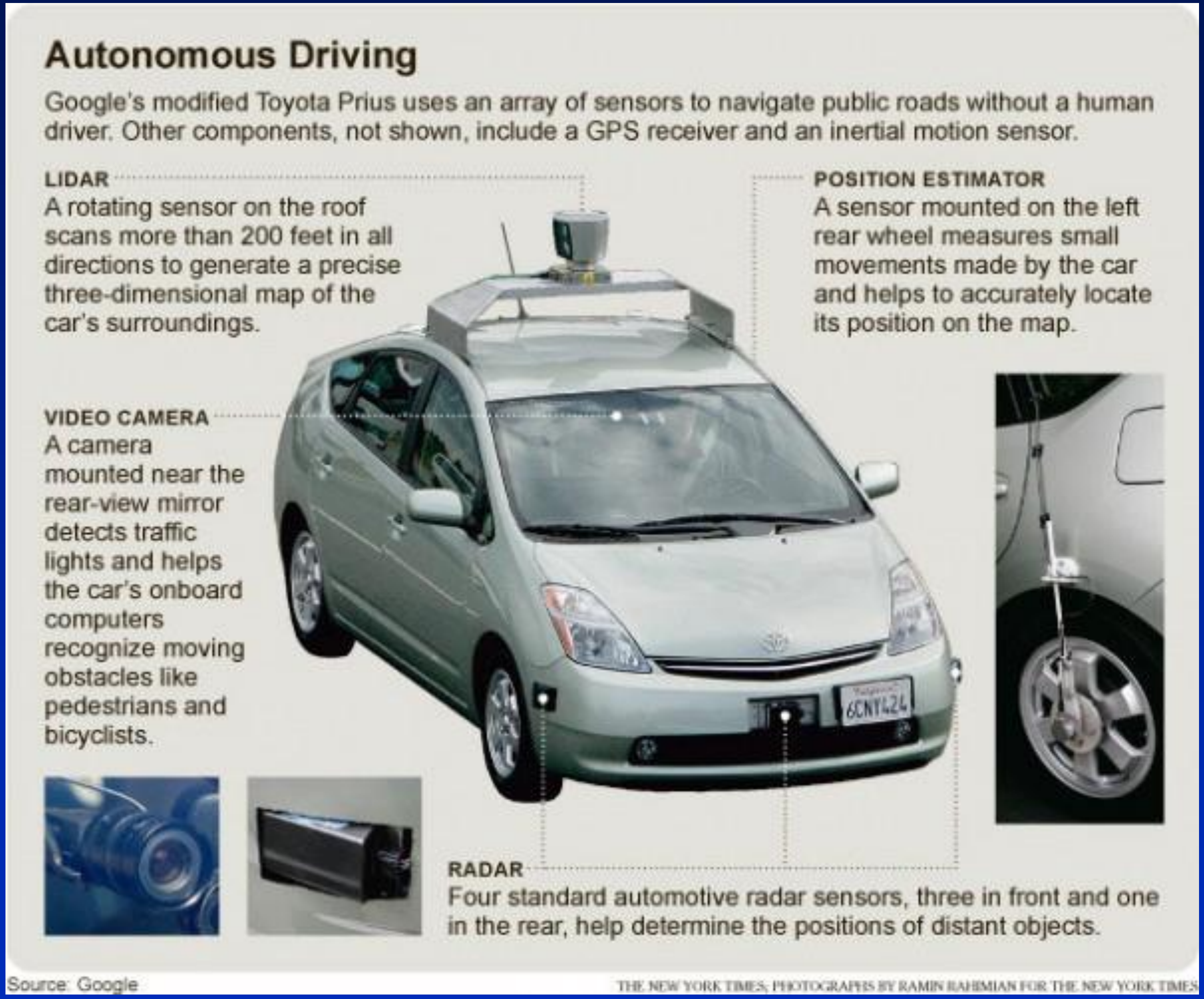
Advanced Digital Photography Geometry and Motion Capture

Lecture #11
September 29, 2015
Donald P. Greenberg

Google Street View Car Fleet

Google's Autonomous Driving Vehicle 2010



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

Google Street View

Google maps

- 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.

Google Street View 2012

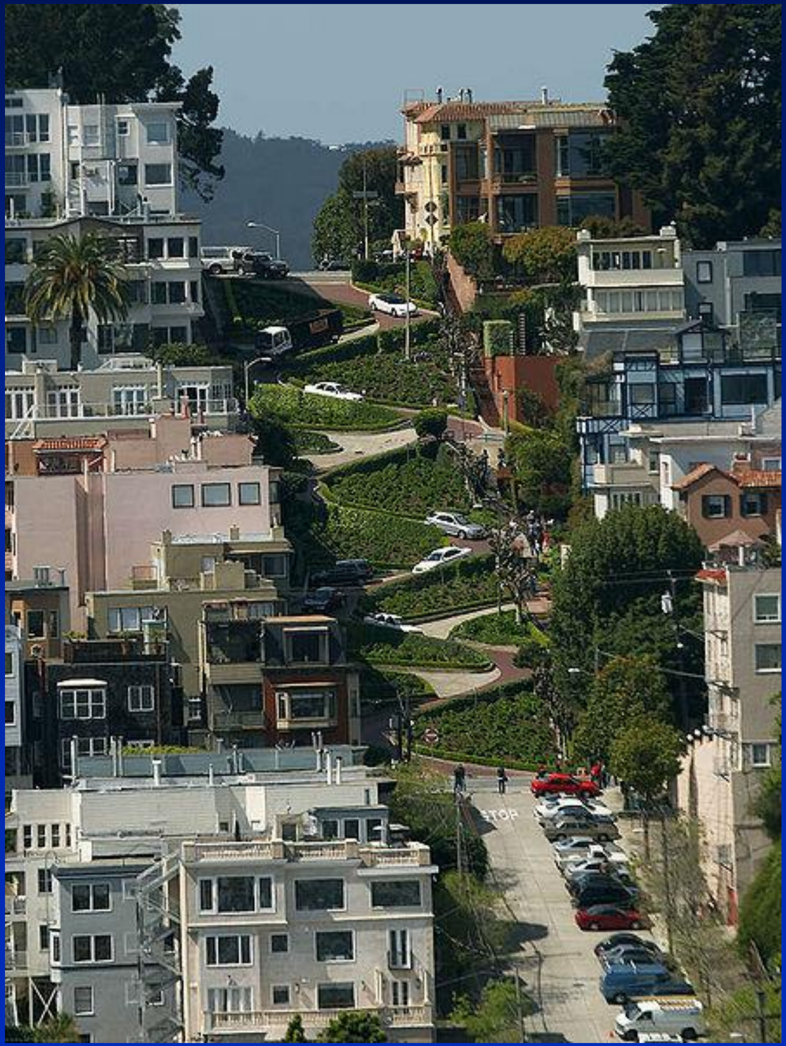
- 2011 Google announced it would start charging (large) commercial sites
- 2012 Google allows users to post photos and reviews of locations

