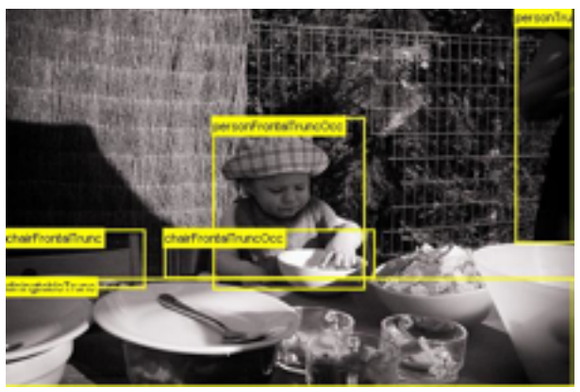
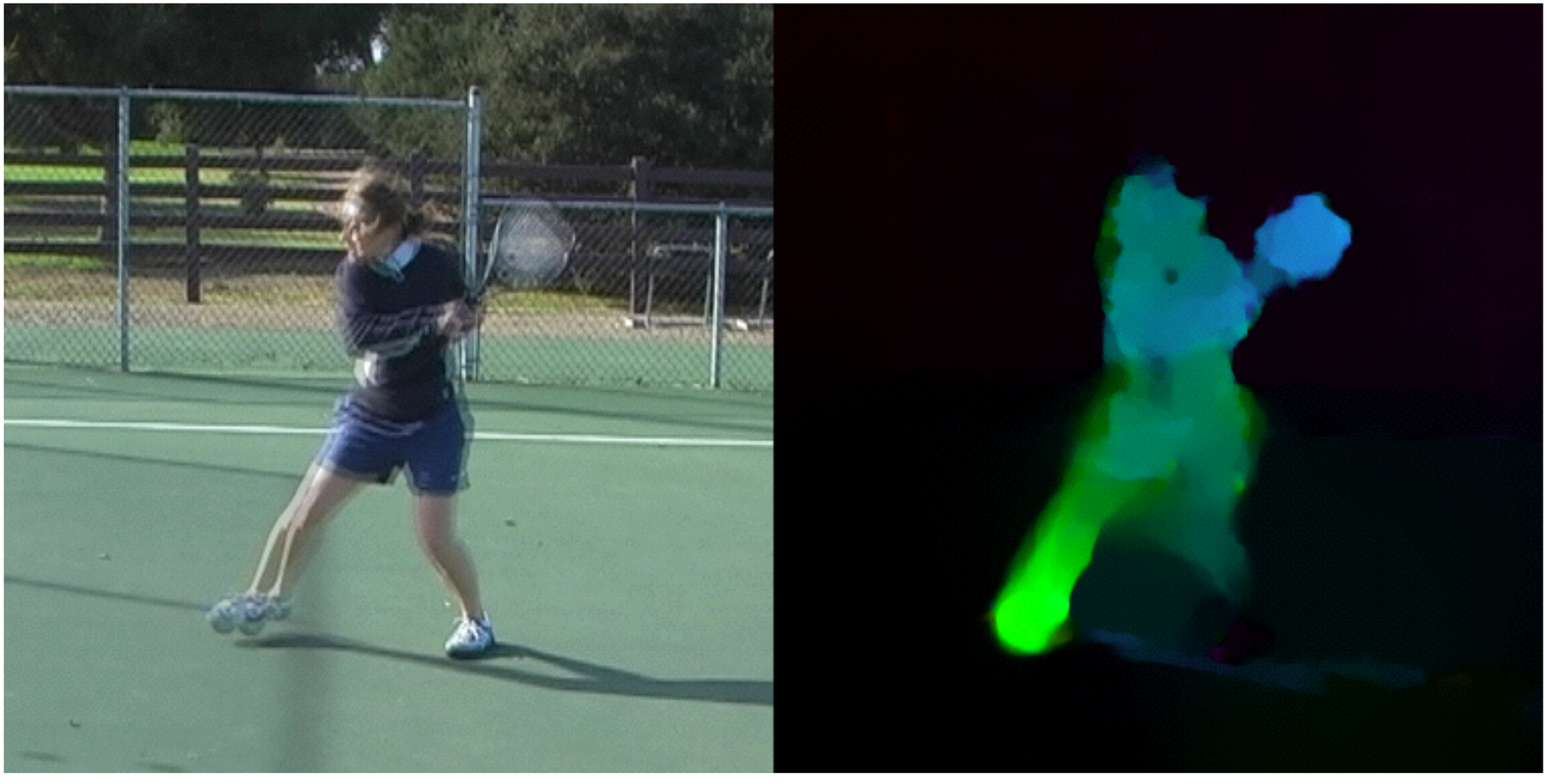


Image mosaicing

Binocular Stereo

Structure from Motion

Optical Flow



Tracking