Advanced Geometry Capture

NBAY 6120
March 14, 2016
Donald P. Greenberg
Lecture 5

Required Reading Lectures 4 & 5

- Bilger, Burkhard. "Has the Self-Driving Car Arrived at Last?" *The New Yorker*. N.p., 25 Nov. 2013. Web. 10 Sept. 2015.
  - http://www.newyorker.com/magazine/2013/11/25/auto-correct

Raffi Khatchadourian. "We Know How You Feel, The New Yorker, January 19, 2015. The New Yorker

Recommended Reading Lectures 4 &5

N. Snavely, S.M. Seitz, and R. Szeliski, "Photo Tourism: Exploring Photo Collections in 3D," *ACM Trans. Graphics, July 2006, pp. 835-846.*

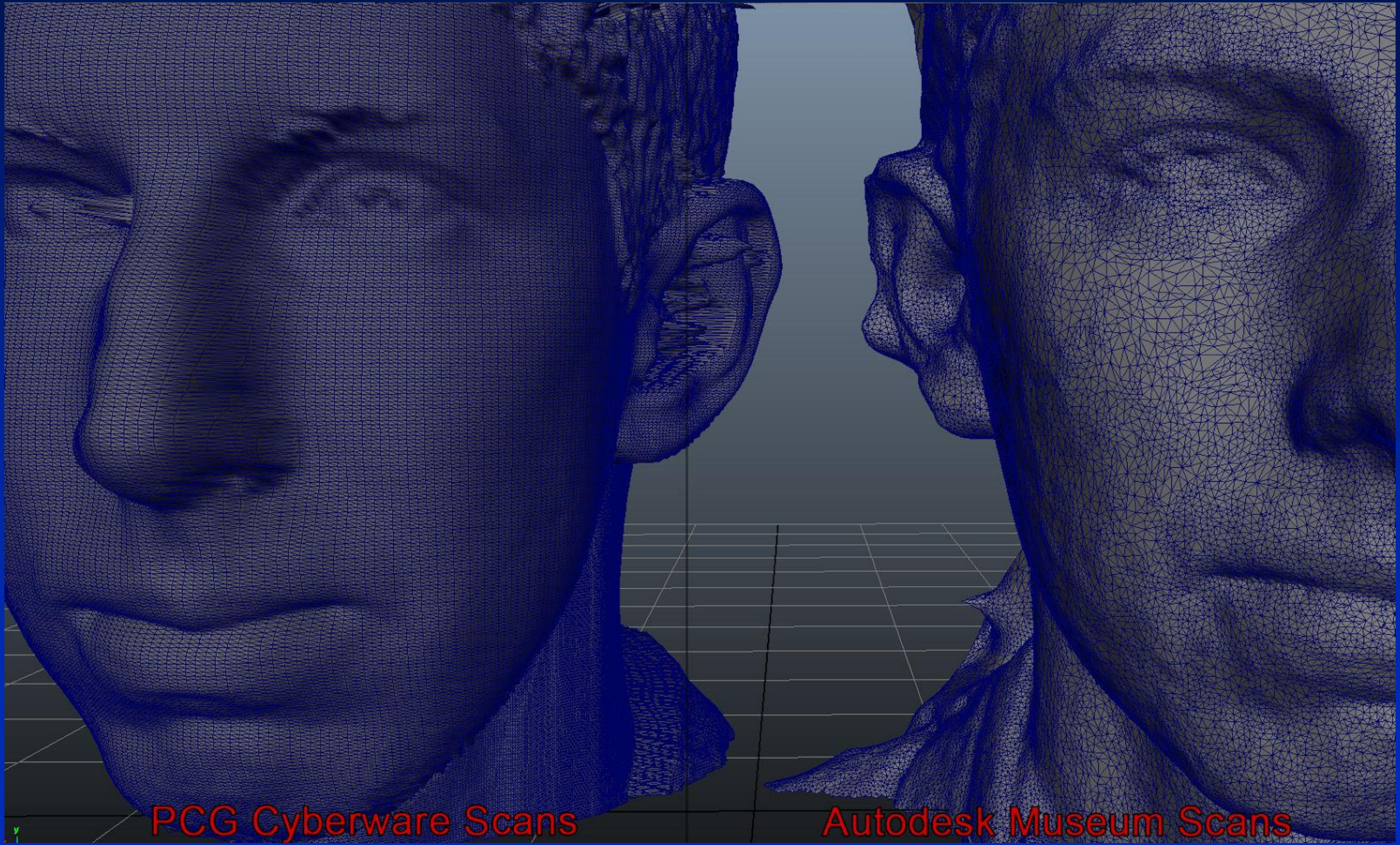
http://phototour.cs.washington.edu/Photo_Tourism.pdf

Digital Geometry Capture

- Photographic methods
- Laser scanning
- Pattern projection methods
- Time of Flight

Cyberware Scanner

Cyberware vs. 1 2 3 Catch



Digital Geometry Capture

- Photographic methods
- Laser scanning
- Pattern projection methods
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Microsoft's Kinect

Microsoft's Kinect

Making Things See, Greg Borenstein

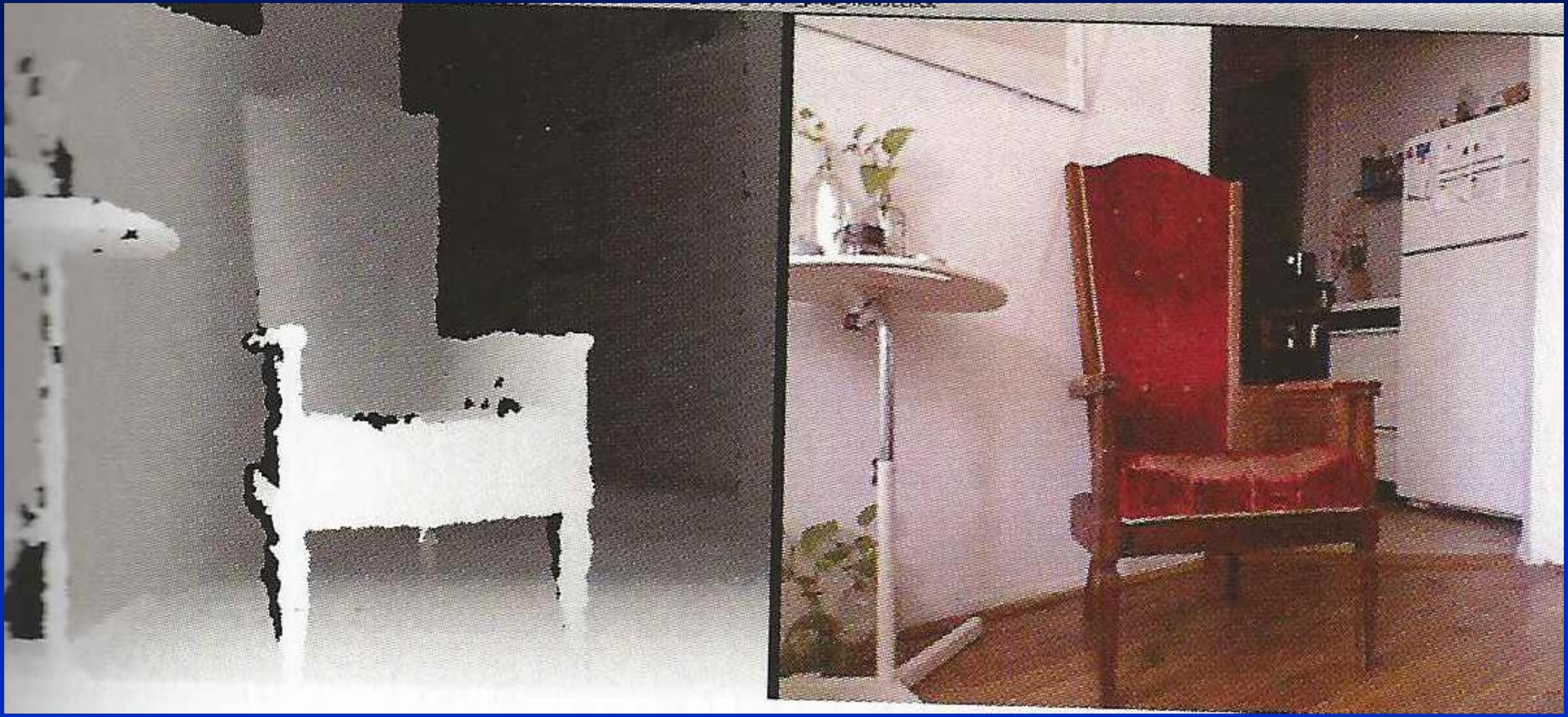
The Kinect uses a pattern projection and machine learning

