Visual Computing

Prof. Marc Pollefeys

Prof. Markus Gross

ETH

inf | Informatik
Computer Science

Two parts

- Part I - Image processing

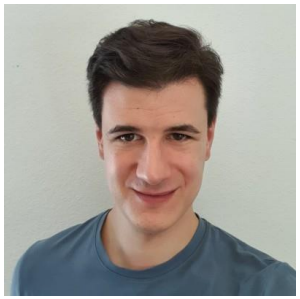
  Prof. Marc Pollefeys

  Main assistant:
  Philipp Lindenberger

- Part II - Computer graphics

  Prof. Markus Gross

  Main assistant:
  Rafael Wampfler



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Topics – Image Processing

- Digital images and sensors
- Image segmentation and morphology
- Convolution and image features
- Fourier transform and filtering
- Unitary transformations and image compression
- Warping, Optical flow and video compression
- Radon transform
- Convolutional Neural Networks

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Topics – Computer Graphics

- Drawing triangles, rasterizing
- Transformations, Geometry and textures
- Rendering pipeline
- Lighting, colors, shading, visibility and shadows
- Curves and surfaces, geometry processing
- Ray tracing
- The Science of Special Effects

Course Logistics

https://cvg.ethz.ch/teaching/visualcomputing/ :

- Tue: 10-12, HG G3
- Thu: 14-16 HG G3

- Exercises (from next week):
  - Tue: 13-16, CHN G42
  - Thu: 09-12, IFW A36

Exercises

- Grade determined by final exam
- Attend one of the two sessions each week

- Exercises complement lectures to provide insight and hands-on experience
- Goals is to finish most exercises during session with assistants (no homework)

Visual Computing @ ETHZ

- Institute of Visual Computing
  - Computer Vision and Geometry Lab – Prof. Marc Pollefeys
  - Computer Graphics Lab – Prof. Markus Gross
  - Interactive Geometry Lab – Prof. Olga Sorkine
  - Vision and learning group – Prof. Siyu Tang
- Advanced Interactive Technologies – Prof. Otmar Hilliges
- CRL Computational Robotics Lab – Prof. Stelian Coros
- CVL Prof. Luc Van Gool, Prof. Ender Konukoglu, Prof. Fisher Yu
- Institute for Machine Learning – Prof. Buhmann, Prof. Hoffman, Prof. Krause, …
- Photogrammetry and remote sensing – Prof. Konrad Schindler
- Autonomous system laboratory – Prof. Roland Siegwart, Prof. Margarita Chli
- Institute of Neuro-Informatics – Prof. Davide Scaramuzza, Prof. Tobi Delbrueck, …

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Computer Vision in Zurich

… and other labs and companies based in Zurich

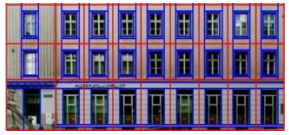
Disney Research
SCIENCE AT PLAY

kooaba

ptc

procedural

esri



SCANDIT

Google

Leica
Geosystems

magic
leap

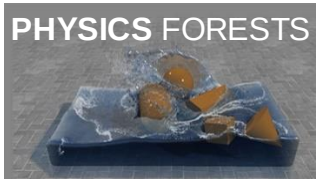
Dacuda

logitech

LiberoVision

vizrt

PHYSICS FORESTS



FASHWELL

NOMOKO

Super computing systems

Microsoft

faceshift

ostrivis

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Computer Vision and Image Analysis

Examples and Applications

3D + Interactive Maps

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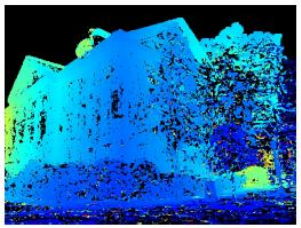
Automated 3D modeling

Gallup et al. 2010

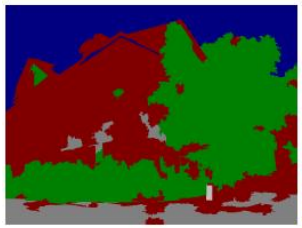
Joint 3D reconstruction and class segmentation

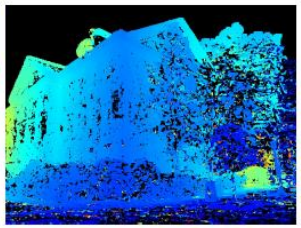
(Haene et al CVPR13)

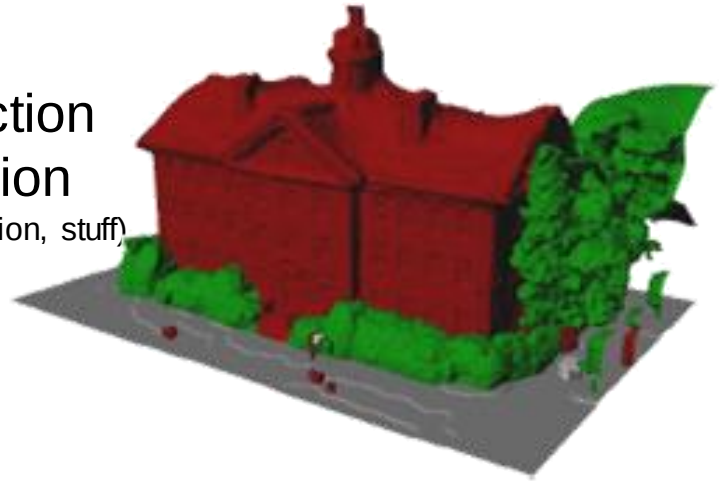


reconstruction only
(uniform smoothness prior)

joint reconstruction
and segmentation
(ground, building, vegetation, stuff)







Robots Learning from Observation

D. Bentivegna & C. Atkeson

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Willow Garage's PR2 plays pool

