The secrets of the Kinect ... in depth!

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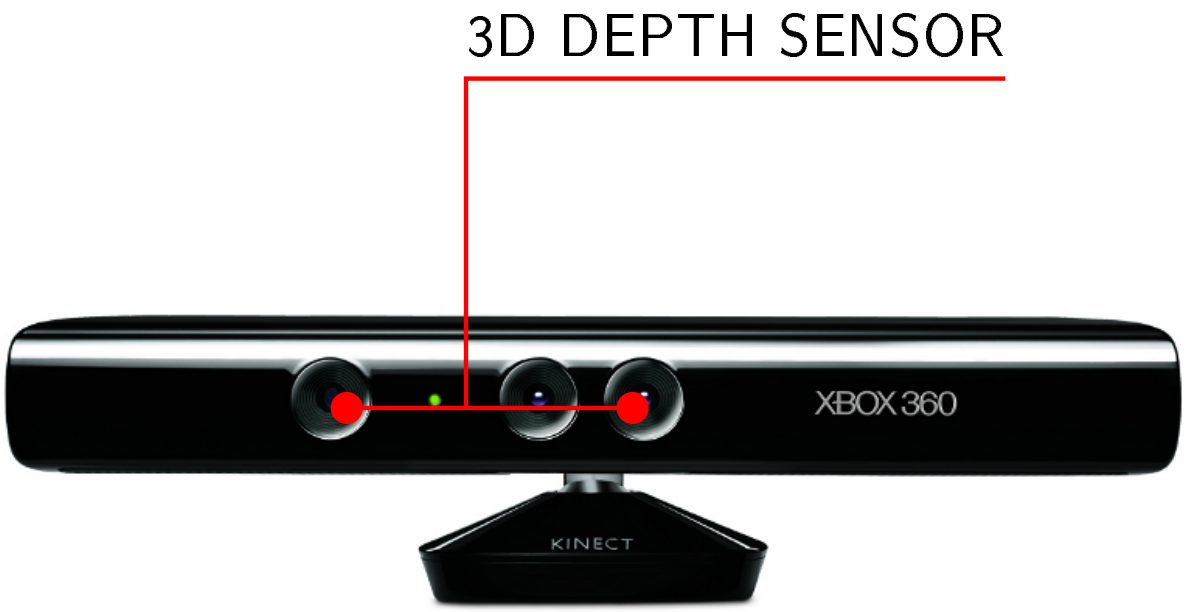
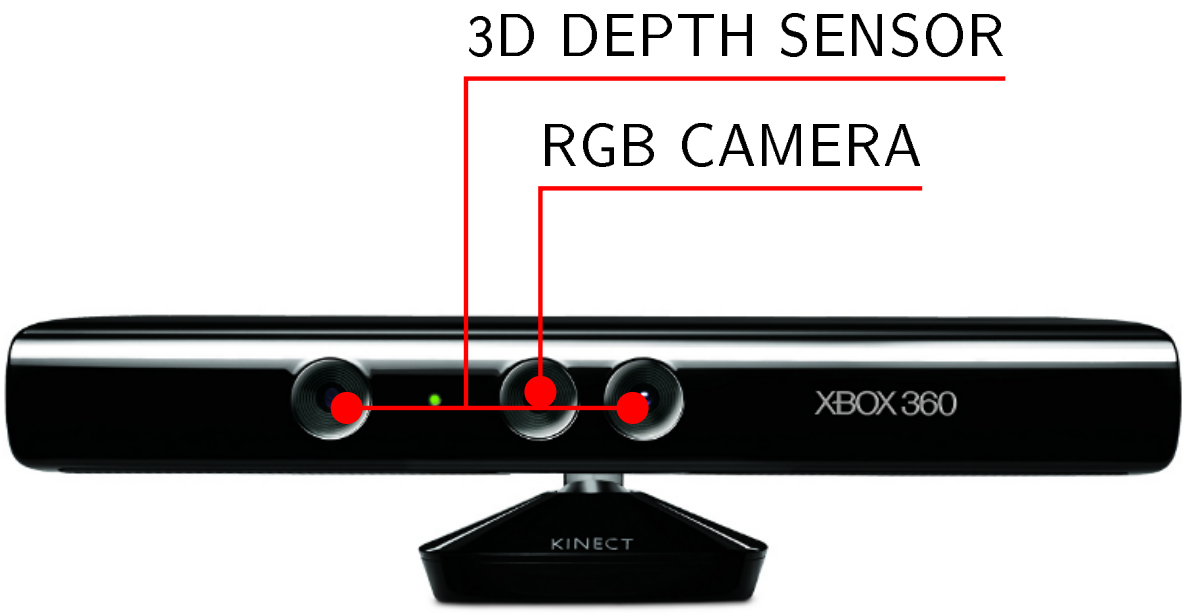
3D Stereo MEDIA 2011