- Inferring body position is a two-stage process: First Compute a depth map (using projected pattern), then infer body position (using machine learning)

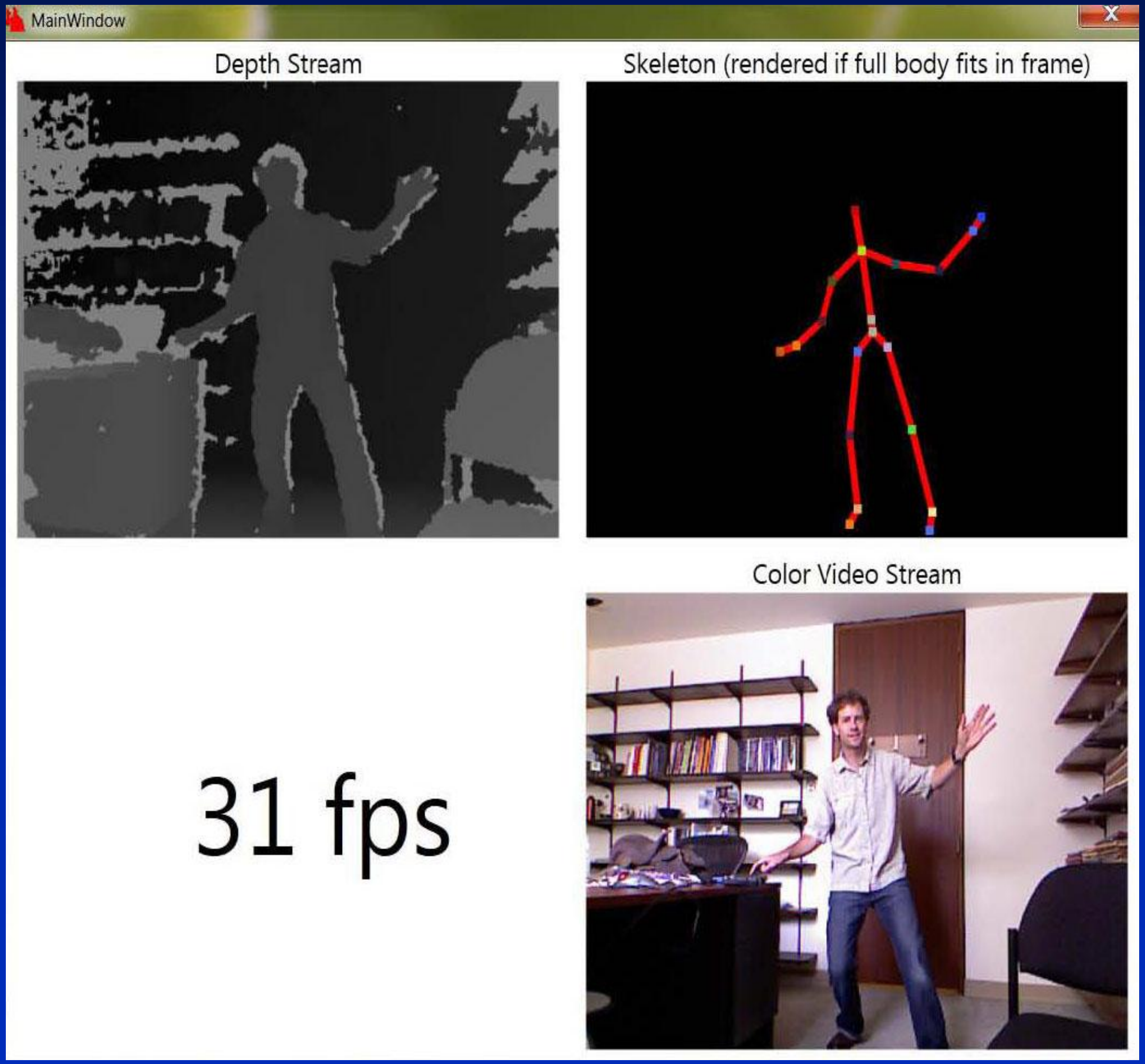
Kinect speckle pattern

- Near region (0.8 – 1.2m)
  Small dots
- Middle region (1.2 – 2.0m)
- Far region (2.0 – 3.5 m)
  Large dots