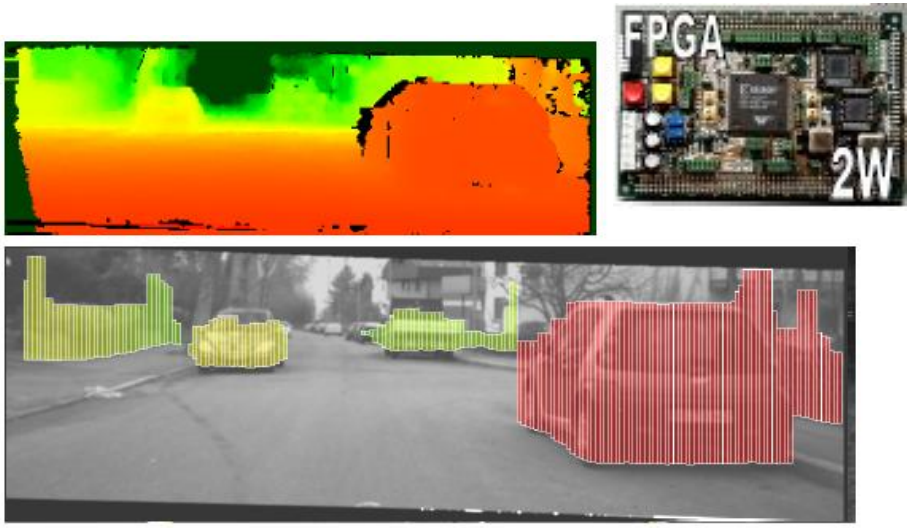
Driver Assistance

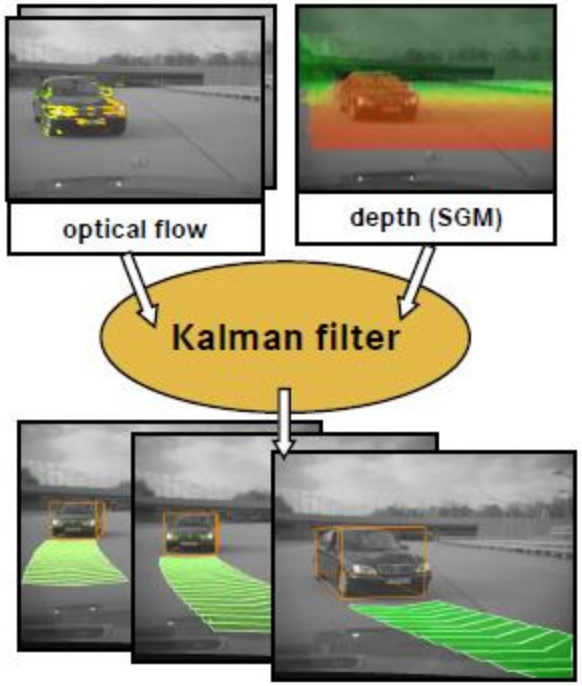
mobileye


MOBILEYE®
Mobileye PCW
Pedestrian Collision Warning

Driver Assistance

Daimler stereo system





6D vision

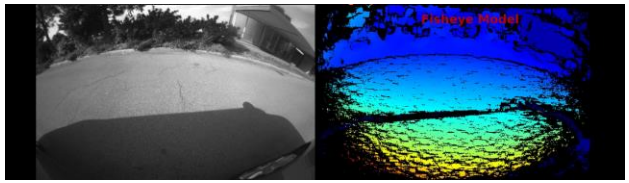
Daimler 6D vision


BOSCH

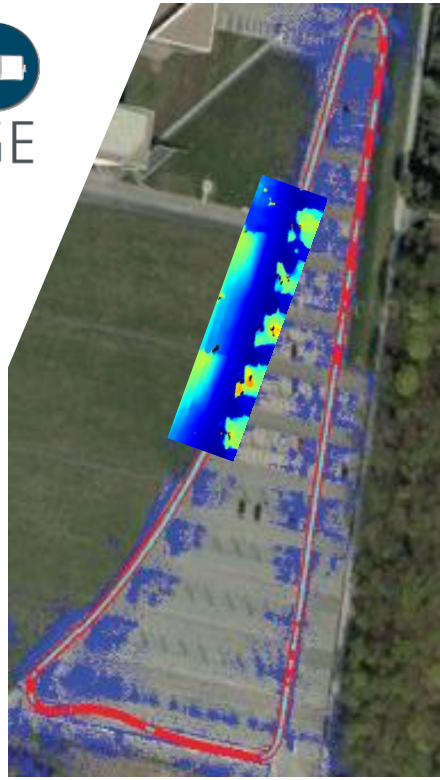
3D mapping for autonomous driving

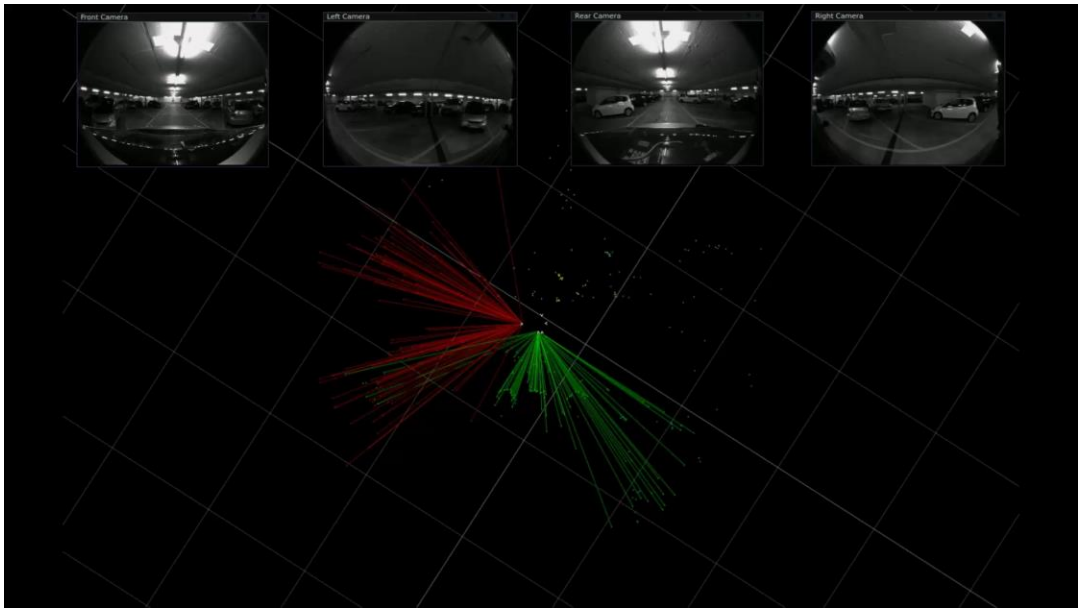
(Lee et al CVPR13;
Heng et al. ICRA14;
Haene et al…)

V-CHARGE



Dense real-time temporal fisheye stereo (GPU)





omnidirectional visual simultaneous localization and mapping

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cameras as main sensors: *no lasers, no GPS*