Microsoft Kinect

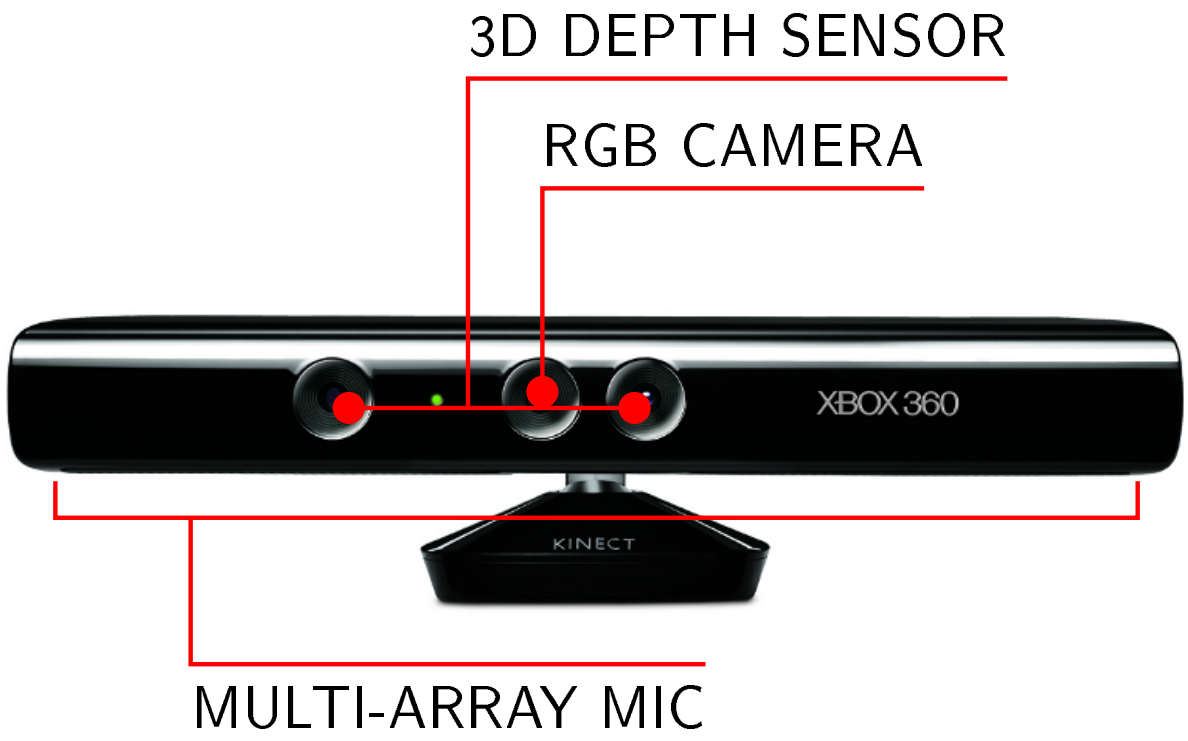
Microsoft Kinect



Microsoft Kinect



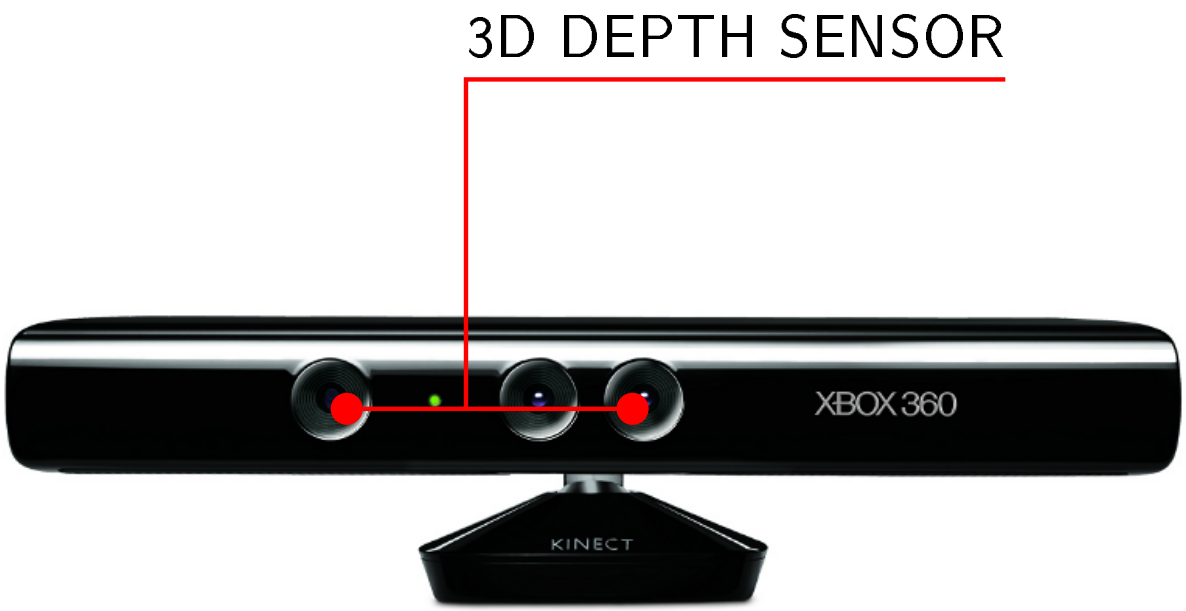
Microsoft Kinect



How does it work?

The 3D sensor is made by PrimeSense (`http://primesense.com`)

- Made of *2* parts



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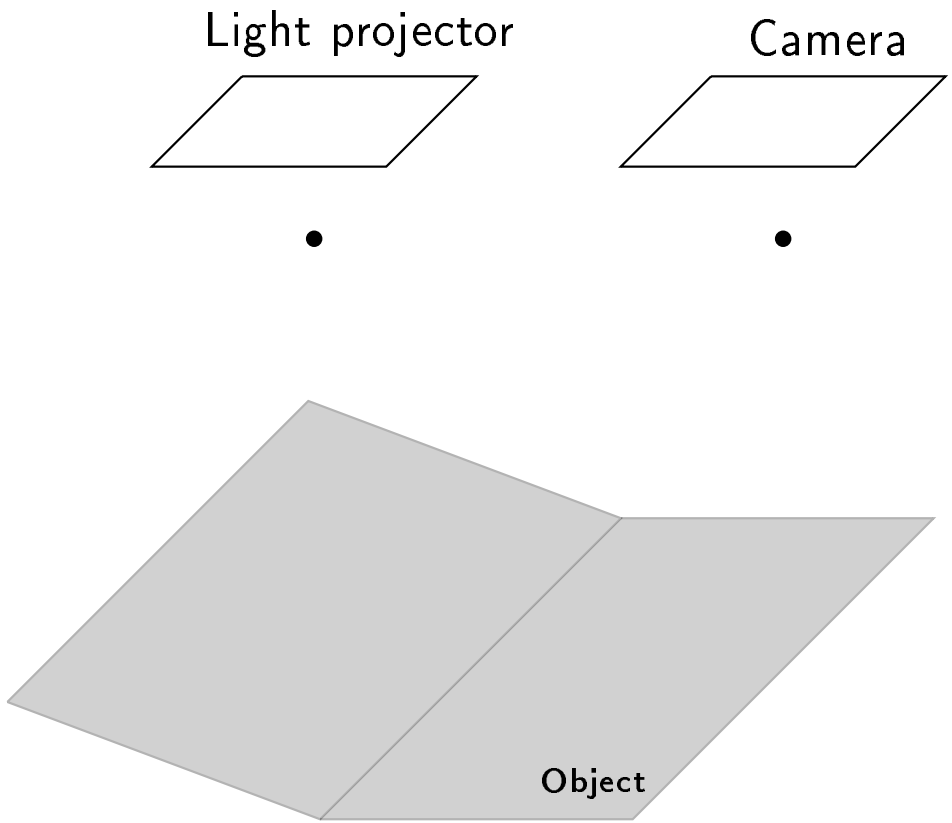
- Made of *2* parts
  - Infrared light source
  - Infrared camera
- Structured light system