Kinect: Depth Image and Real Image

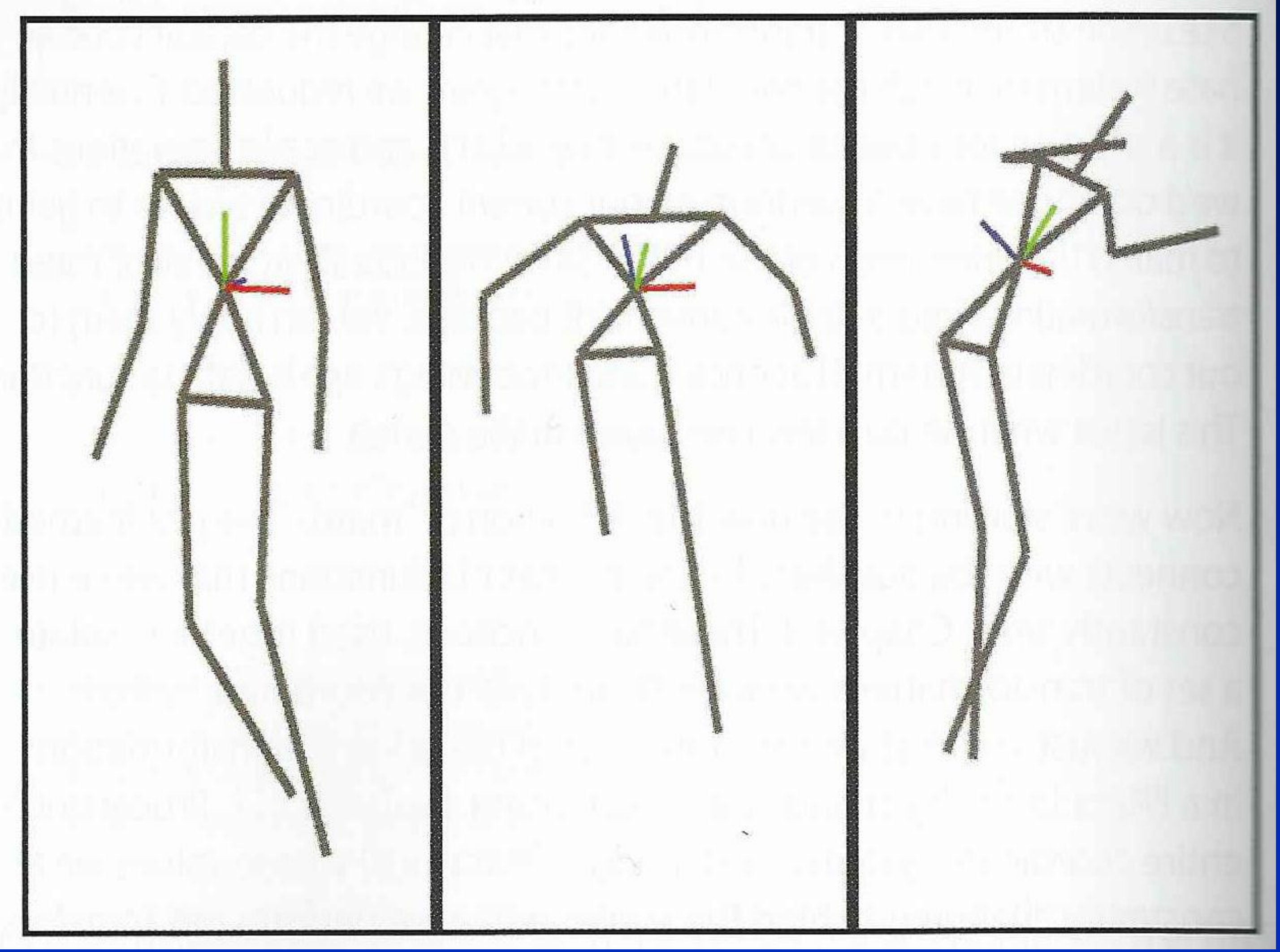


Step 1: Compute a Depth Map

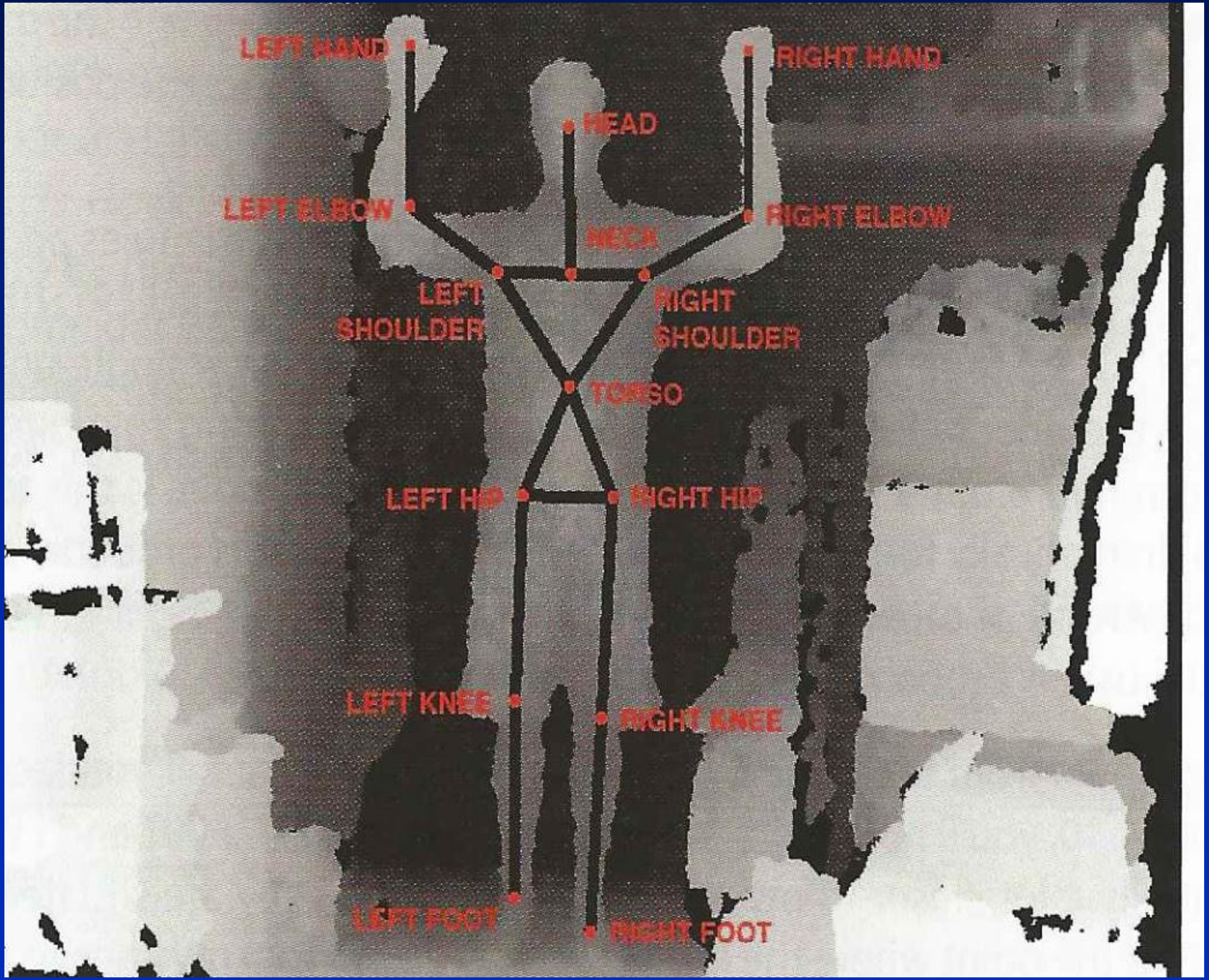


Step 2: Infer a Body Position

Skeleton Manipulation



Extracted Skeleton   Kinect



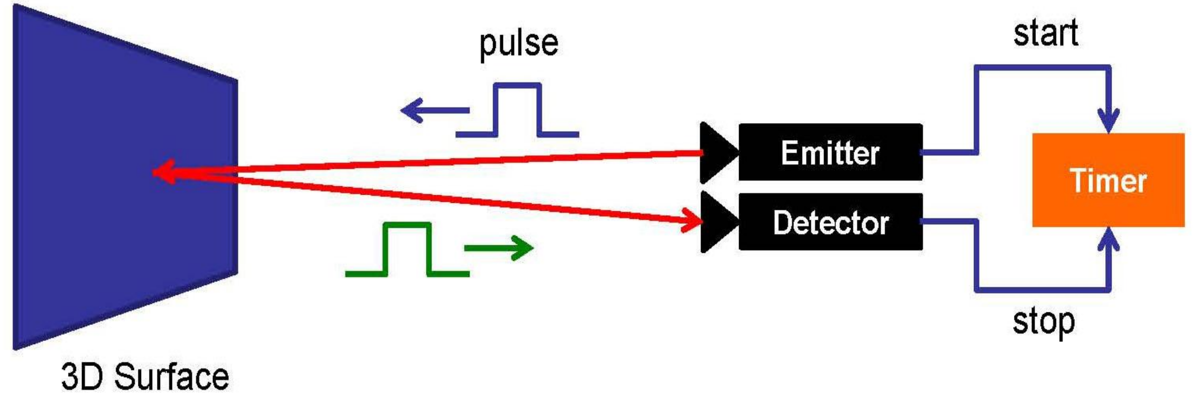
Tracking

Digital Geometry Capture

- Photographic methods
- Laser scanning
- Pattern projection methods
- Time of Flight

Pulsed Modulation

- Measure distance to a 3D object by measuring the absolute time a light pulse needs to travel from a source into the 3D scene and back, after reflection
- Speed of light is constant and known, $c = 3 \cdot 10^8 m/s$