Robot navigation

Online Environment Mapping

Supplementary Video

Paper ID: #828

collaboration with Honda

Micro Aerial Vehicles

pixhawk

auterion

https://auterion.com/

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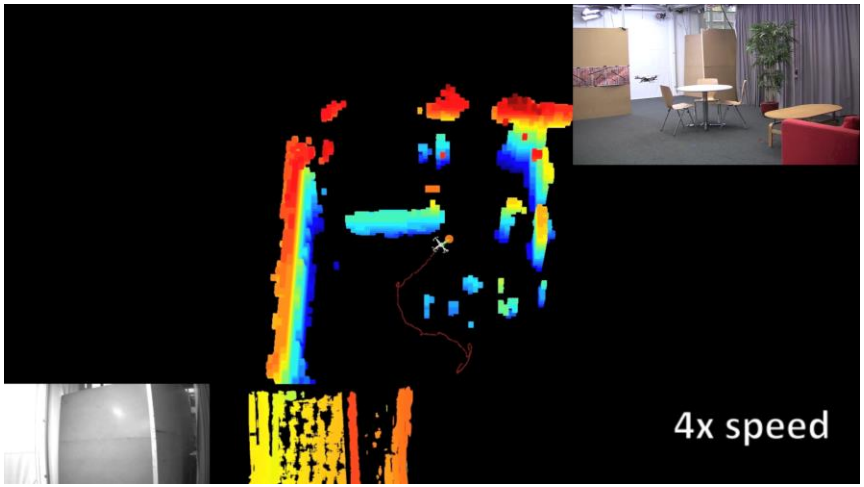
Full autonomous vision-based navigation and mapping

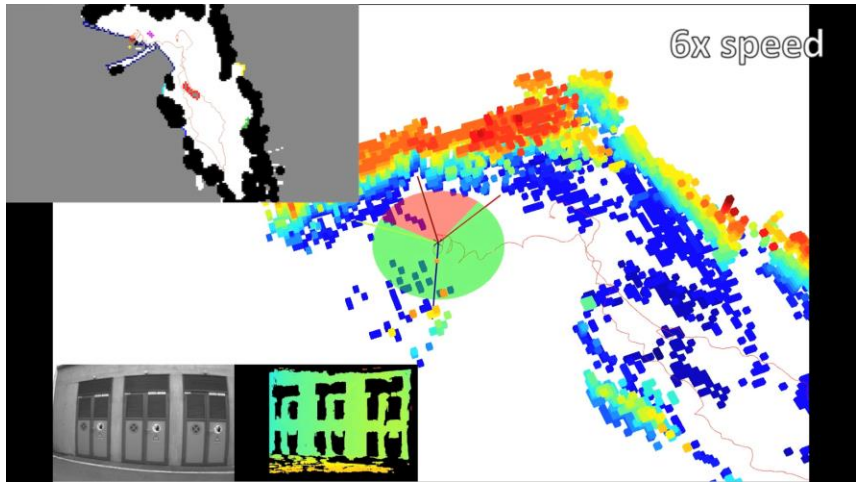
(Fraundorfer et al. IROS12 best paper finalist)

full on-board processing
2+1 cameras + IMU

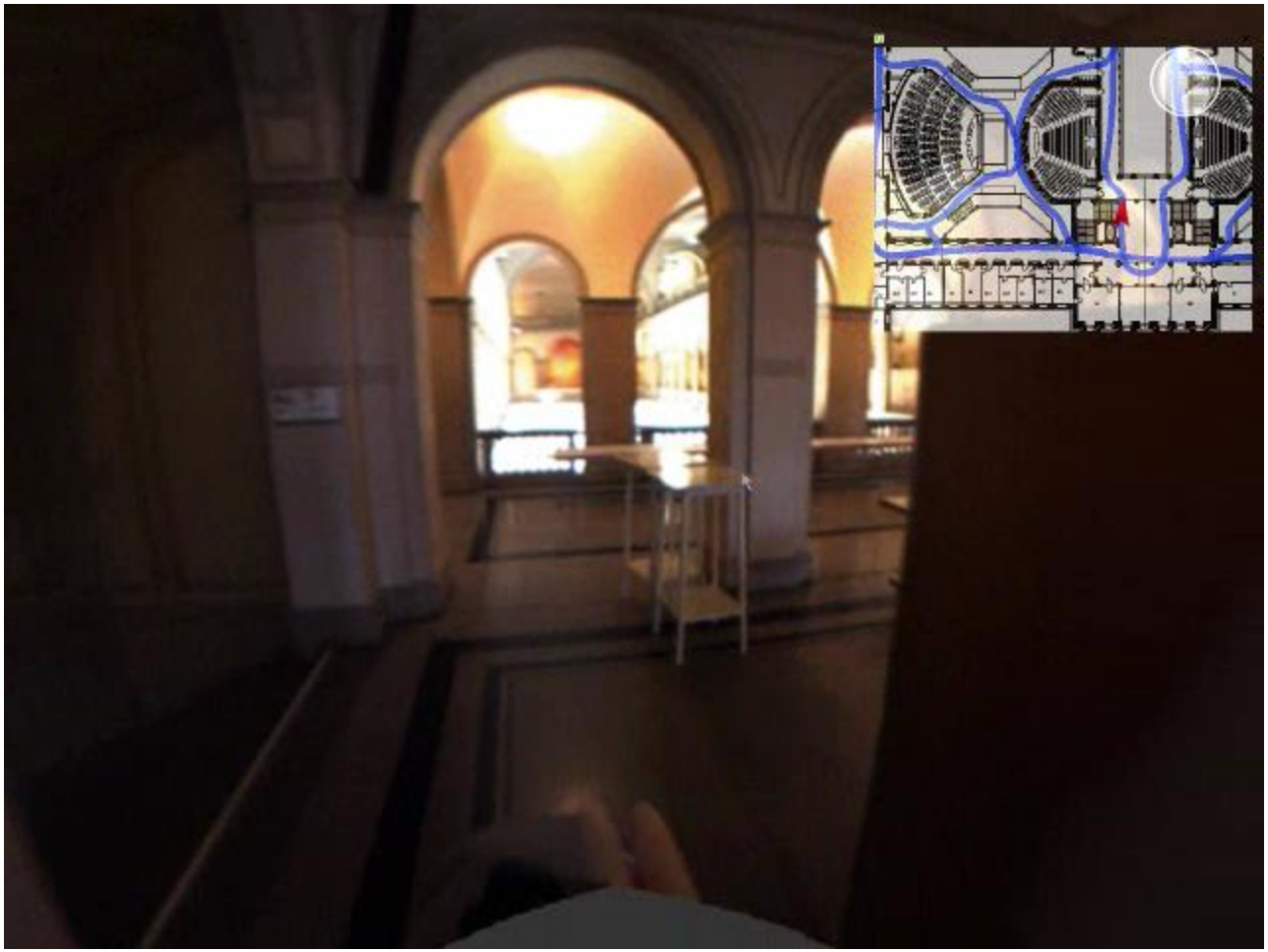
indoor and outdoor operation
obstacle avoidance, mapping
and exploration