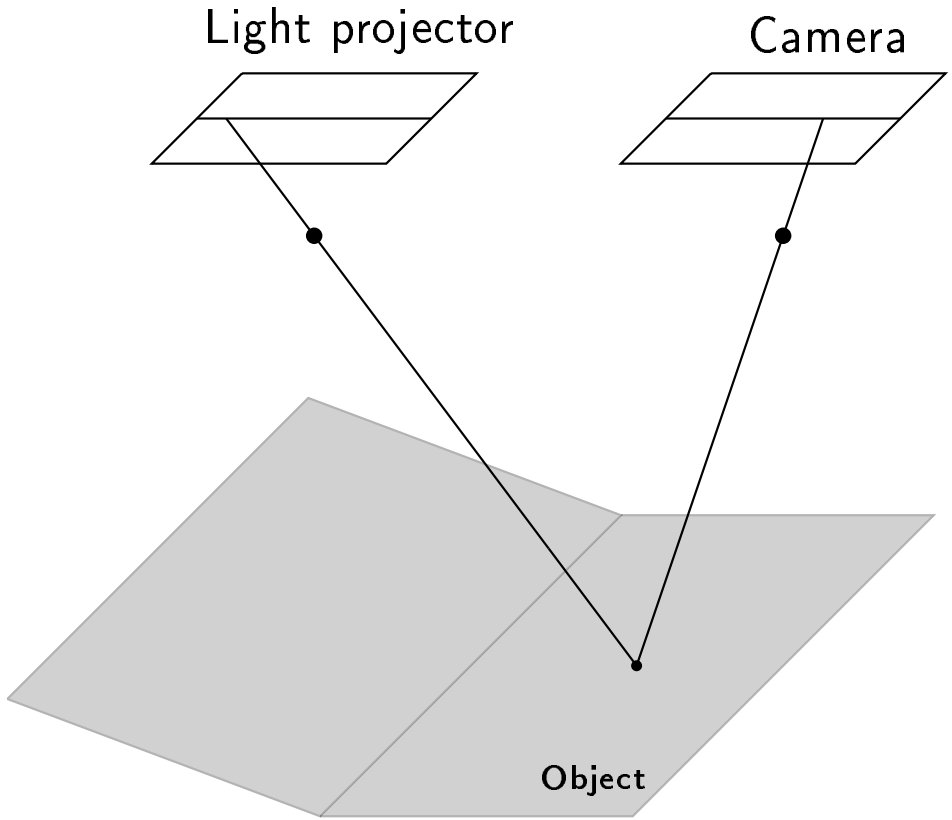
Structured light

- Schematic representation of a structured light system



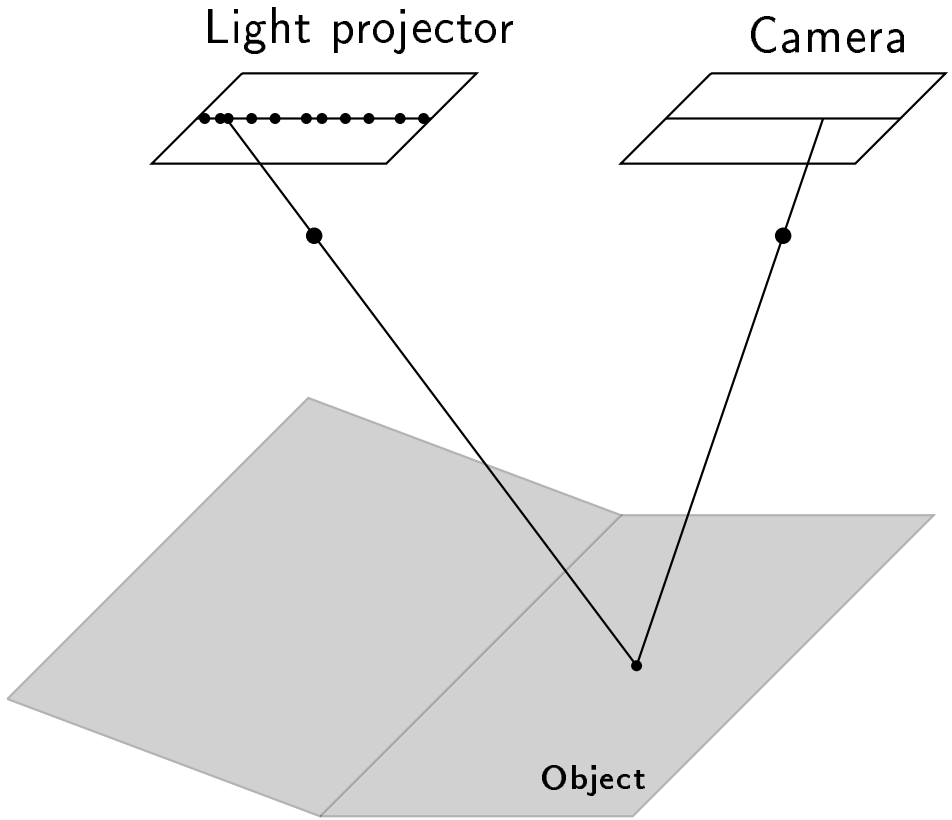
Structured light

- Light patterns are projected onto the scene



Structured light

- The patterns are made so that each token of light is distinguishable from the others