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

Note: They have also added Google Moon and Google Mars

Google Street View Acquisition Map 2012

Lombard Street, San Francisco

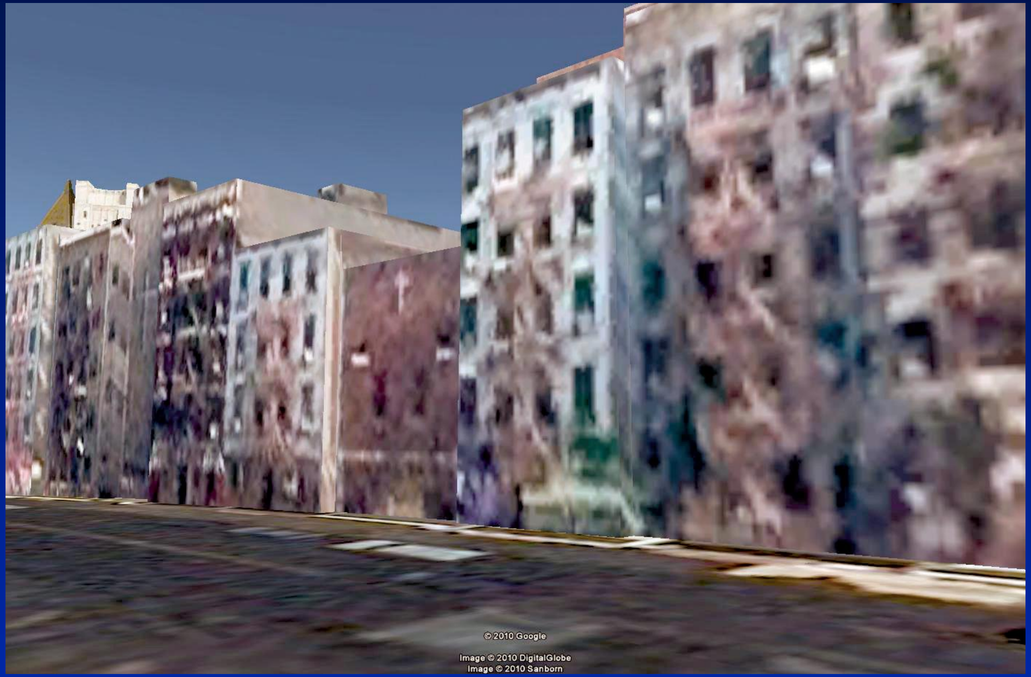


Street View Vehicular Platforms

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.

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.

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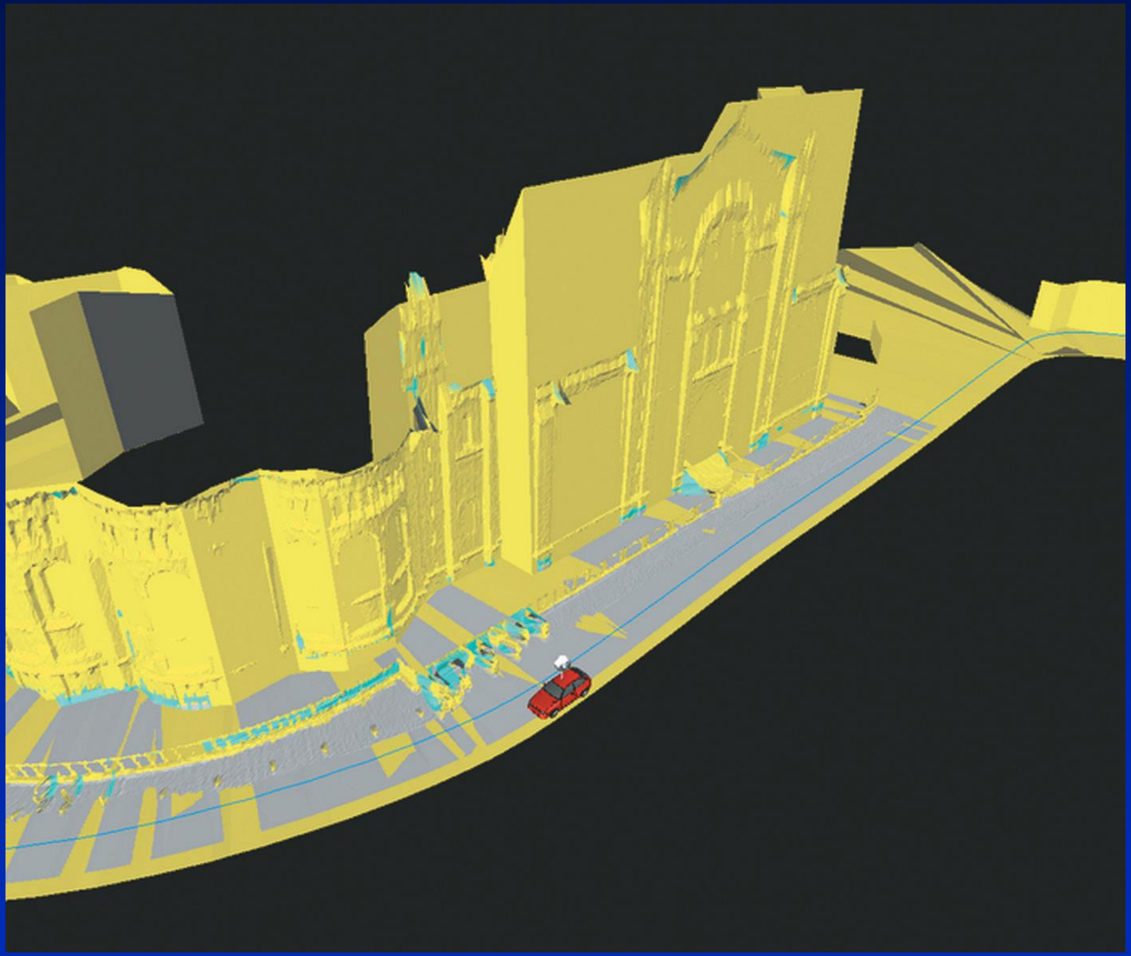
Imagery from new Street View Vehicle is accompanied by laser range data