no laser, no GPS, no network

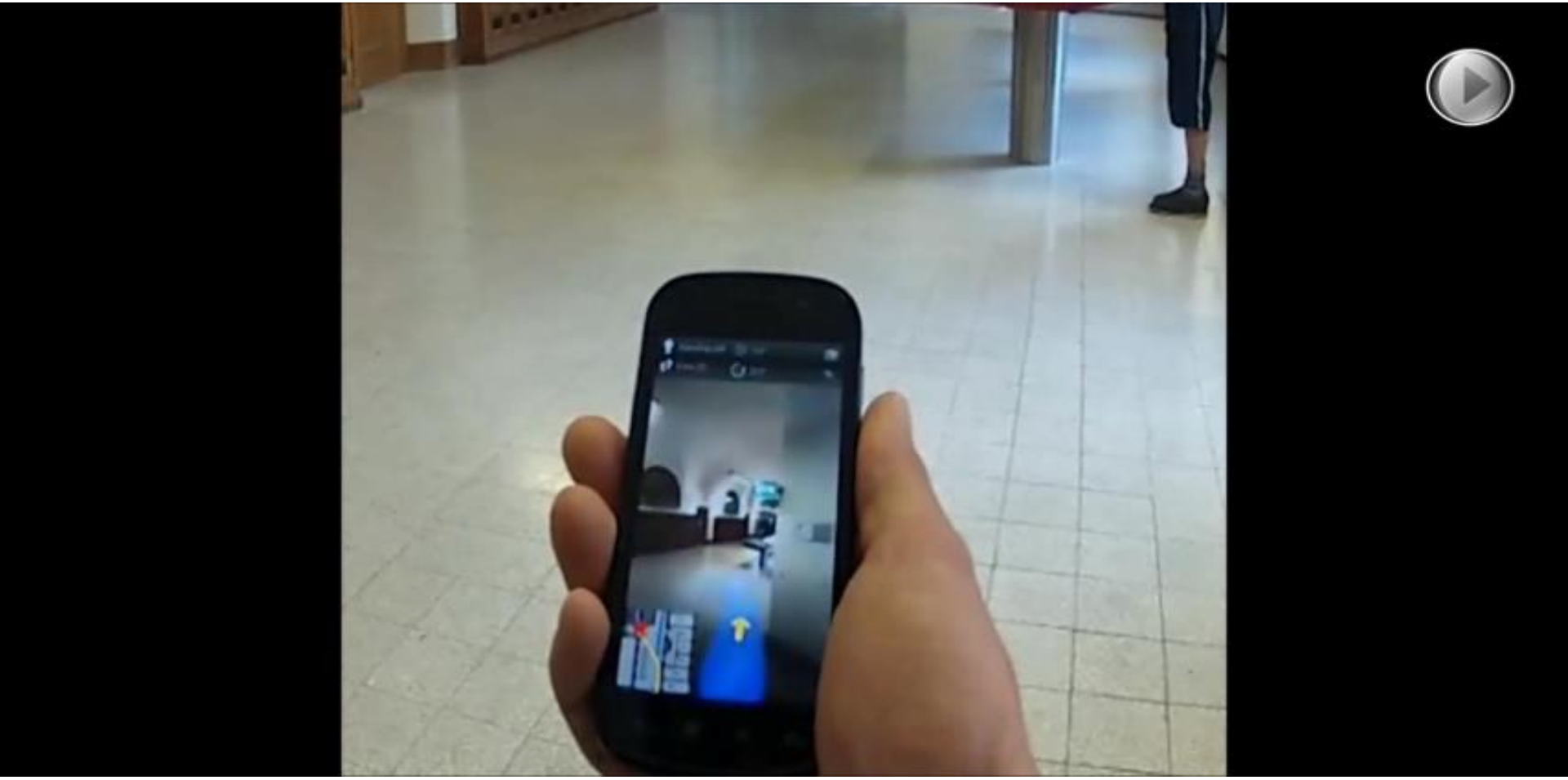




Mapping and localization



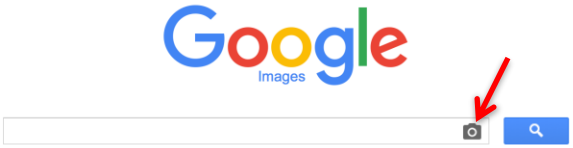
MobileTour



Uses accelerometers (as pedometer) and gyroscope to track user location

Image-based retrieval

- Google Image Search



- Kooaba (now PTC) (http://www.kooaba.com/)
- Nokia Point & Click
- Seeing AI

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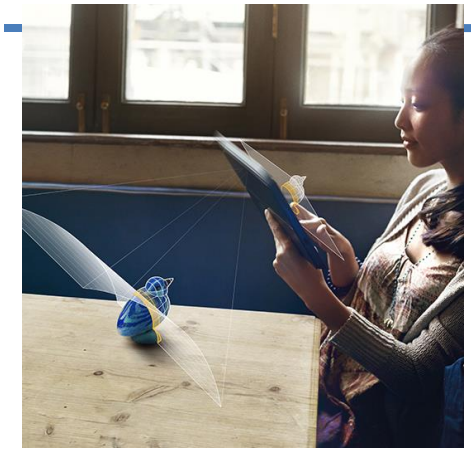
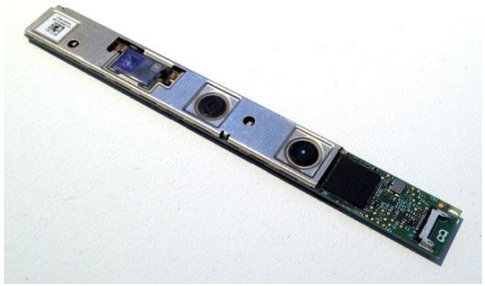
Intel RealSense technology