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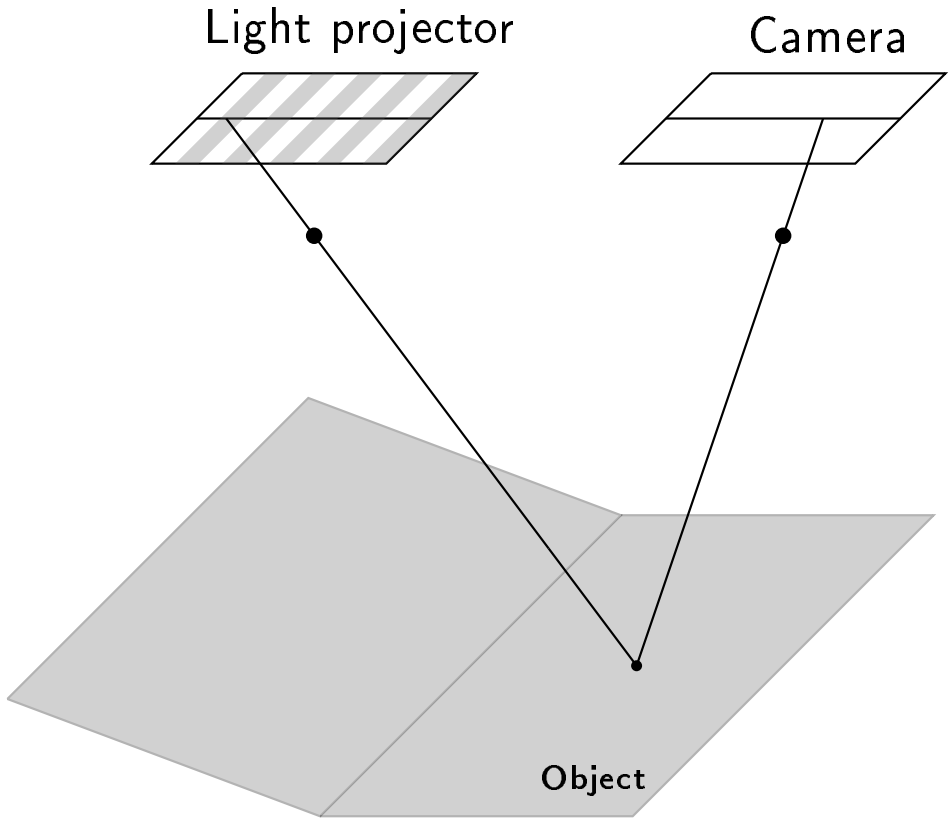
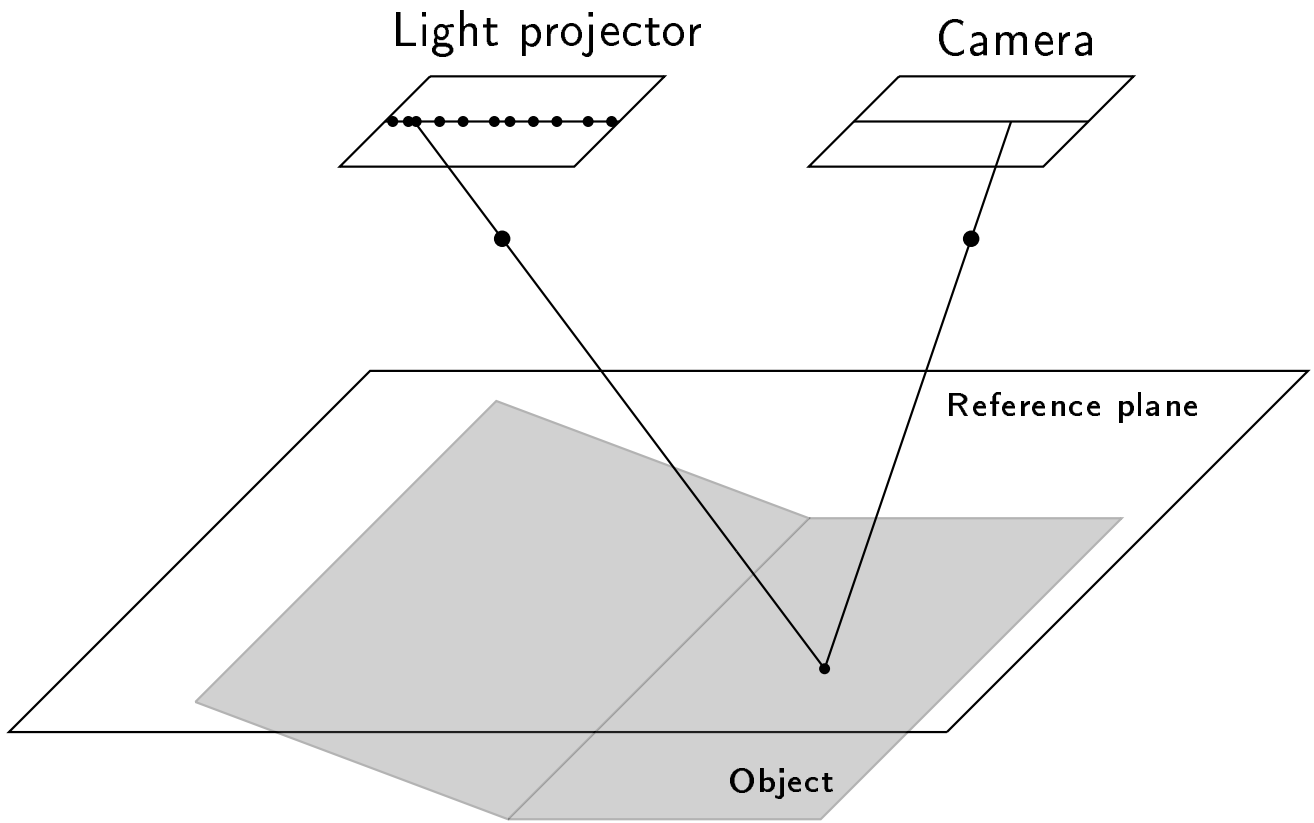