Kinect 2

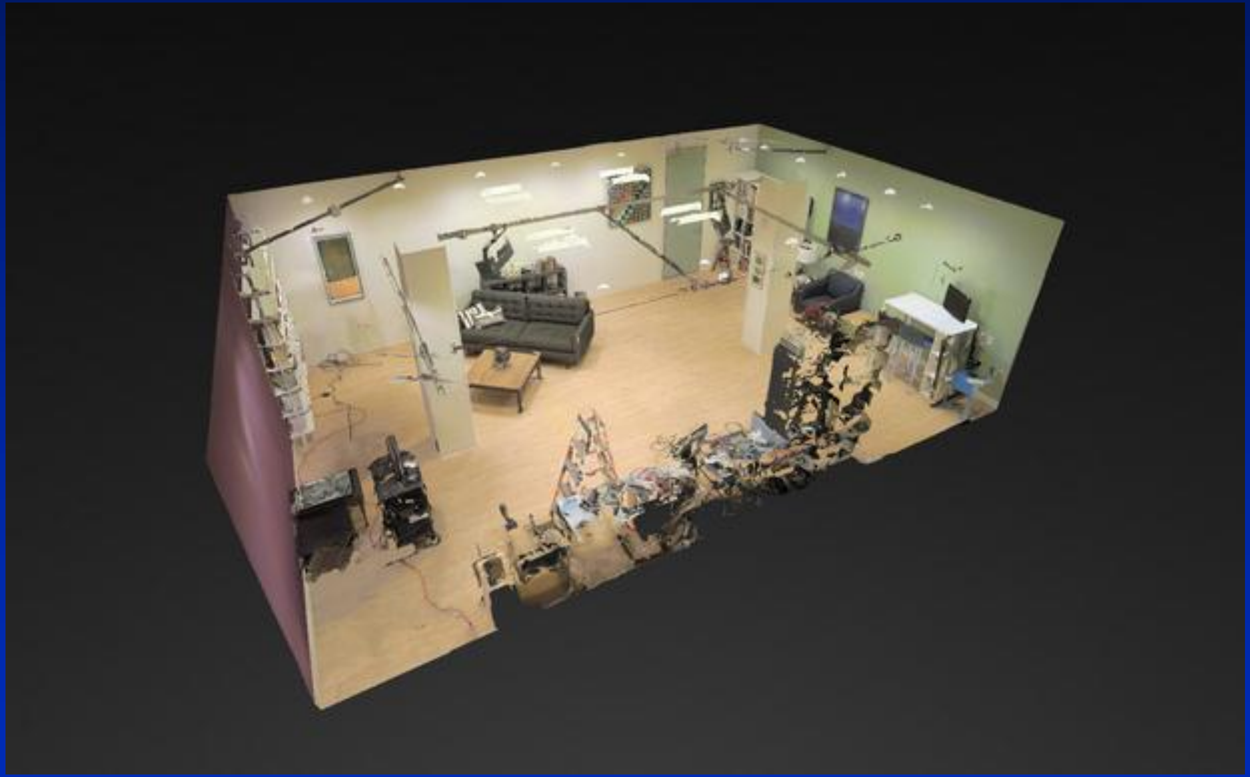
Kinect 2


Kinect For Windows 1
Processed Image From Kinect
Kinect For Windows 2
Image via http://blogs.msdn.com

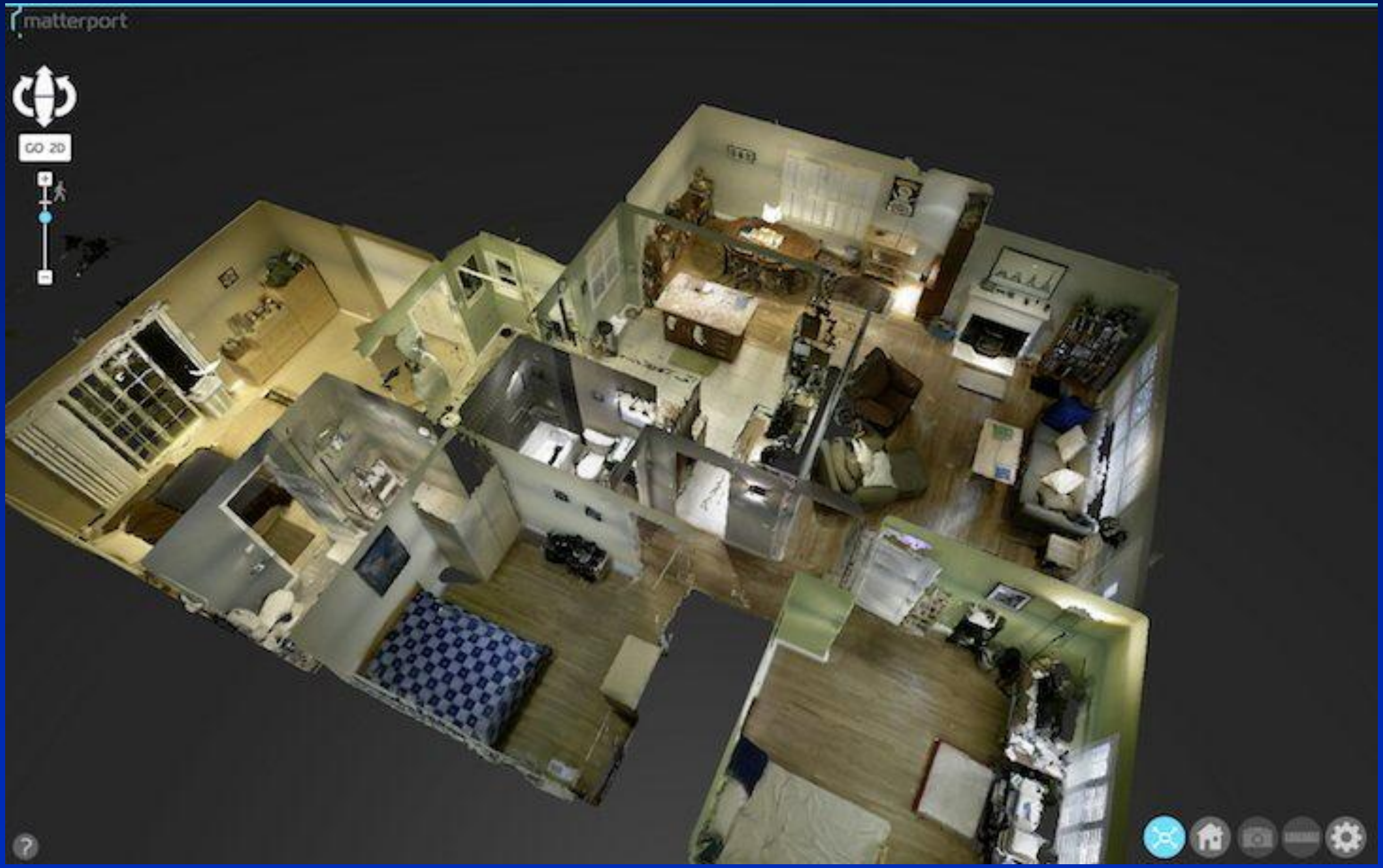
Floored

- http://labs.floored.com/clients/mrp-realty/900-g-roof/

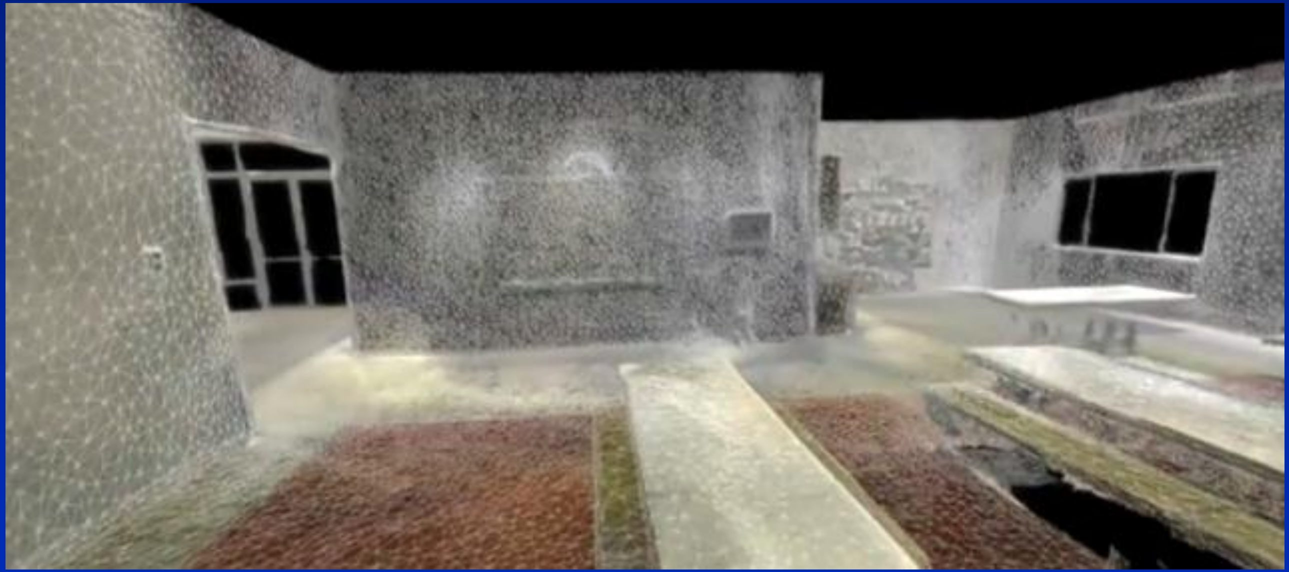
Matterport



Matterport



Matterport



Digital Geometry Capture

- Photographic methods
- Time of Flight
- Radar
- Sonar
- All of the Above

Google Street View and Google Maps 2007-2012

- In 2007, Larry Page requests Thrun and Levandowski to create a virtual map of the U.S.
- Engineers jury-rigged some vans with GPS and rooftop cameras which shot 360° panoramas for any address. They equipped 100 cars which were sent around the U.S.
- Data was put together with a program written by Marc Levoy.
- In 2011, Google announced it would start charging (large) commercial sites
- In 2012, Google allows users to post photos and reviews of locations

By October 2012, Google will have updated 250,000 miles of U.S. roads

Note: They have also added Google Moon and Google Mars

R7 Street View Camera System - 2009

The system is a rosette ® of 15 small, outward-looking cameras using 5-megapixel CMOS image sensors and custom, low-flare, controlled-distortion lenses.