Low power (<1W) models for tablet and for PC



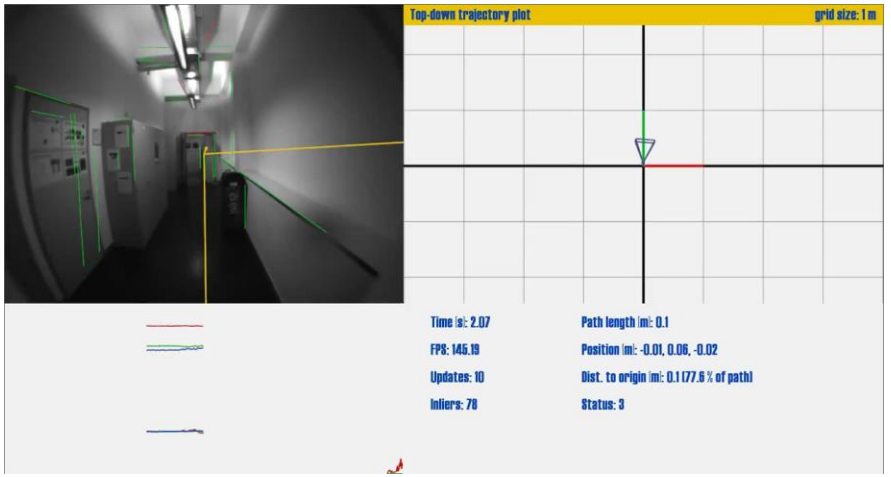


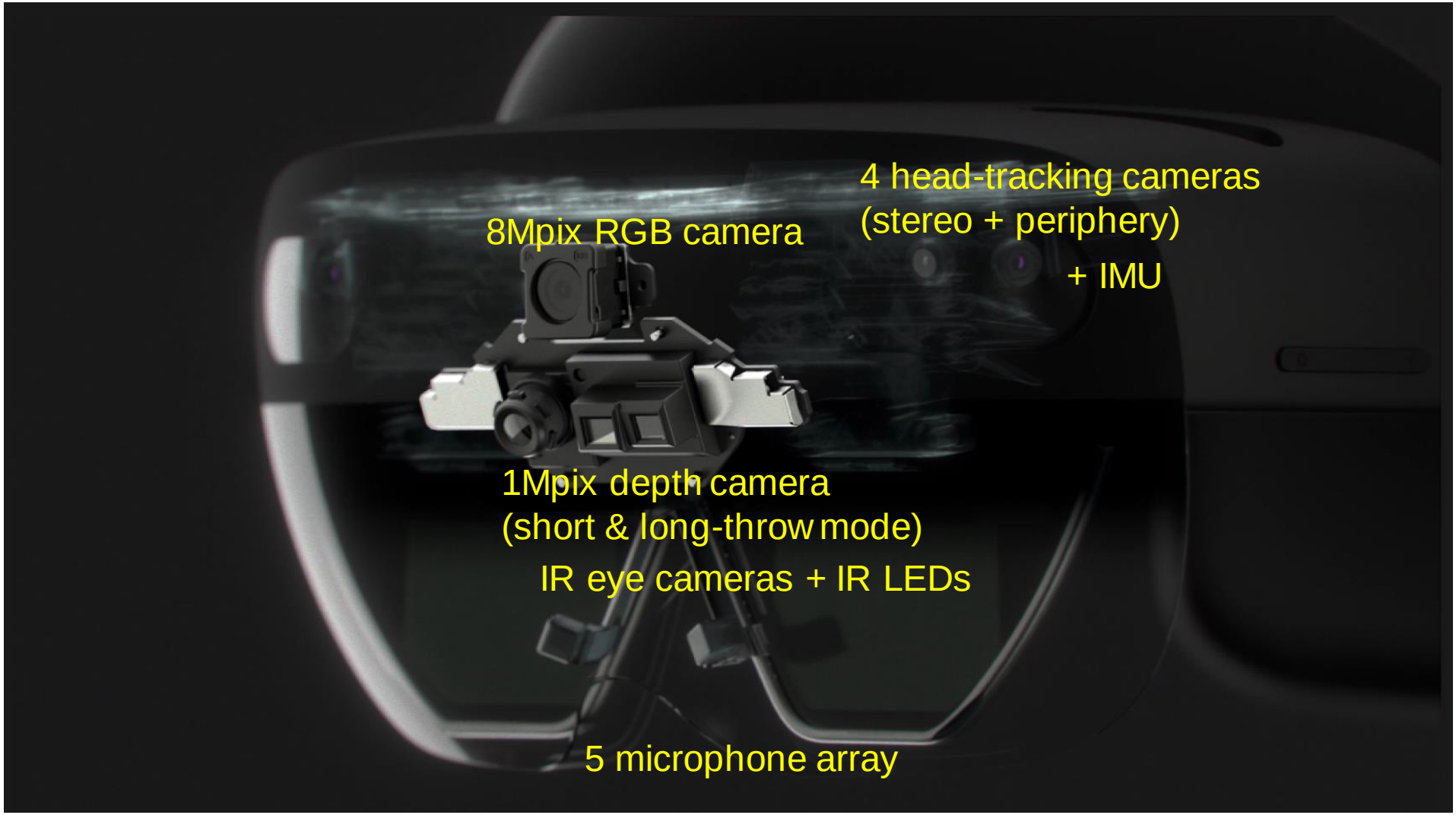
depth from 2 (or 1) cameras + (un)structured laser pattern


Project Tango

Research partner of Google's Project Tango

Project Tango




4 head-tracking cameras
(stereo + periphery)
+ IMU
8Mpix RGB camera
1Mpix depth camera
(short & long-throw mode)
IR eye cameras + IR LEDs
5 microphone array

Visual Modeling for Archaeology

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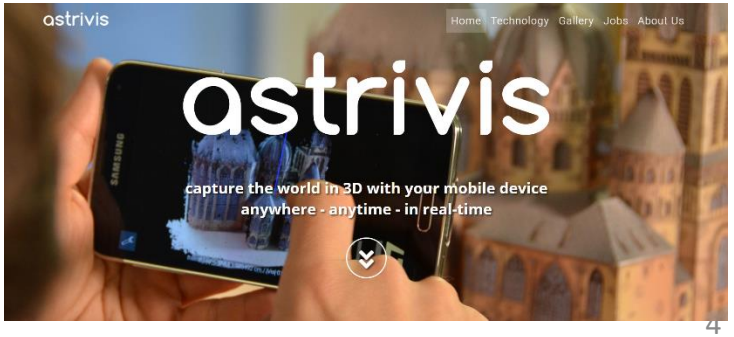
Visual modeling with a hand-held camera, Pollefeys et al. 2004

3D on mobile phone

(Tanskanen et al. ICCV13)



(Delaunoy et al. CVPR14)