Structured light

- A reference image at known depth is captured using the camera



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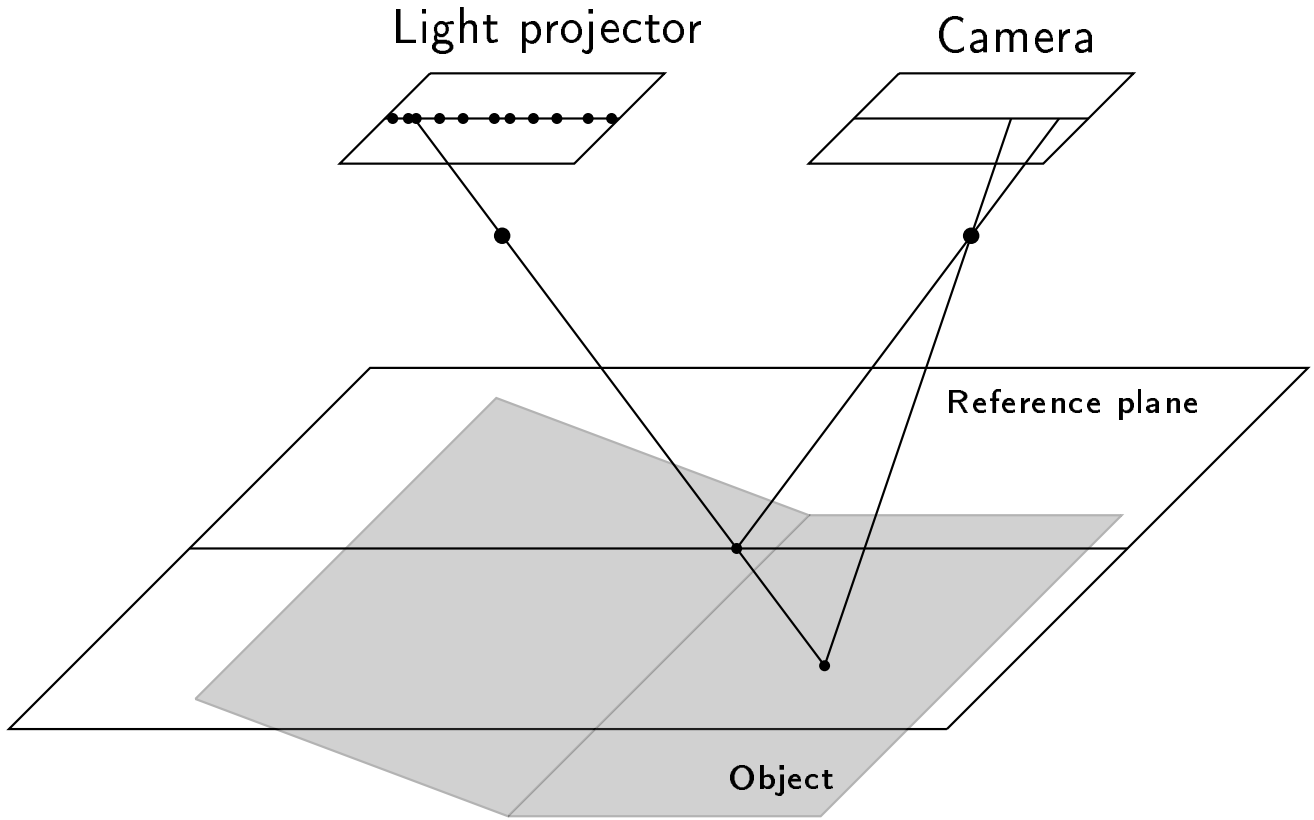
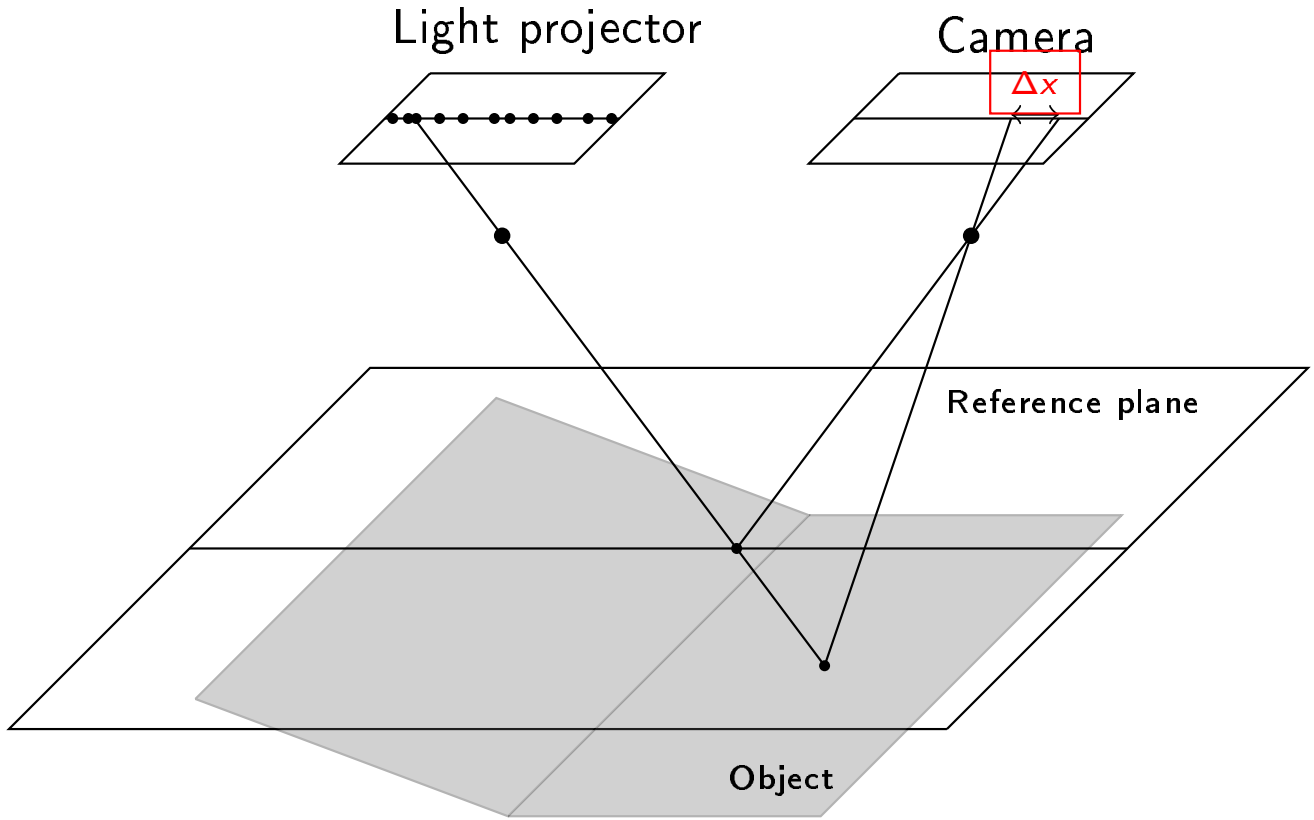
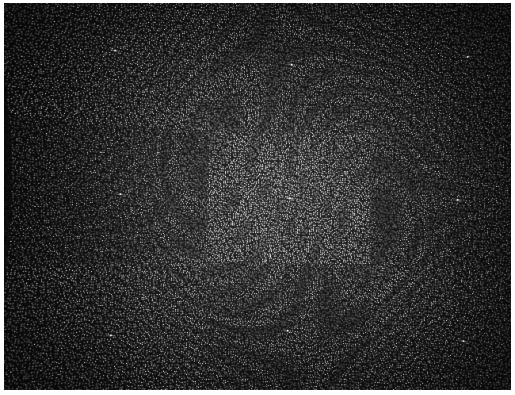


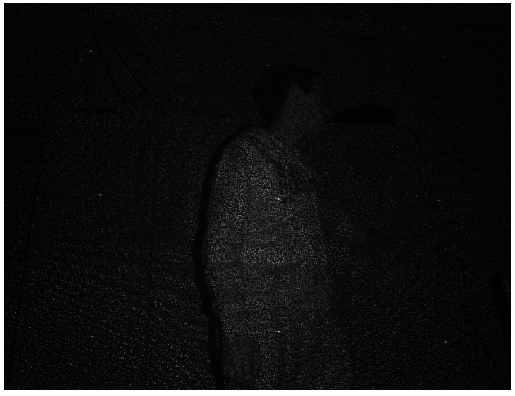
Structured light

- The shift Δx is proportional to the depth of the object



The Kinect



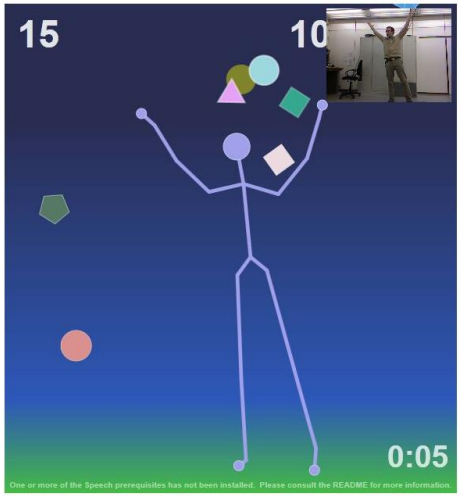


- The IR light source emits a fixed pattern of spots (randomly distributed)
- A group of spots must be distinguishable from any other group on the same row
- The IR camera captures the pattern of spots deformed by the geometry of the scene
- The internal processor computes the depth from the shift between the reference frame and the current image

Using the Kinect

Why?

- **Natural interactions**
- Robotic
- Augmented reality



Games

How?