Drafomir Anguelov, Carole Dulong, Daniel Filip, Christian Frueh, Stepheane Lafon, Richard Lyon, Abhijit Ogale, Luc Vincent, Josh Weaver. “Google Street View: Capturing The World At Street Level,” IEEE Computer, June 2010.

Street View Vehicular Platforms

Second-(right) and Third- (left)

Drafomir Anguelov, Carole Dulong, Daniel Filip, Christian Frueh, Stepheane Lafon, Richard Lyon, Abhijit Ogale, Luc Vincent, Josh Weaver. “Google Street View: Capturing The World At Street Level,” IEEE Computer, June 2010.

Google Street View Car Fleet

Google Street View Acquisition Map 2012

Google Street View

- The world contains roughly 50 million miles of roads, paved and unpaved, across 219 countries (ref.)
- This is equivalent to circumnavigating the globe 1250 times.
- To date, hundreds of cities in many countries across four continents have been captured.
- Google has developed several vehicular platforms and texture information in the project’s seven year history.

Drafomir Anguelov, Carole Dulong, Daniel Filip, Christian Frueh, Stepheane Lafon, Richard Lyon, Abhijit Ogale, Luc Vincent, Josh Weaver. “Google Street View: Capturing The World At Street Level,” IEEE Computer, June 2010.

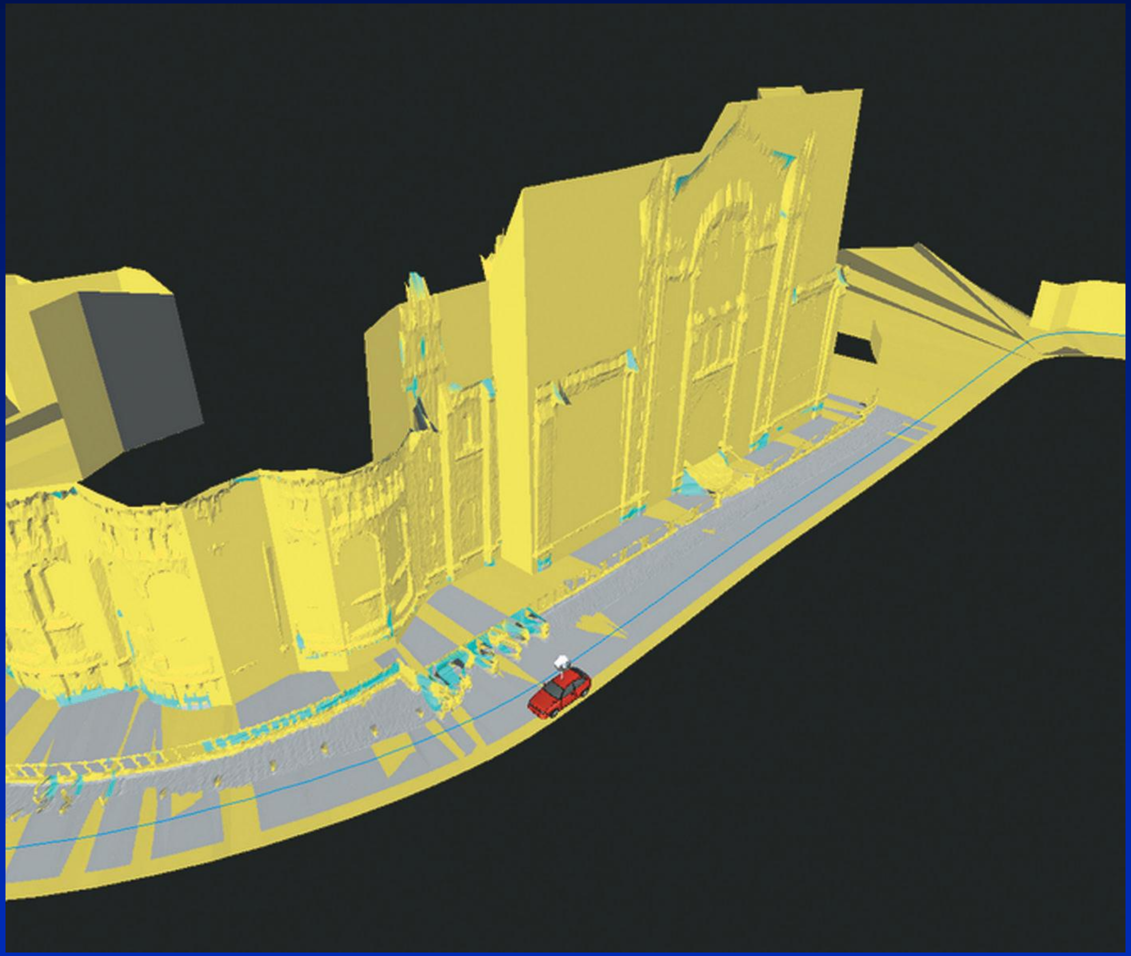
Street View Vehicular Platforms

Trike

Modified Snowmobile

Drafomir Anguelov, Carole Dulong, Daniel Filip, Christian Frueh, Stepheane Lafon, Richard Lyon, Abhijit Ogale, Luc Vincent, Josh Weaver. “Google Street View: Capturing The World At Street Level,” IEEE Computer, June 2010.

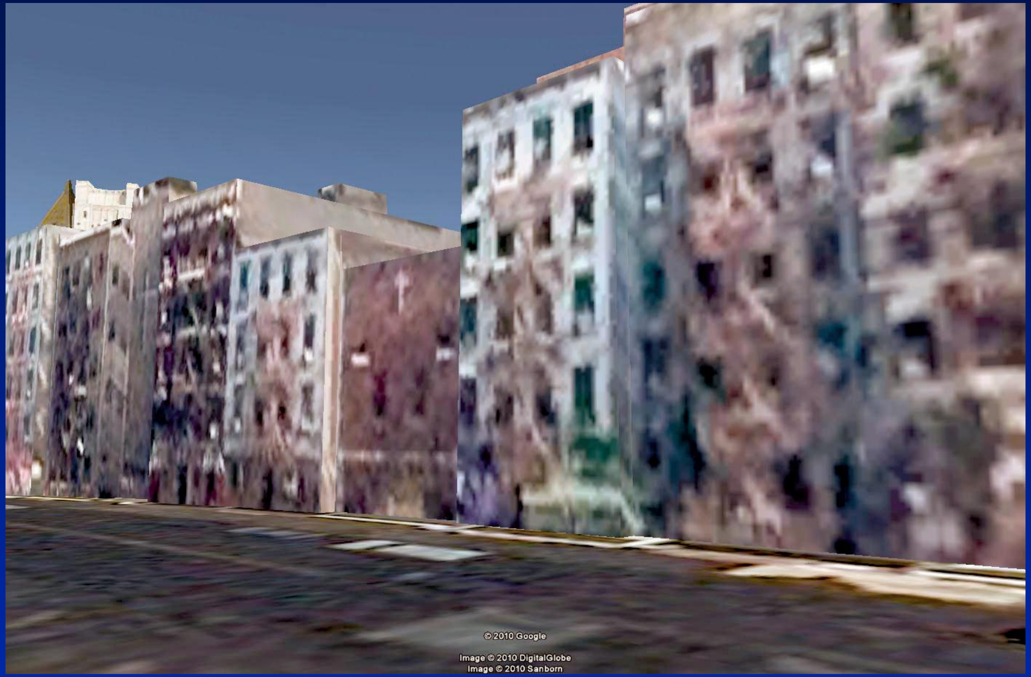
Imagery from new Street View Vehicle is accompanied by laser range data



- which is aggregated and simplified by robustly fitting it in a coarse mesh that models the dominant scene surfaces.