3D selfies

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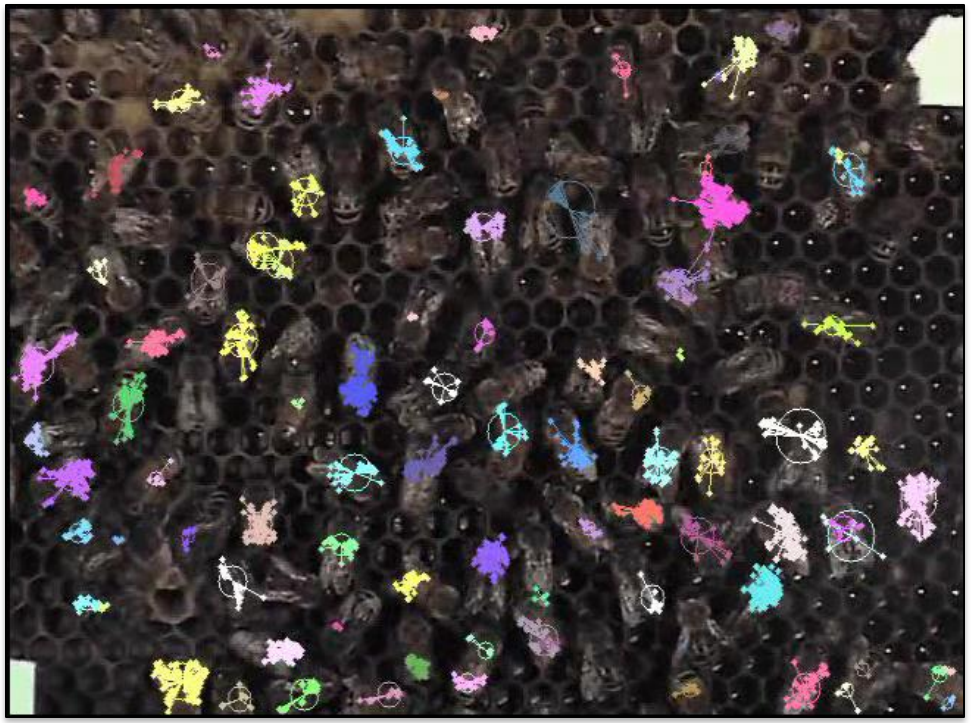
Surveillance

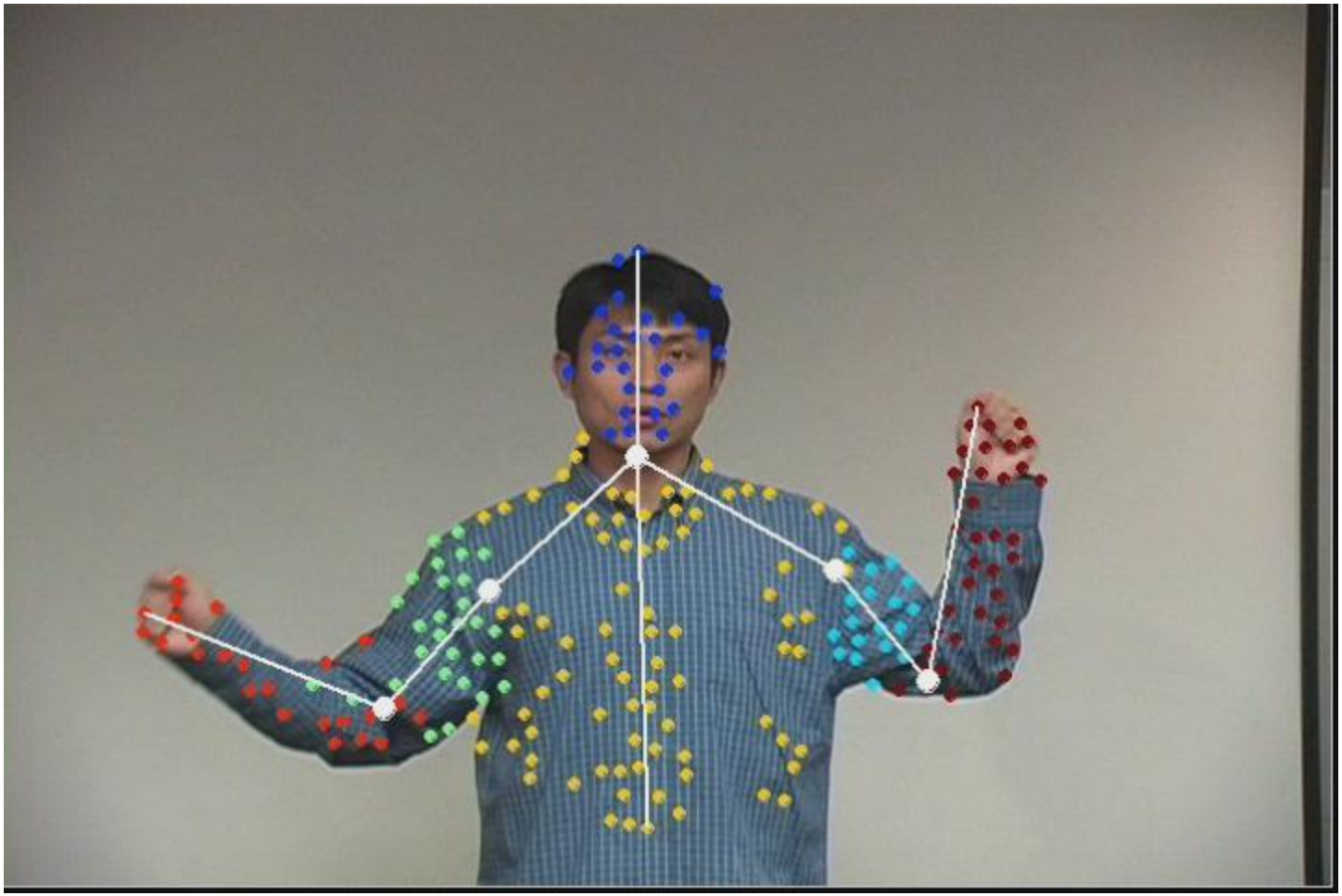


Brostow & Cipolla 2006

Character Animation: Motion Capture

Michael Jackson - Ghost

Articulate Motion Analysis



Yan and Pollefeys 2006

Markerless motion capture

Ballan and Cortelazzo 3DIMPVT2008

MS Kinect

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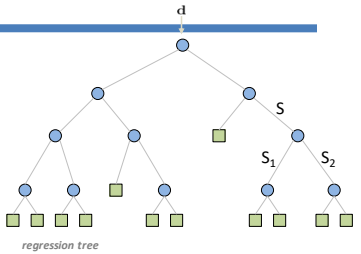
Bodytracking

Randomized forest
(Shotton et al.)