- Using software development kits (SDKs) or libraries
- For data acquisition:
  - libfreenect, OpenNI, Kinect for Windows
- For data processing:
  - general purpose (OpenCV, pcl)
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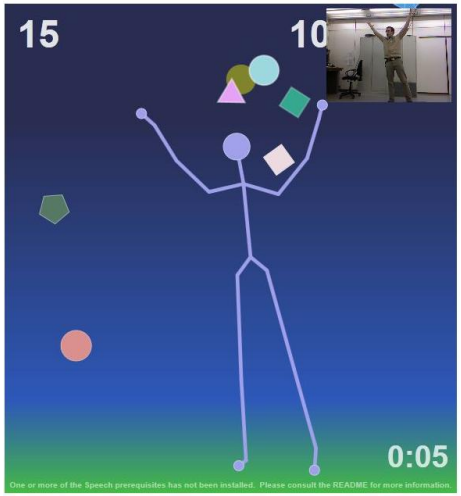

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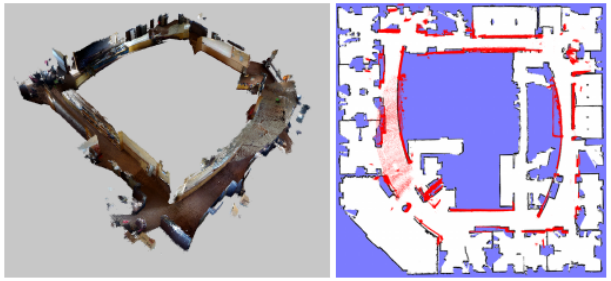

Robotic mapping (Henry *et al.*)

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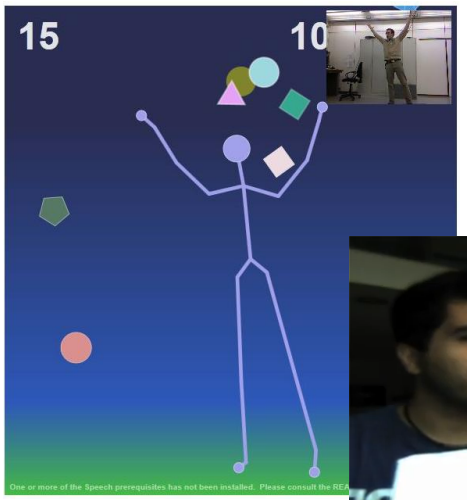

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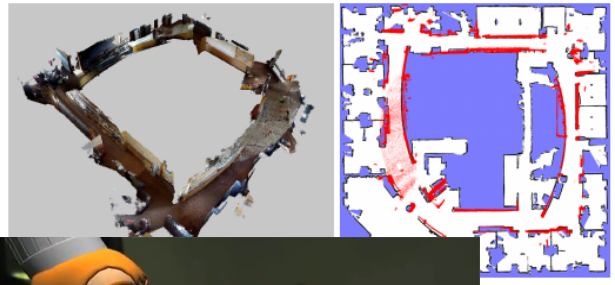

et al.)

SensaaInteractive

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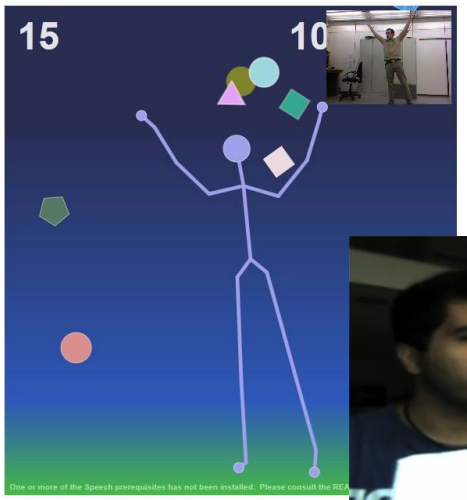

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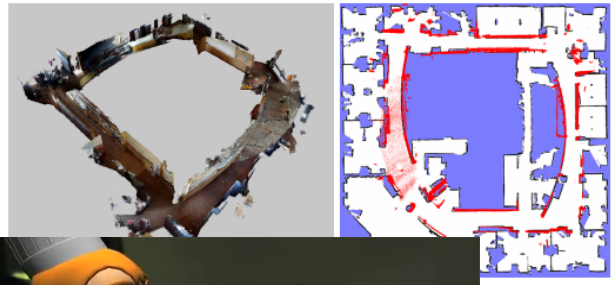

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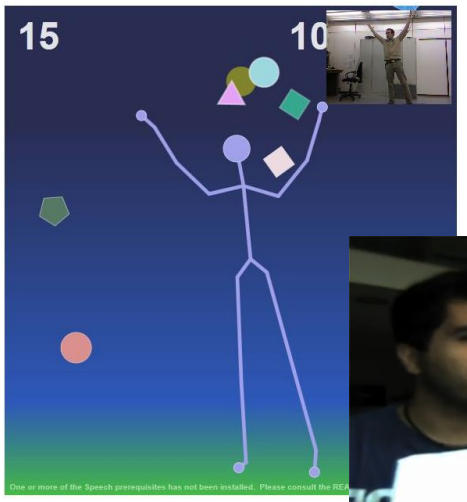

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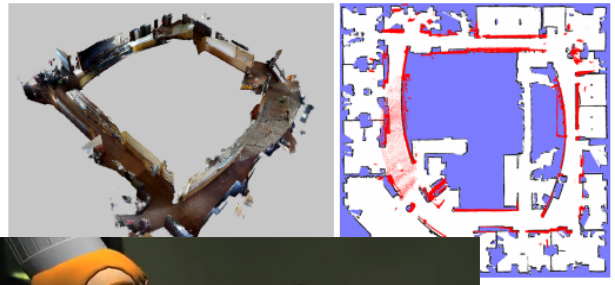

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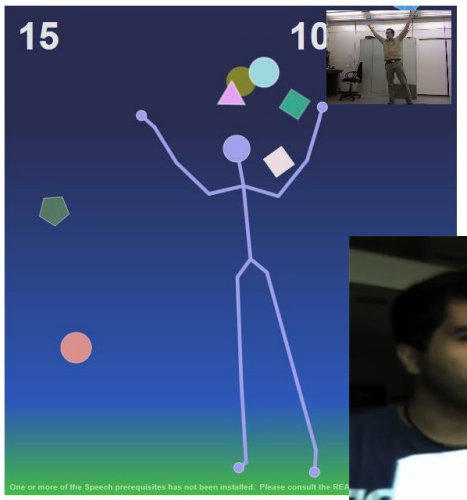