Drafomir Anguelov, Carole Dulong, Daniel Filip, Christian Frueh, Stepheane Lafon, Richard Lyon, Abhijit Ogale, Luc Vincent, Josh Weaver. “Google Street View: Capturing The World At Street Level,” IEEE Computer, June 2010.

Using Street View data to enhance user walk-through experiences in Google Earth.



Original 3D models of a New York City scene from airborne data only.

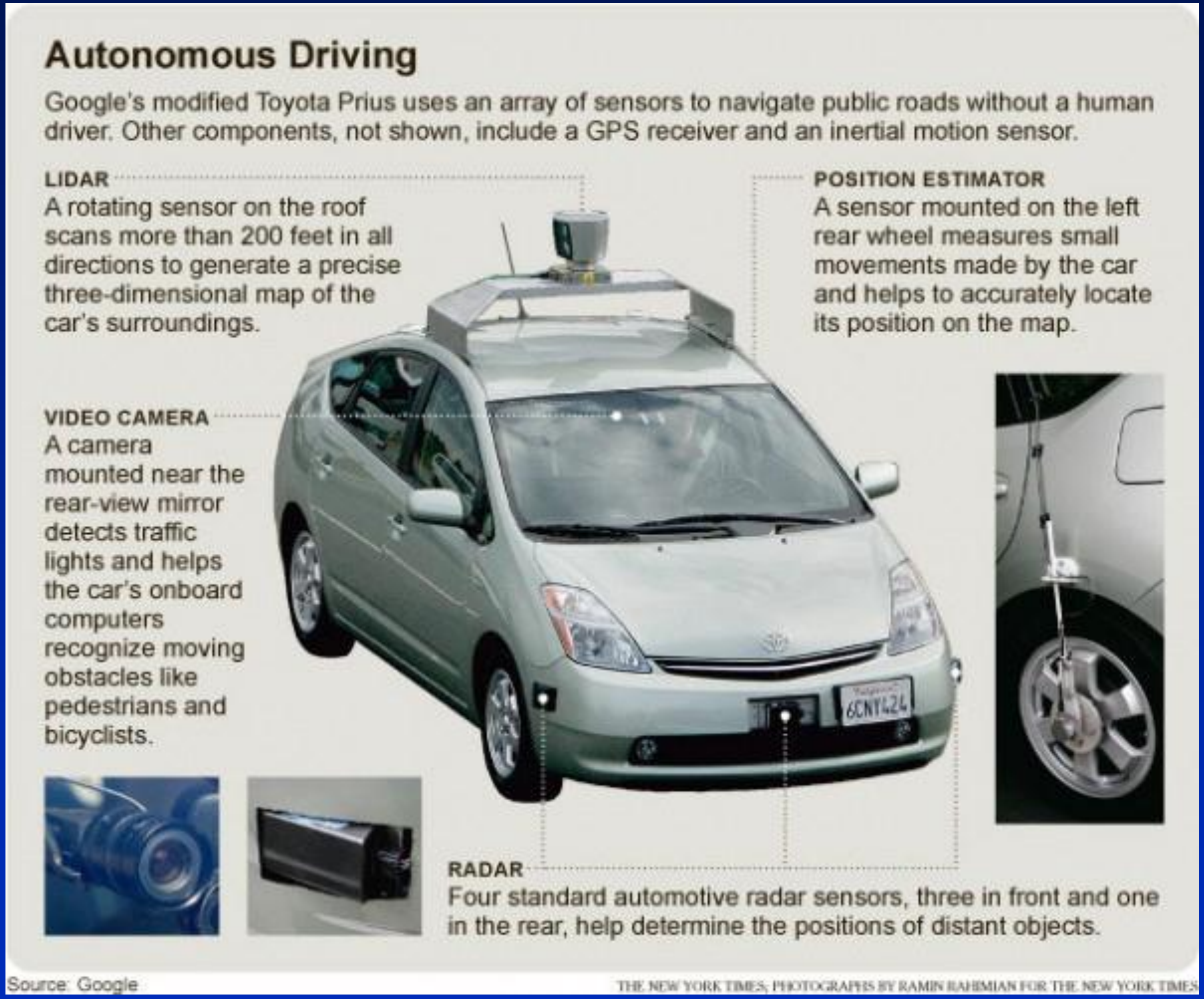
Fused 3D model with high-resolution facades. The visual quality is considerably higher, and many storefronts and signs can now be easily identified and recognized.

Drafomir Anguelov, Carole Dulong, Daniel Filip, Christian Frueh, Stepheane Lafon, Richard Lyon, Abhijit Ogale, Luc Vincent, Josh Weaver. “Google Street View: Capturing The World At Street Level,” IEEE Computer, June 2010.

Google's Autonomous Driving Vehicle 2013

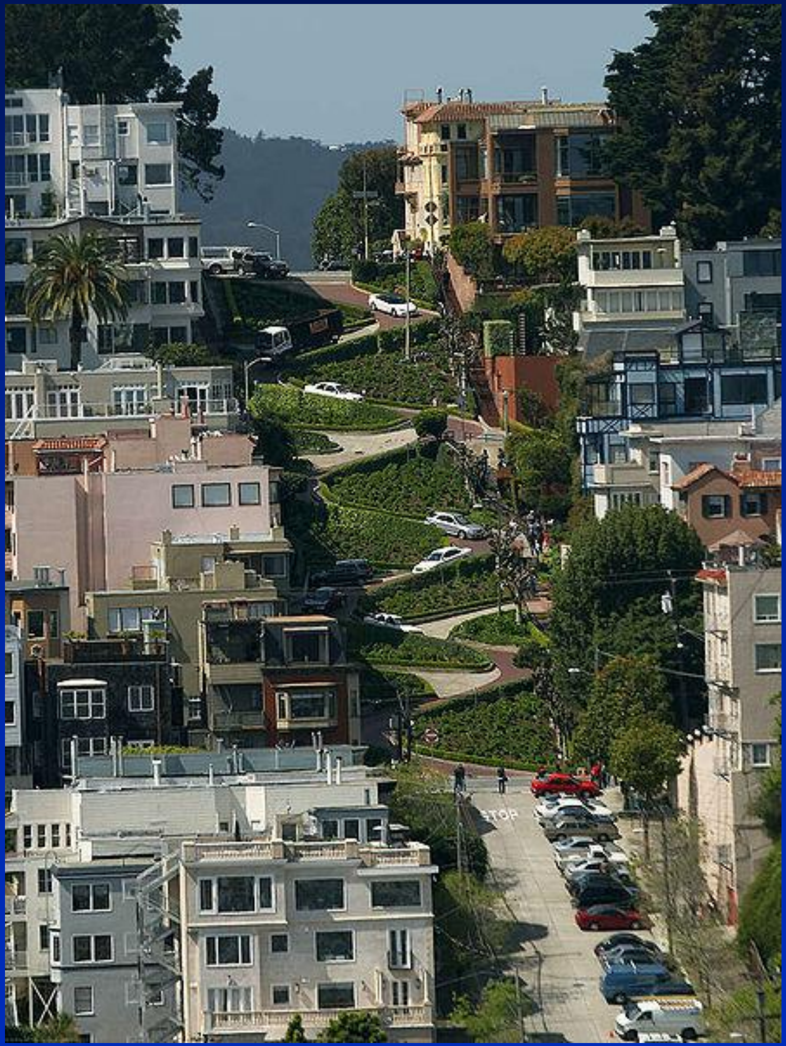
- Uses multiple sensors, each with a different view of the world
- Laser
  - 64 beams @ 10 revolutions/second scanning 1.3 million points in concentric waves starting 8 feet from the car
  - It can spot a 14" object at a distance of 160 feet
- Radar
  - Has twice the range of the Laser, but much less precision
- Photography
  - Excellent at identifying road signs, turn signals, colors and lights