based on simple depth difference tests at each node

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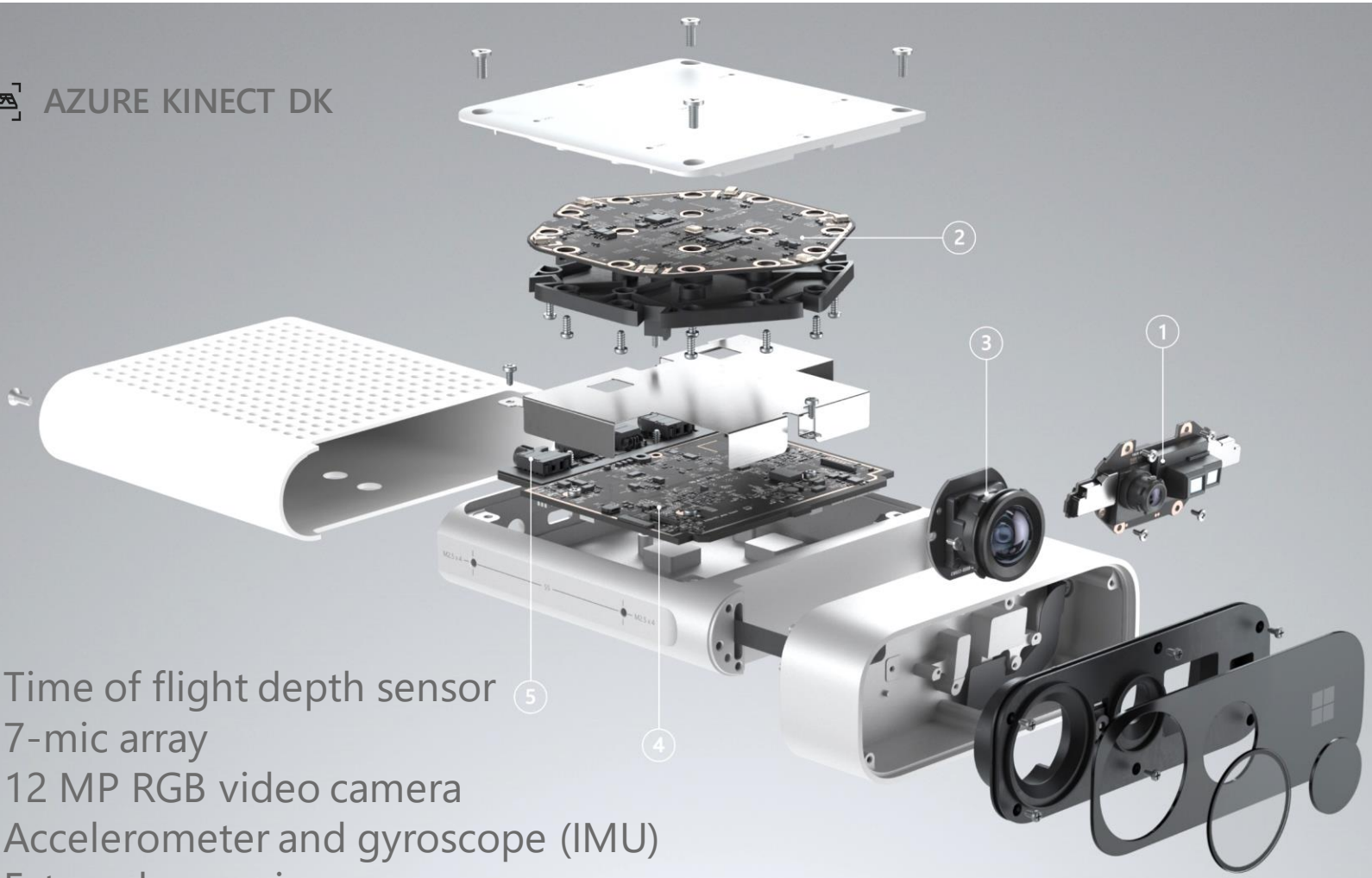
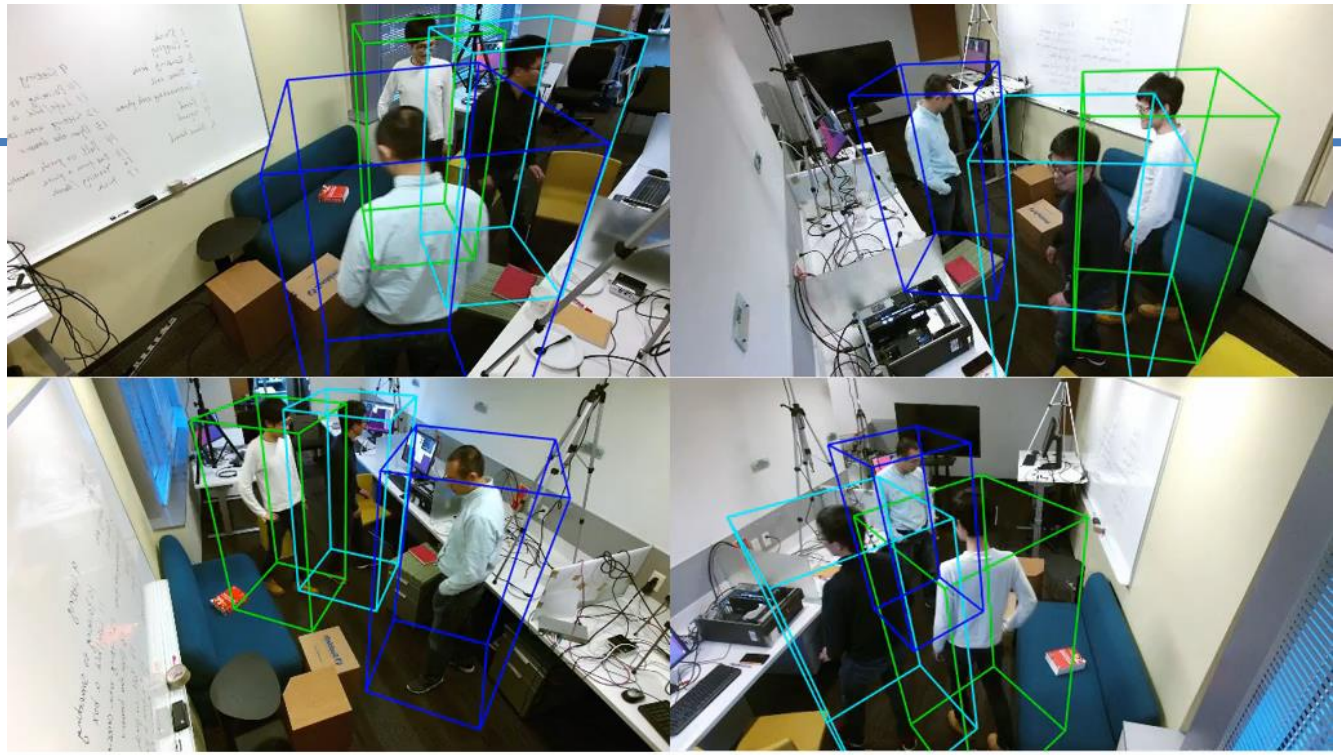
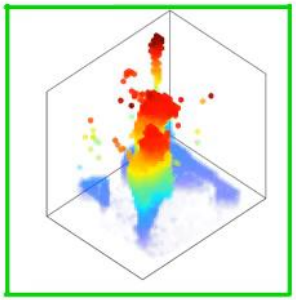
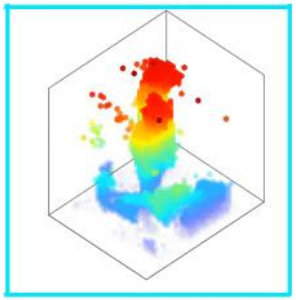
AZURE KINECT DK