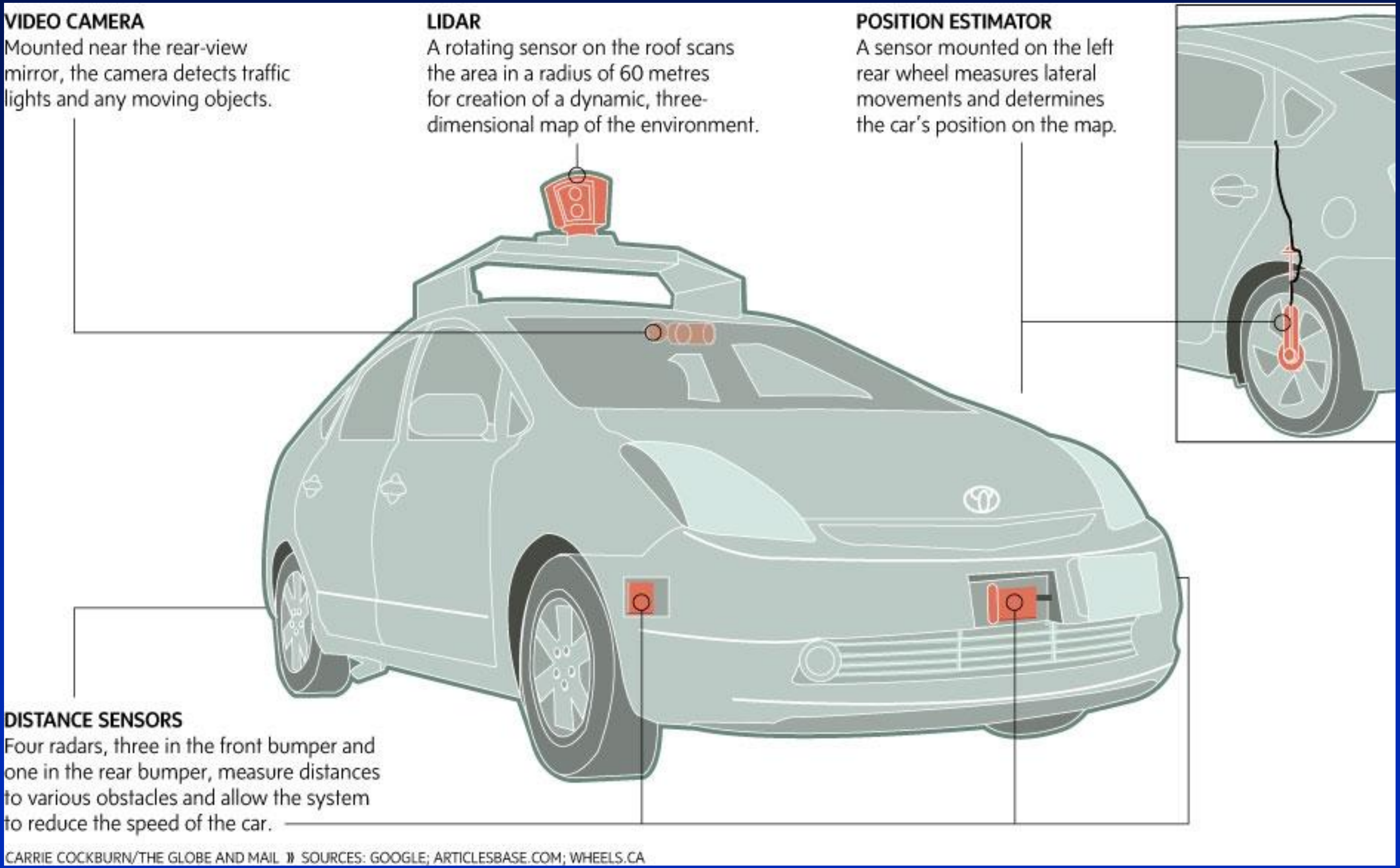
- which is aggregated and simplified by robustly fitting it in a coarse mesh that models the dominant scene surfaces.

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.