Google's Autonomous Driving Vehicle



http://erictric.com/2010/10/09/google-secretly-develops-tests-automated-cars/

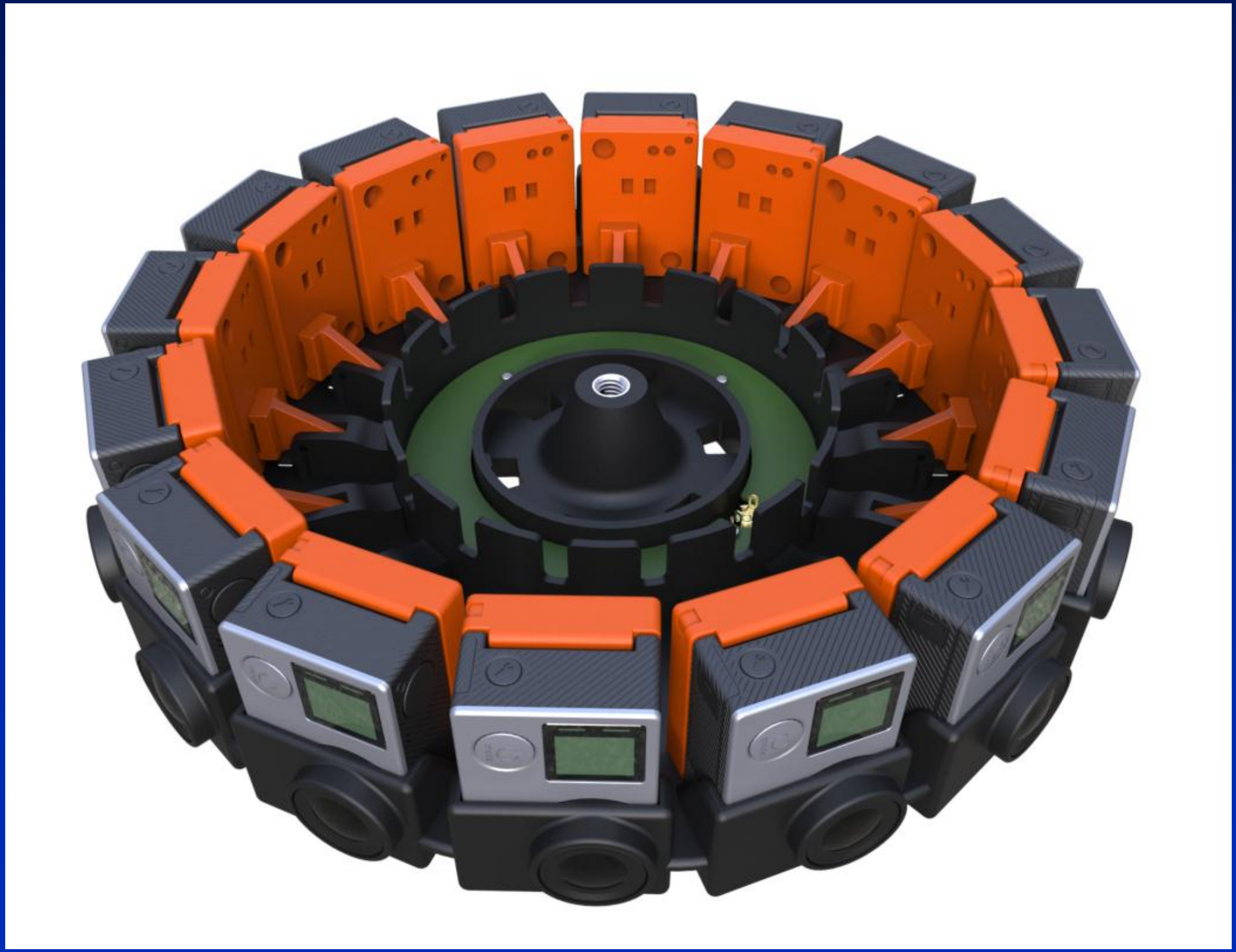
Lombard Street, San Francisco



Google’s Autonomous Driving Vehicle 2014-2015

- New laser sensors
  - 2 X range
  - 30 X resolution
  - @ 300’ can spot a metal plate <2” thick
  - Size of a coffee mug
  - Cost ≈ $10,000 (less than current model @ $80,000)