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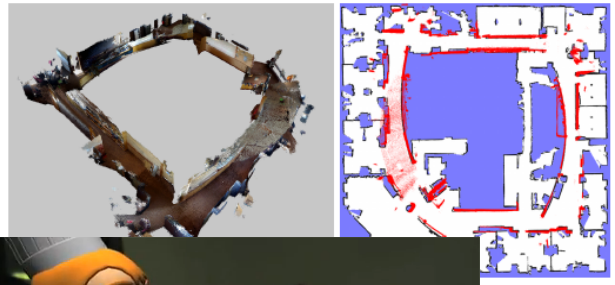

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libfreenect

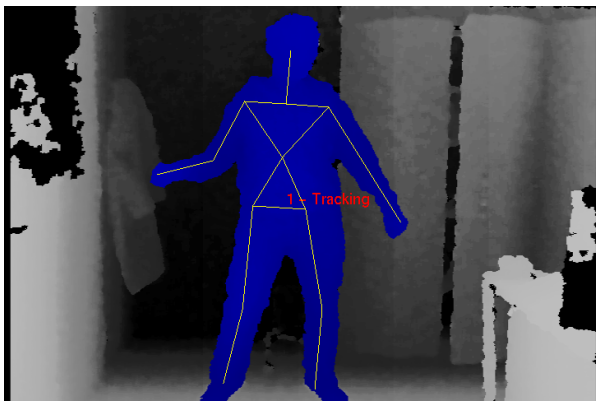
https://github.com/OpenKinect/libfreenect/

- First SDK that was available
- For Windows, Linux and Mac OS X
- Raw sensor streams (Depth, RGB, IR)

OpenNI

http://www.openni.org

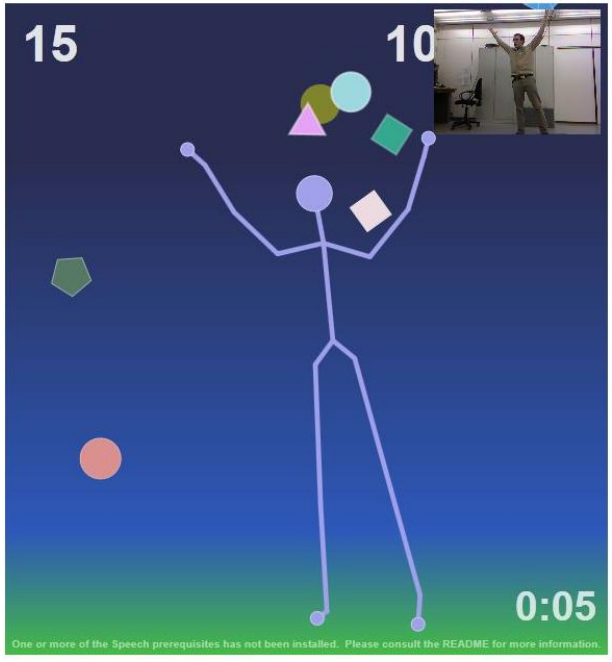
- OpenSource Framework dedicated to natural interactions
- Initiated by PrimeSense
- Raw sensor streams (Depth, RGB, IR, Audio)
- High-level processing functions: hand tracking, user segmentation, skeleton tracking.

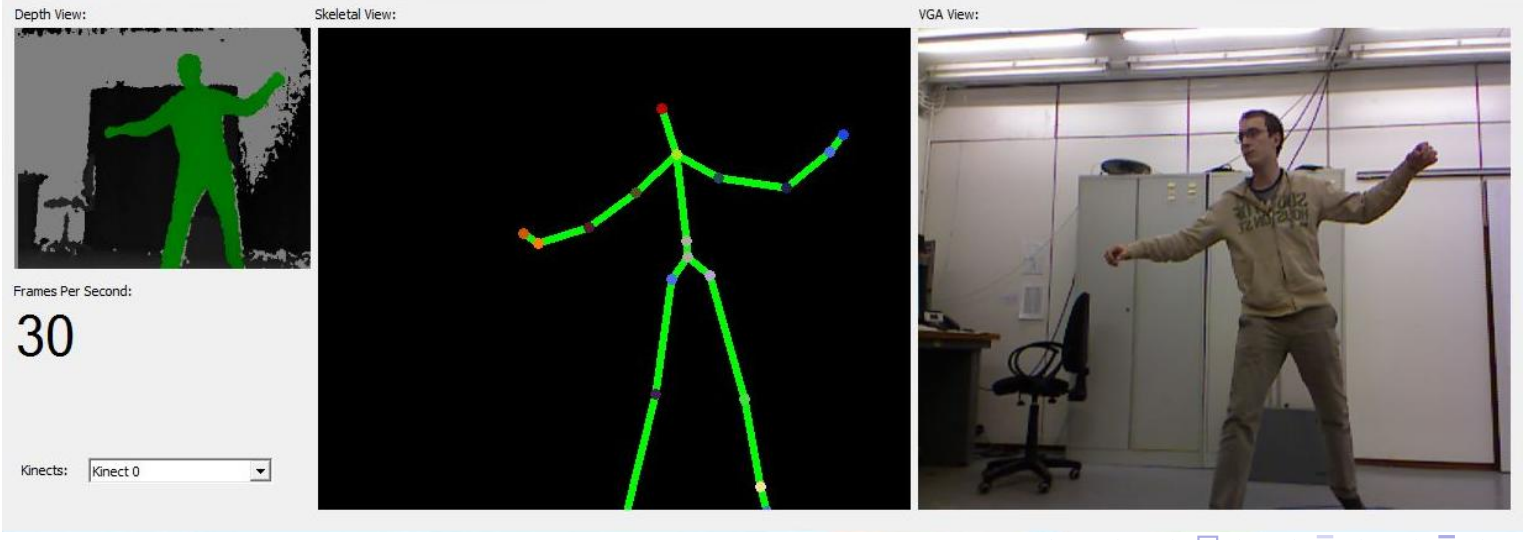


Kinect for Windows SDK

http://kinectforwindows.org

- Raw sensor streams
- Processing functions
  - Skeleton tracking
  - Advanced audio capabilities