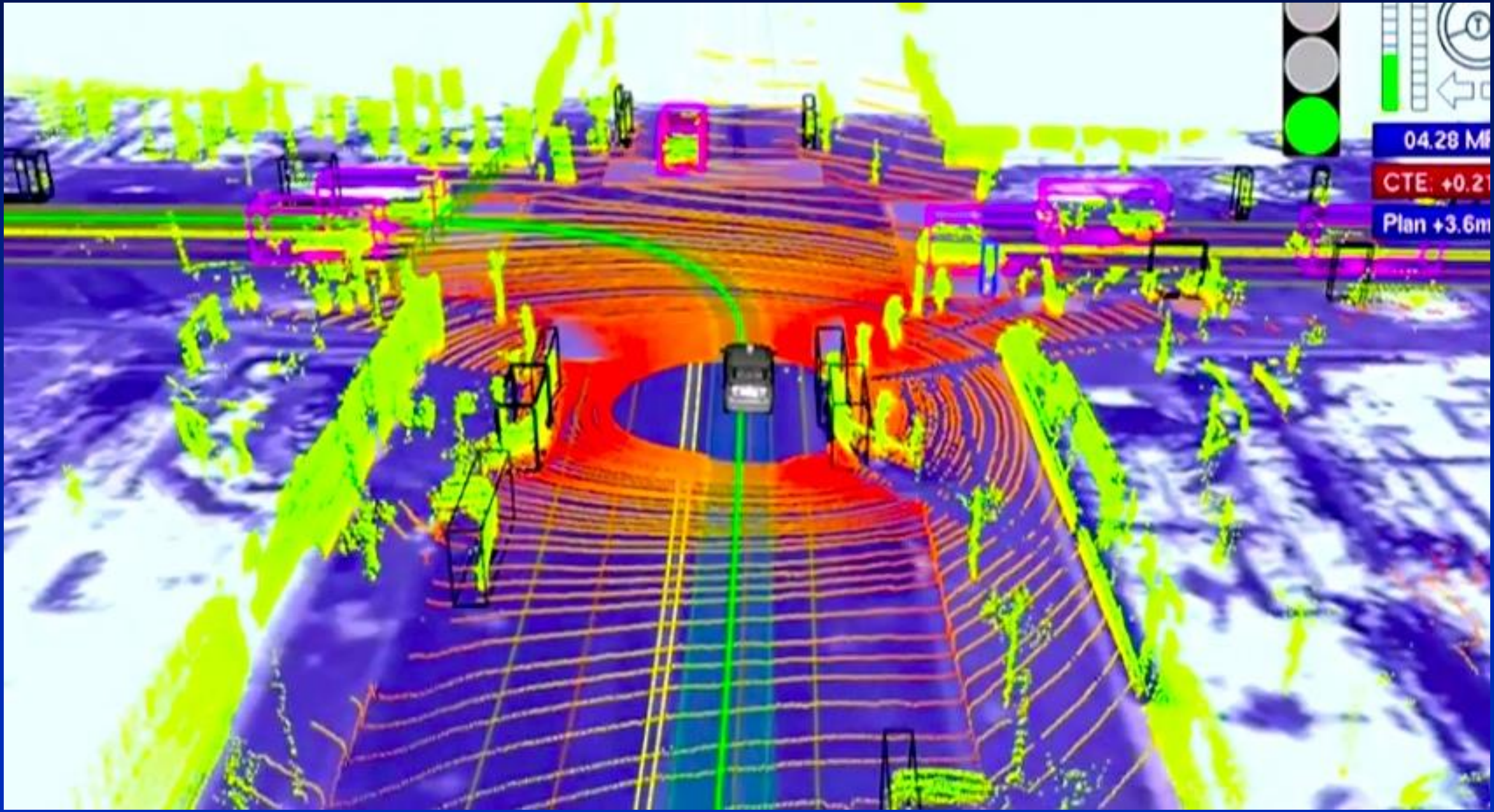
Digital Geometry Capture

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

Sensors on Google's ADV



Sensors on Google's ADV



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 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)

Autonomous Driving Vehicles Pre-2000

- “There was no way, before 2000, to make something interesting”
- “The sensors weren’t there
- The computers weren’t there
- The mapping wasn’t there”
- “Radar was a device on a hilltop that cost $200M”

Sebastian Thrun

Founder of the Google Car Project

Will We Have Autonomous Driving Vehicles?

- Every decade another bit of automation is introduced:
  - 1950s — Power steering
  - 1970s — Cruise control
  - 1980s — Anti-lock brakes
  - 1990s — Electronic stability control
  - 2000s — The first self-parking cars