Google's Recording Rig 2015

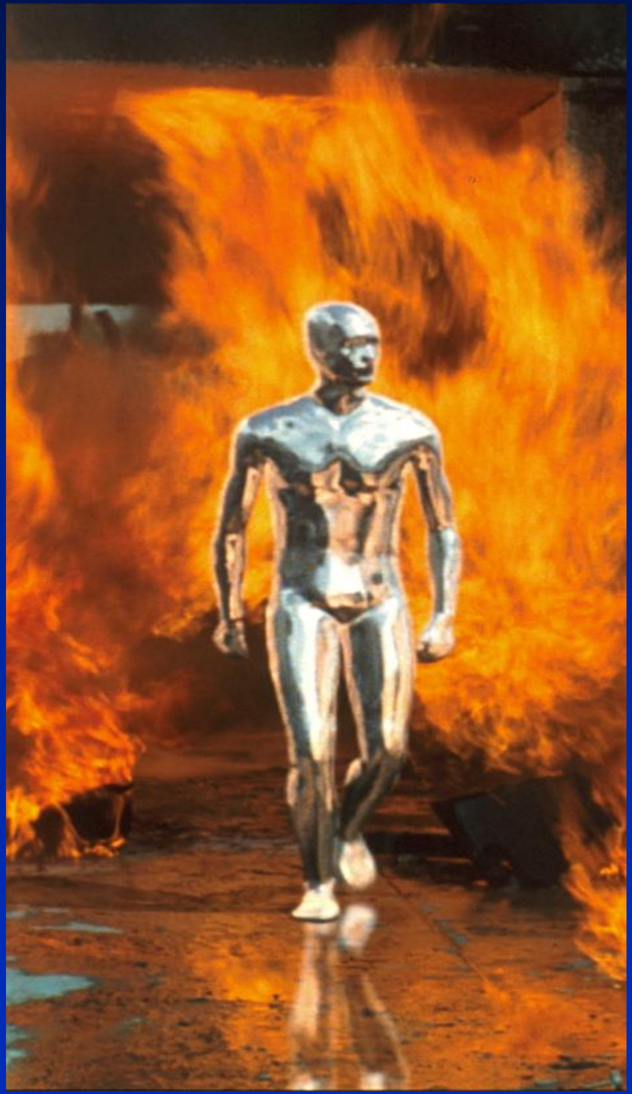


Capturing Motion

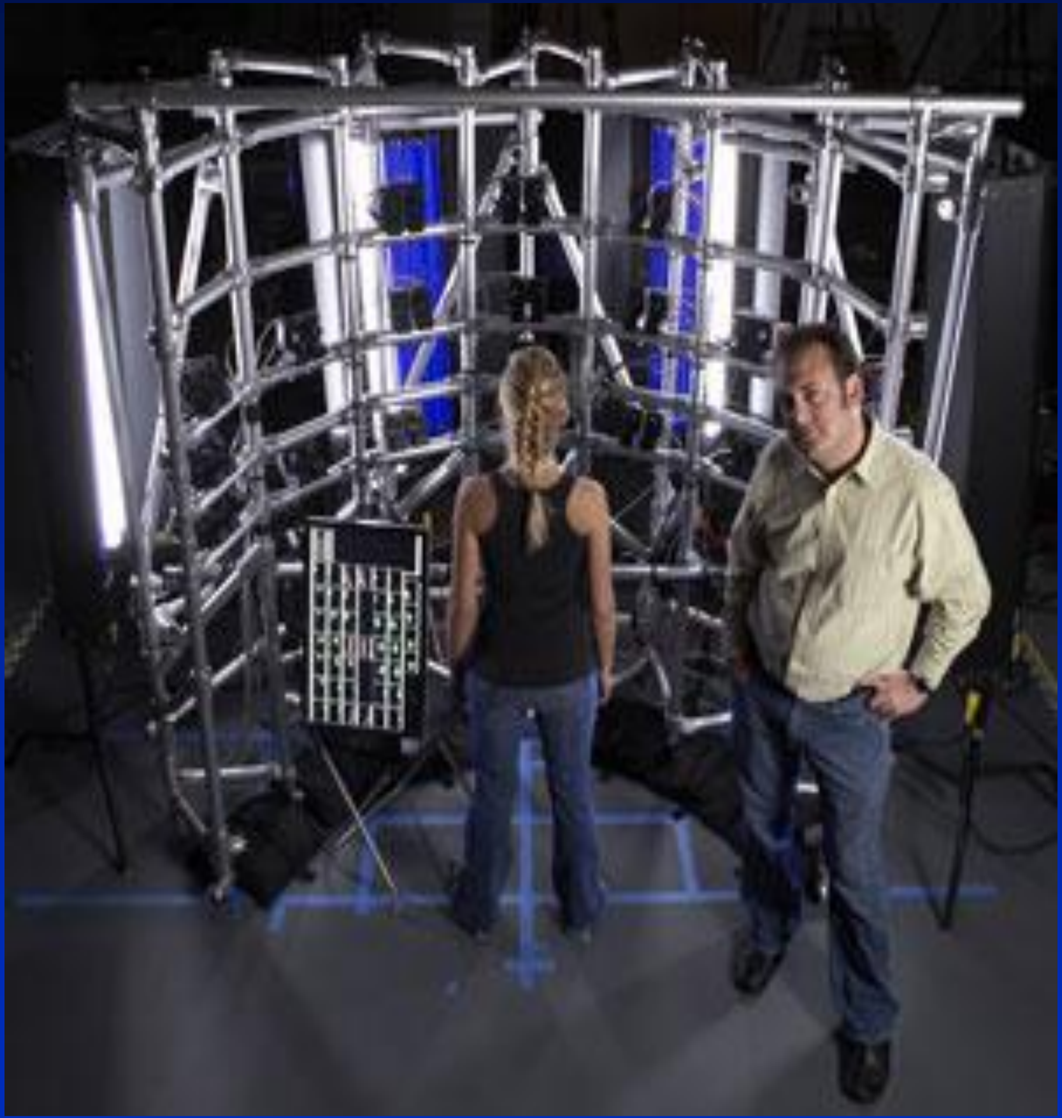
- Gunnar Johansson, event, and biological motion

Motion Capture Markers

Motion Capture



Markerless Motion Capture



http://macanimationpro.digitalmedianet.com/articles/viewarticle.jsp?id=54623

The Curious Case of Benjamin Button 2008

Cinefex 116, January 2009

The Curious Case of Benjamin Button 2008

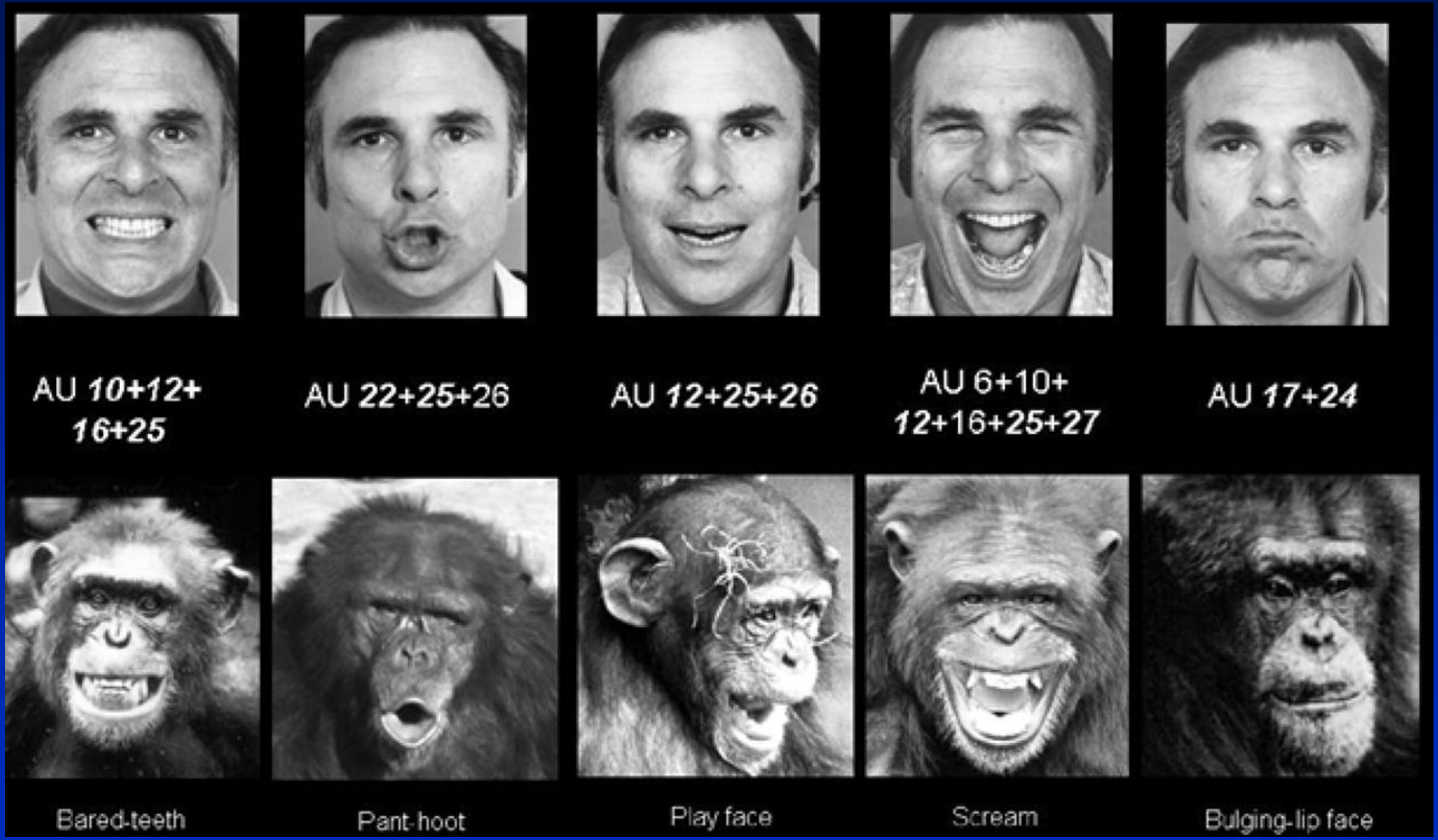
Cinefex 116, January 2009

Affective Computing

Facial Recognition

Science Magazine, 30.Jan.2015 – The End of Privacy

Eckman


AU 10+12+ 16+25
AU 22+25+26
AU 12+25+26
AU 6+10+ 12+16+25+27
AU 17+24
Bared-teeth
Pant-hoot
Play face
Scream
Bulging-lip face

Eckman


anger
1 eyebrows down and together
2 eyes glare
3 narrowing of the lips
disgust
1 nose wrinkling
2 upper lip raised
fear
1 eyebrows raised and pulled together
2 raised upper eyelids
3 tensed lower eyelids
4 lips slightly stretched horizontally back to ears
happiness
A real smile always includes:
1 crow's feet wrinkles
2 pushed up cheeks
3 movement from muscle that orbits the eye
sadness
1 drooping upper eyelids
2 losing focus in eyes
3 slight pulling down of lip corners
surprise
Lasts for only one second:
1 eyebrows raised
2 eyes widened
3 mouth open
contempt
1 lip corner tightened and raised on only one side of face

Inside Out

DISGUST
INSIDE OUT
FEAR
INSIDE OUT
JOY
INSIDE OUT
SADNESS
INSIDE OUT
ANGER
INSIDE OUT

Inside Out

Project Beyond Samsung 2015

Project Beyond Samsung 2015

The Game of Drones

Science Magazine, 30.Jan.2015 – The End of Privacy

End