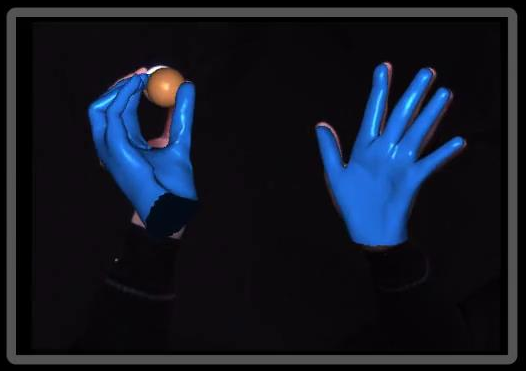
(1) Time of flight depth sensor
(2) 7-mic array
(3) 12 MP RGB video camera
(4) Accelerometer and gyroscope (IMU)
(5) External sync pins





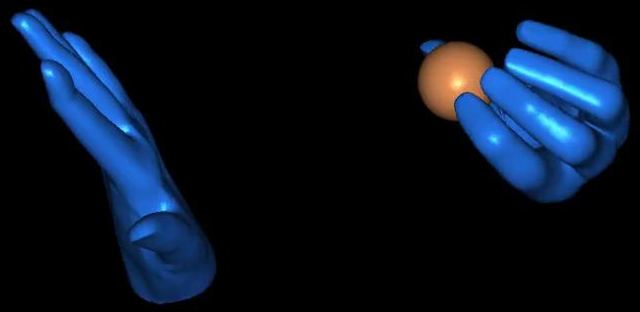


Holding and Passing a Ball



Cam #3
(Result overlaid
on Input Video)

Cam #5
(Input video)



Cam #5
(Result)

Facial animation capture

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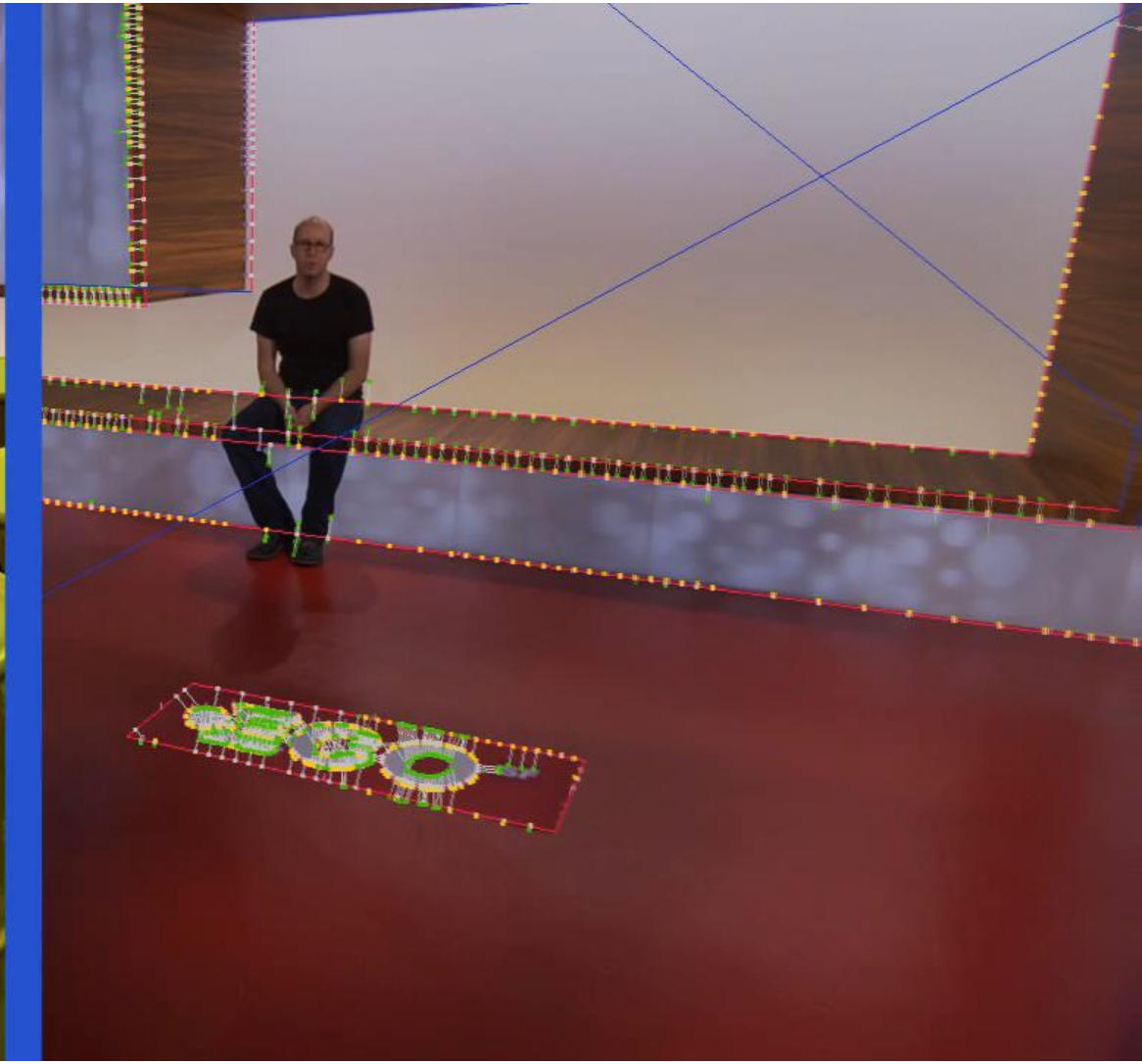
Match Moving: Joining CG + Real



… and much more

see you Thursday!