- Now — Detection of lane lines

  Distance from car ahead

  Night vision

  Blind spot detection

  Stereo cameras to identify pedestrians

The Game of Drones

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

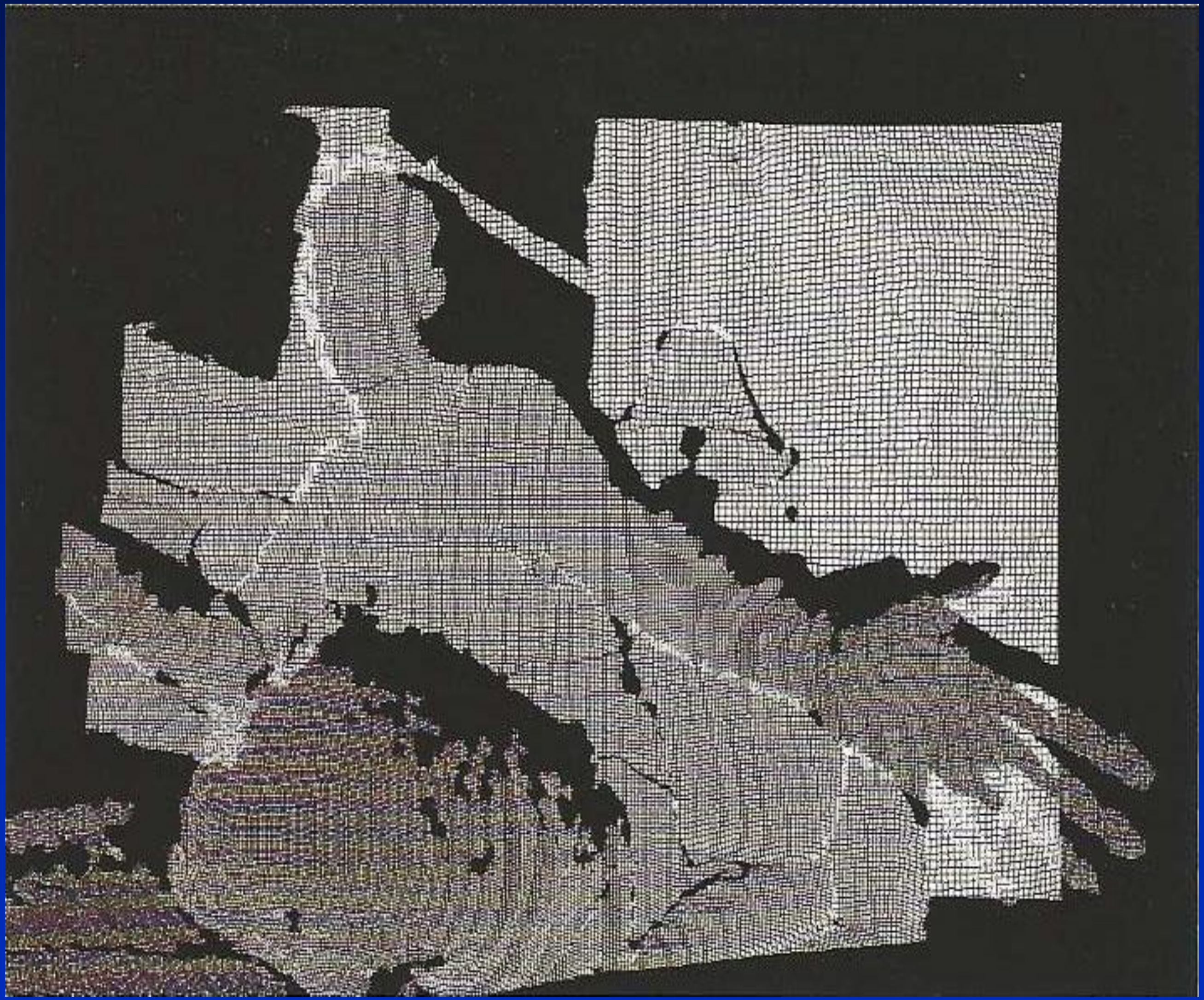