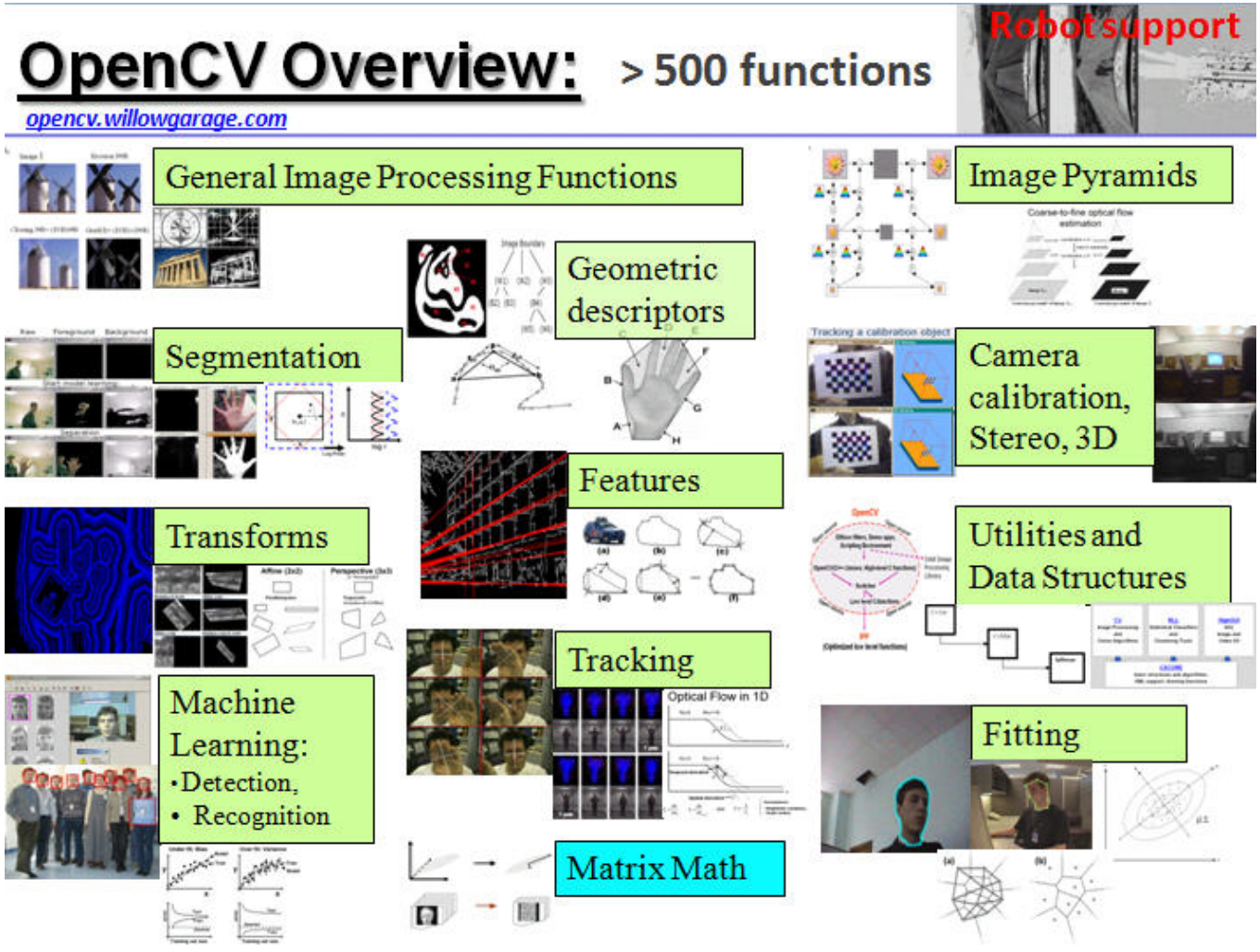




OpenCV

http://opencv.willowgarage.com/

- General purpose image processing library



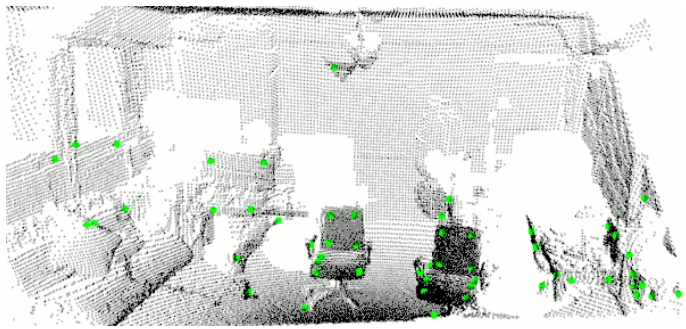
Images source: http://opencv.willowgarage.com/

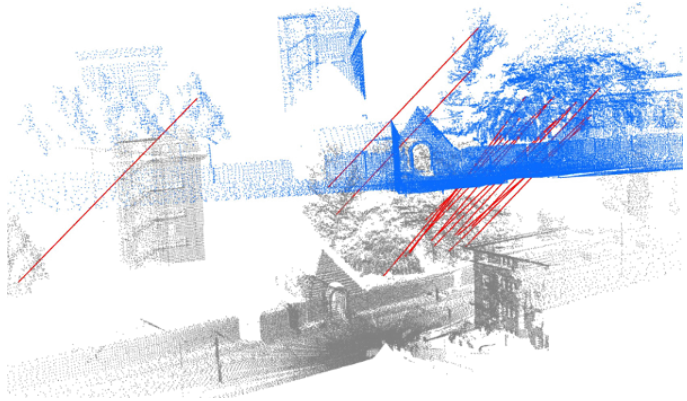
Point Cloud Library

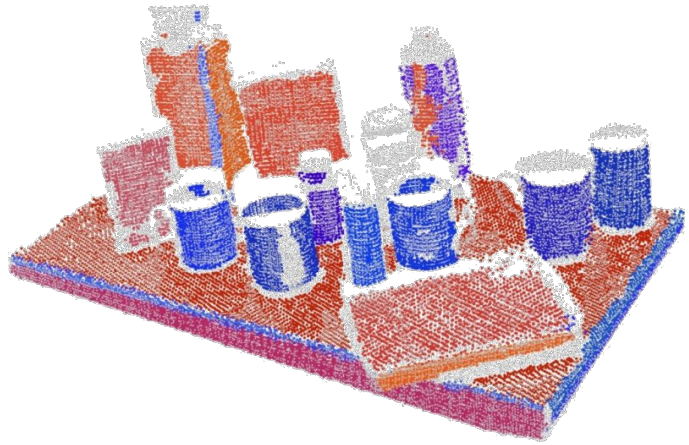
http://pointclouds.org/

pointcloudlibrary

- General purpose 3D point cloud processing library: filtering, interest points, registration, model fitting, ...







Images source: http://pointclouds.org/

State of the art techniques

- Research and development for the Kinect is still at the beginning and is more and more active every day!
- Example: new method from Microsoft (KinectFusion)

Figure 1: KinectFusion enables real-time detailed 3D reconstructions of indoor scenes using only the depth data from a standard Kinect camera. A) user points Kinect at coffee table scene. B) Phong shaded reconstructed 3D model (the wireframe frustum shows current tracked 3D pose of Kinect). C) 3D model texture mapped using Kinect RGB data with real-time particles simulated on the 3D model as reconstruction occurs. D) Multi-touch interactions performed on any reconstructed surface. E) Real-time segmentation and 3D tracking of a physical object.

Image source: "KinectFusion: Real-time 3D Reconstruction and Interaction Using a Moving Depth Camera", S. Izadi *et al.*

Conclusion

- First consumer depth camera.
- Directly giving information about the geometry of the scene.
- Tons of applications are yet to be invented!

Contact information

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