Capturing Motion

Kinect 2

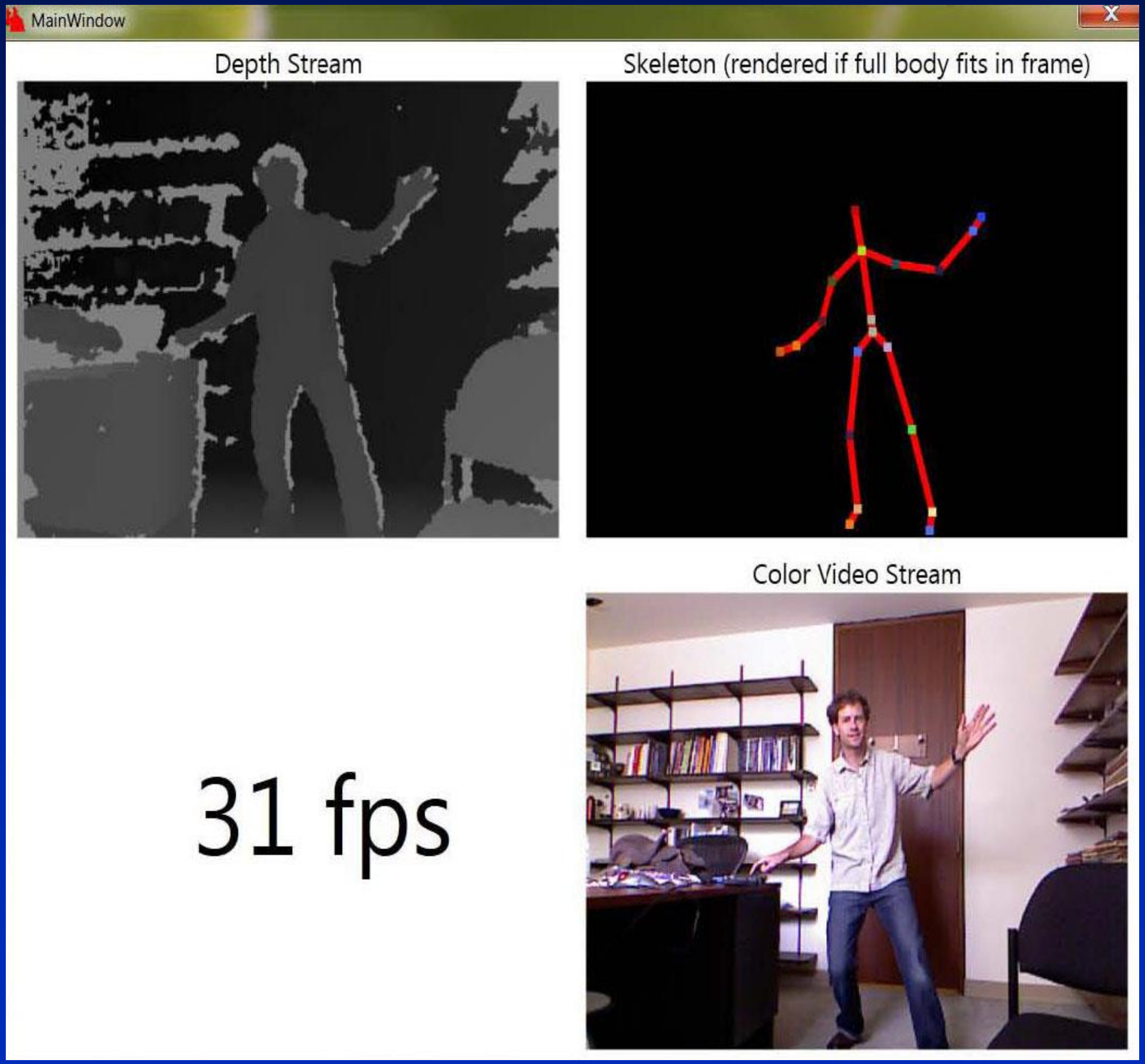
The Kinect uses a pattern projection and machine learning

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

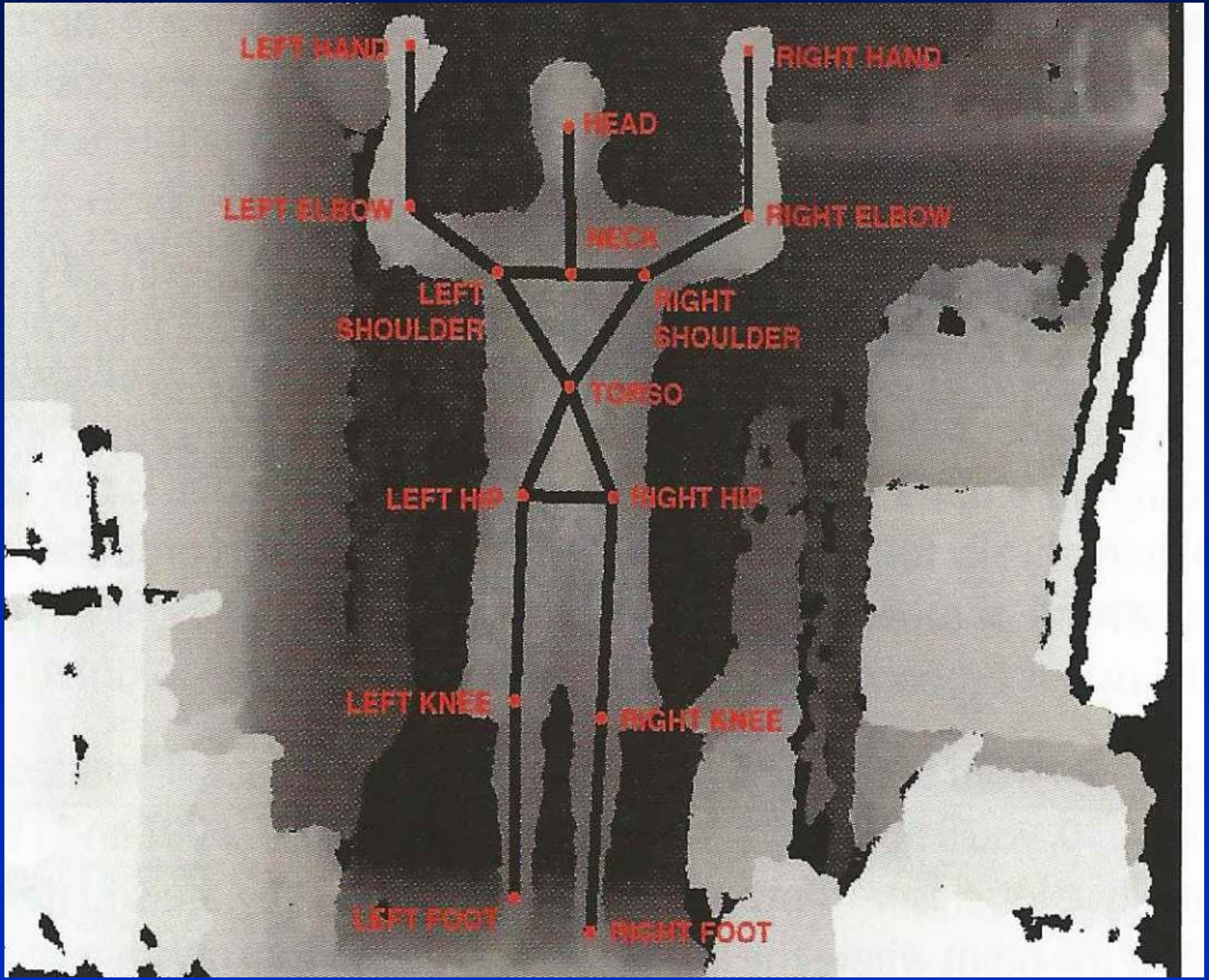
Point Cloud Drawn from the Kinect's 3D data



Step 1: Compute a Depth Map

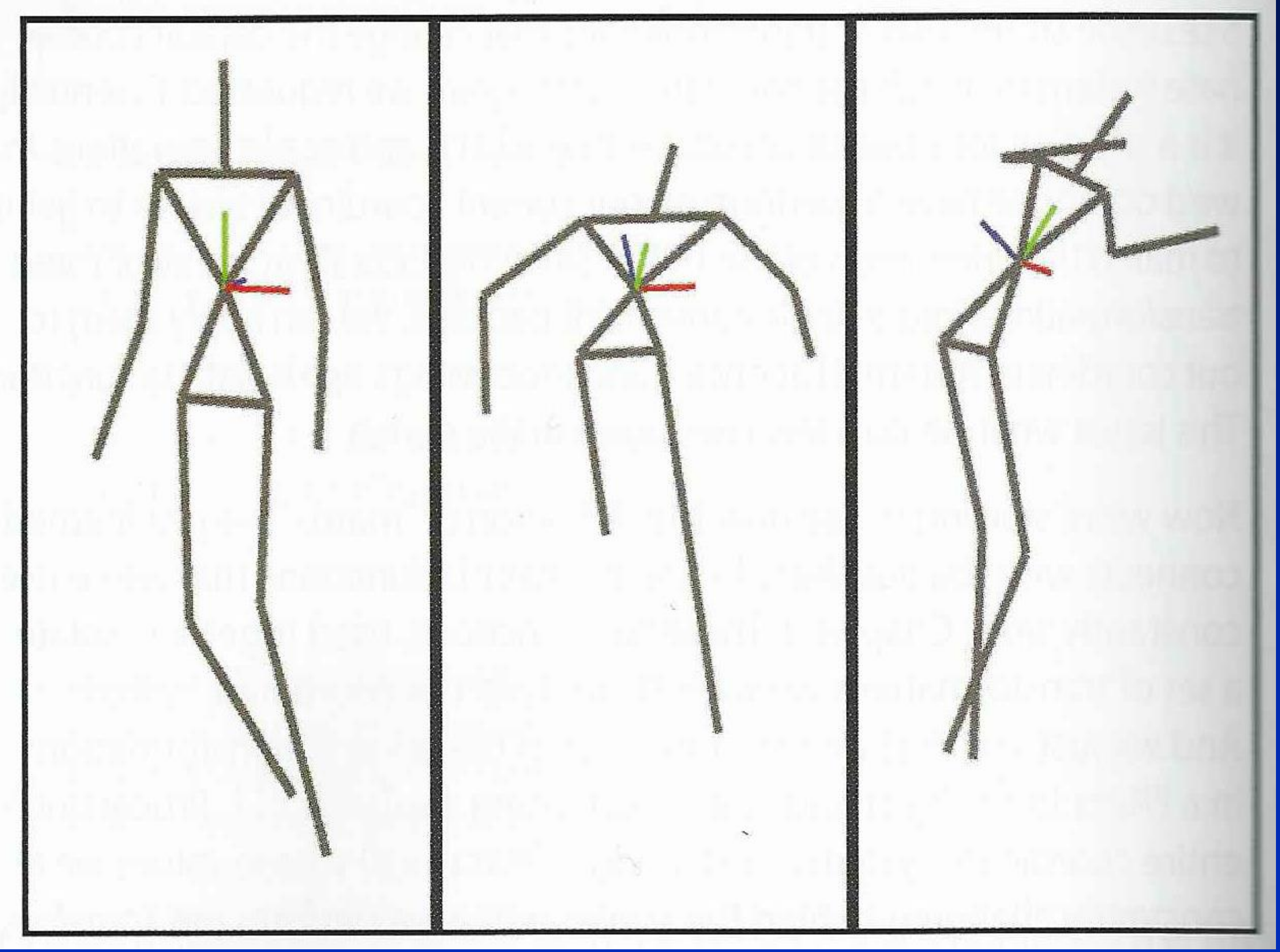


Extracted Skeleton Kinect



Step 2: Infer a Body Position

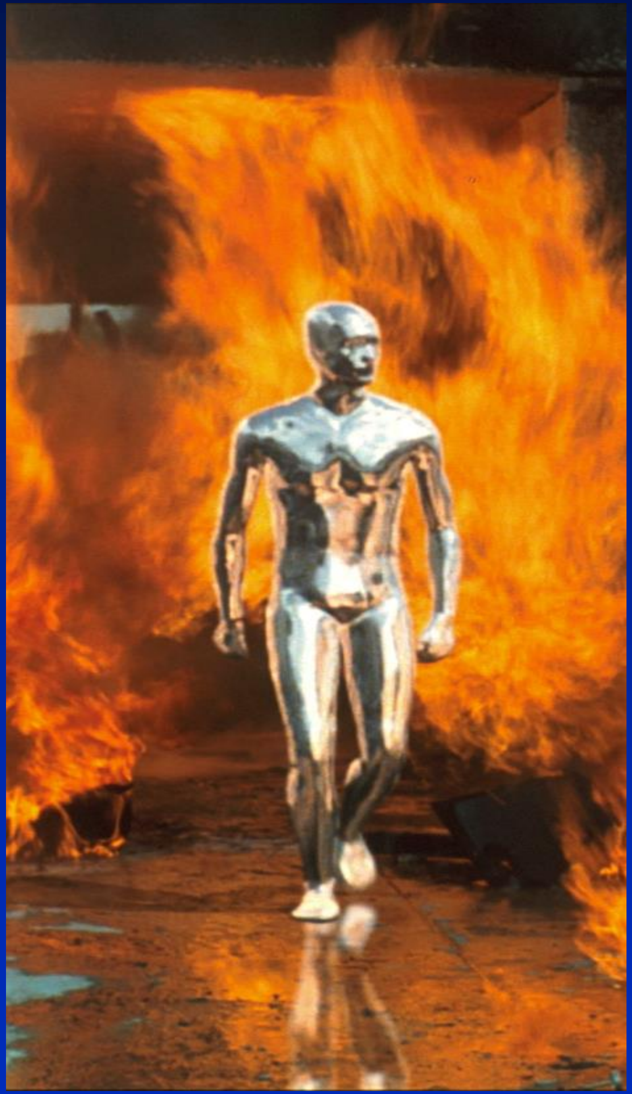
Skeleton Manipulation



Tracking

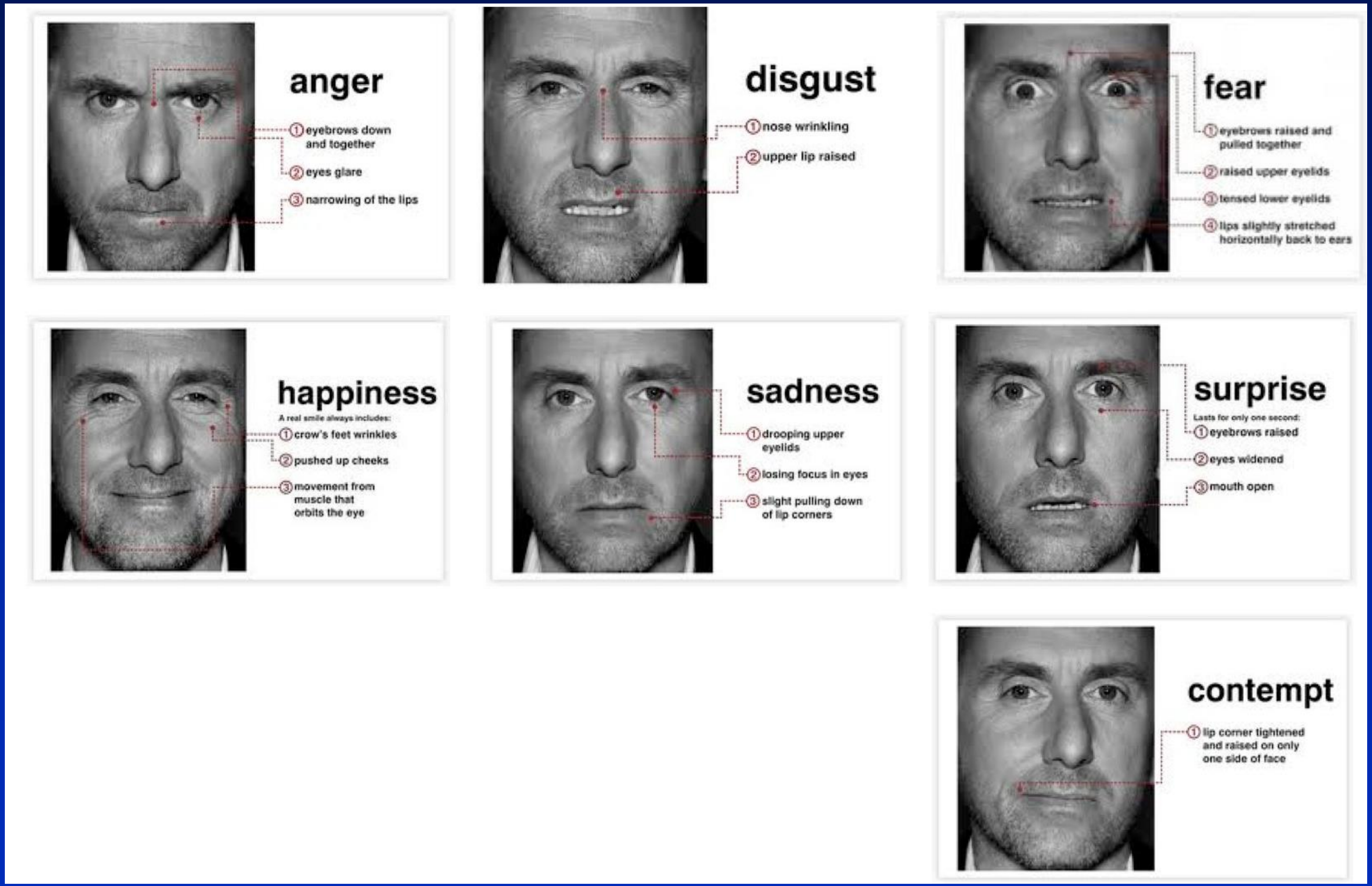
Motion Capture Markers

Motion Capture



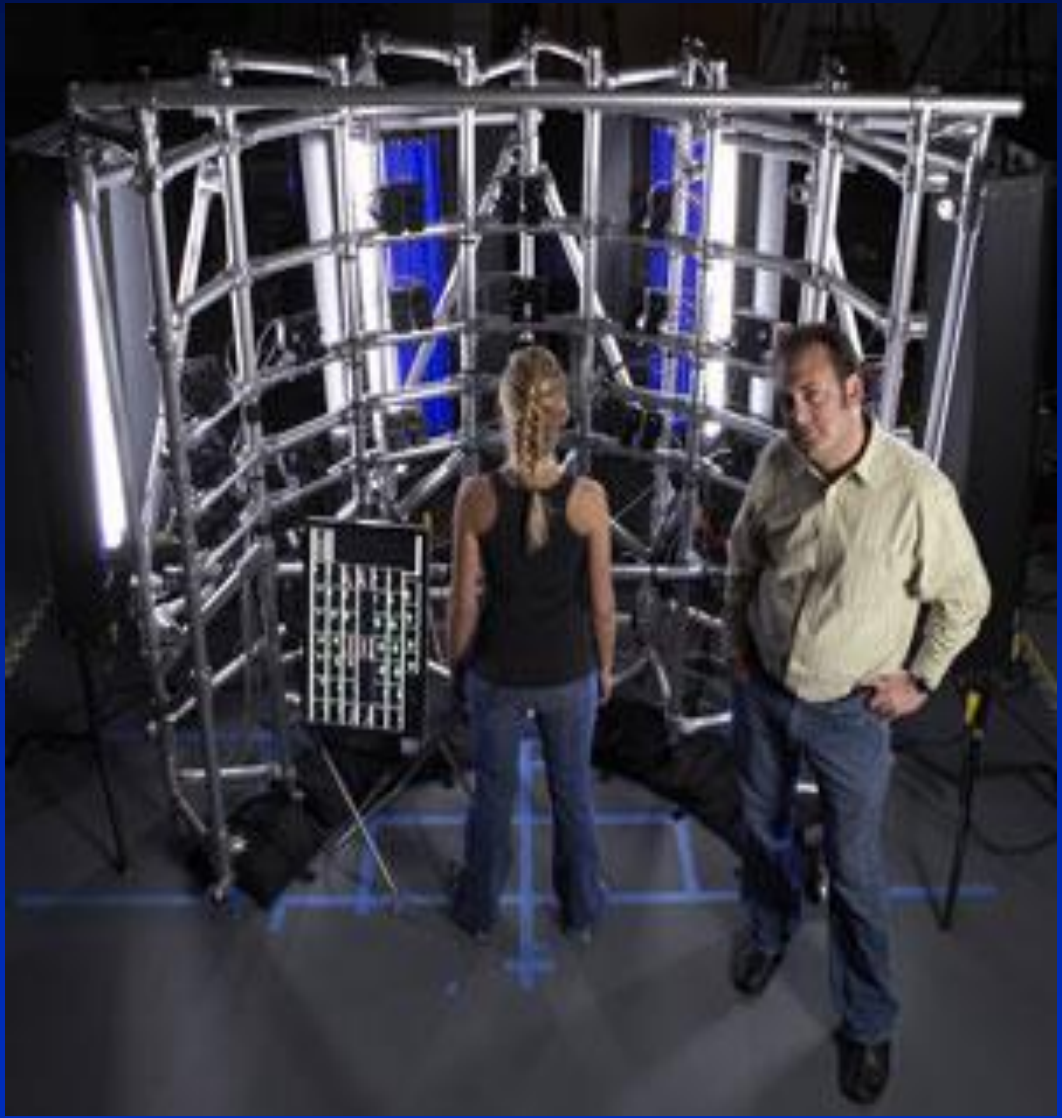
Seven Universal Expressions of Emotion

- Paul Ekman



Inside Out

Markerless Motion Capture



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

The Curious Case of Benjamin Button 2008

Cinefex 116, January 2009

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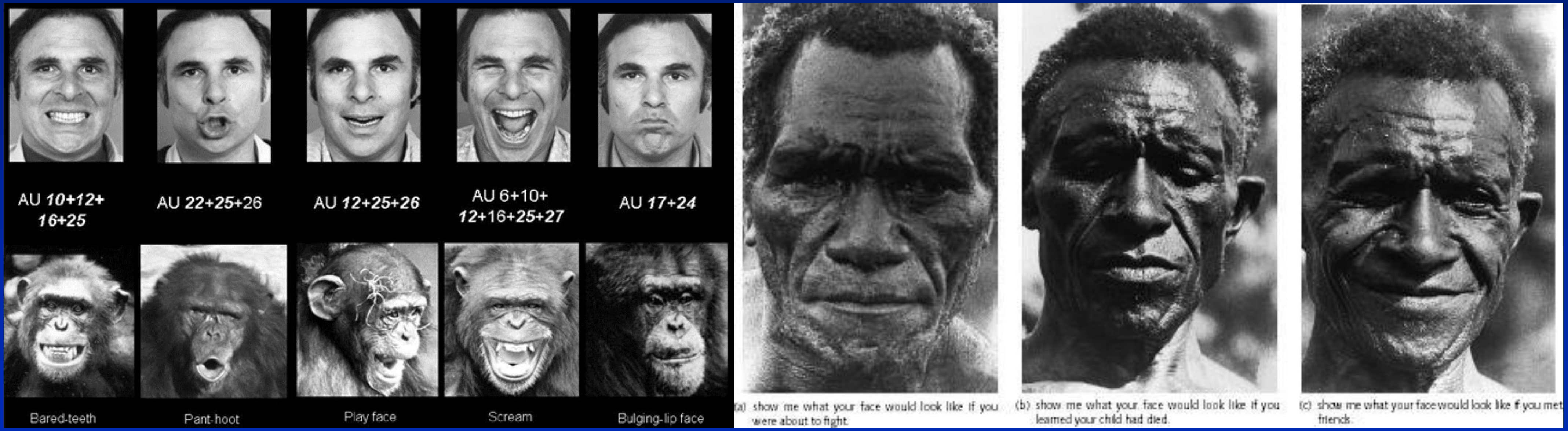

Affective Computing

Affidex Software

- Scan the image for a face(s) and isolates one.
- Using feature detection algorithms, identify the face’s main regions (mouth, nose, eyes, eyebrows, etc.) and ascribe dots to each.
- Separate the dots into “deformable” and “non-deformable” points.
- Deformable points serve as anchors to estimate the magnitude of movement.

Affective Computing

- “I think that, ten years down the line, we won’t remember what it was like when we couldn’t just frown at our device, and our device would say, “Oh, you didn’t like that, did you?”
  - Rana el Kaliouby
    Affectiva

End