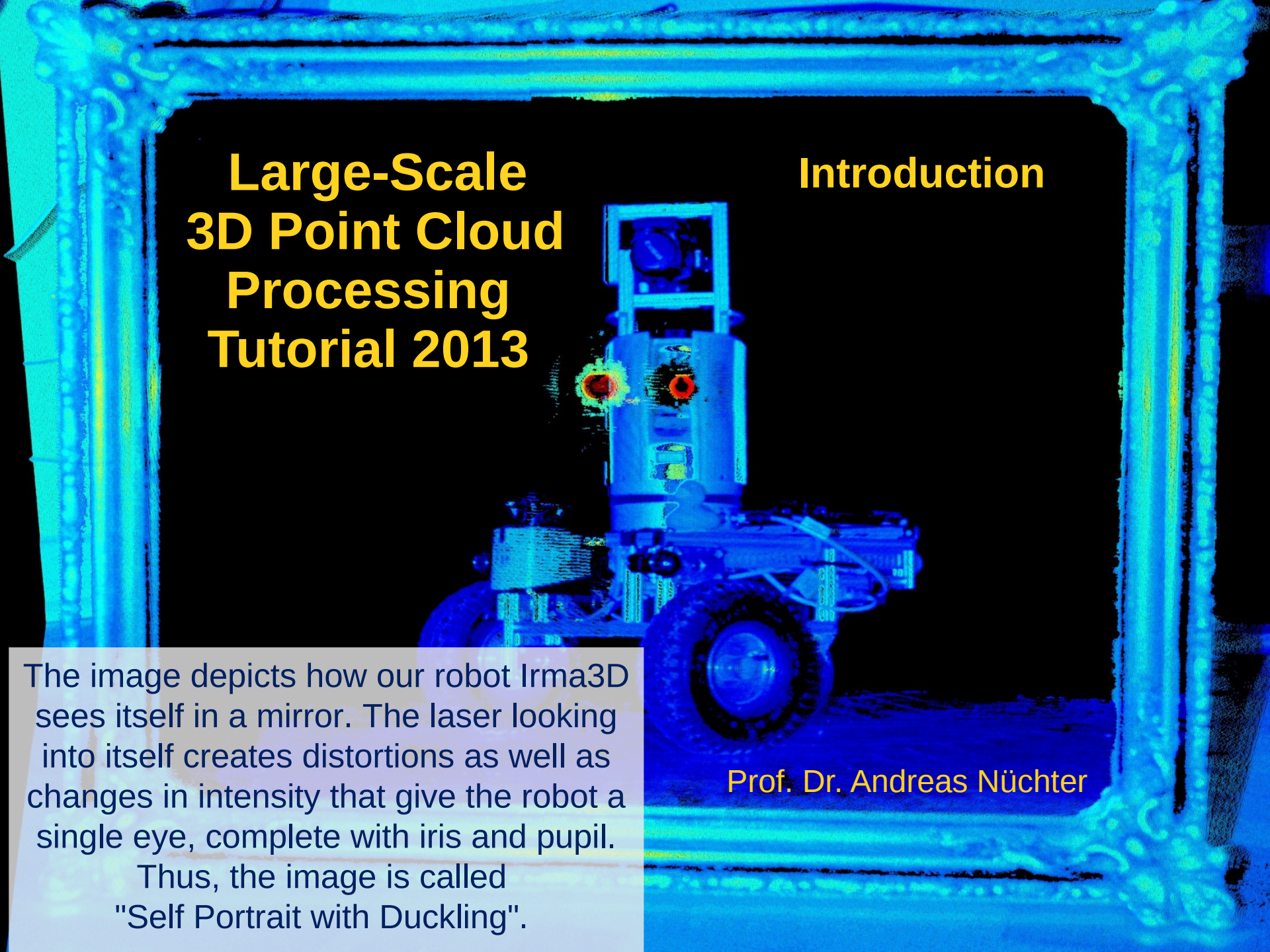
Large-Scale 3D Point Cloud Processing Tutorial 2013

Introduction



The image depicts how our robot Irma3D sees itself in a mirror. The laser looking into itself creates distortions as well as changes in intensity that give the robot a single eye, complete with iris and pupil. Thus, the image is called "Self Portrait with Duckling".

Prof. Dr. Andreas Nüchter

Goals of this Tutorial

We are aiming at enabling participants...

- To understand the basic principles of all aspects of 3D point cloud processing
- To understand the Simultaneous Localization and Mapping (SLAM) problem
- To enable your to talk to engineers / surveyors / CV-people / CS-people / ...
- To solve problems of modern sensor data processing
- To experience that real application scenarios are challenging
  - In terms of computational requirements
  - In terms of memory requirements
  - In terms of implementation issues

Mapping the **Old** Problem

Spare Time Reading:
"Measuring the World"
(Daniel Kehlmann)

- Carl Friedrich Gauß (1777–1855), mathematician, astronomer, geodesist and physicist Professor in Göttingen

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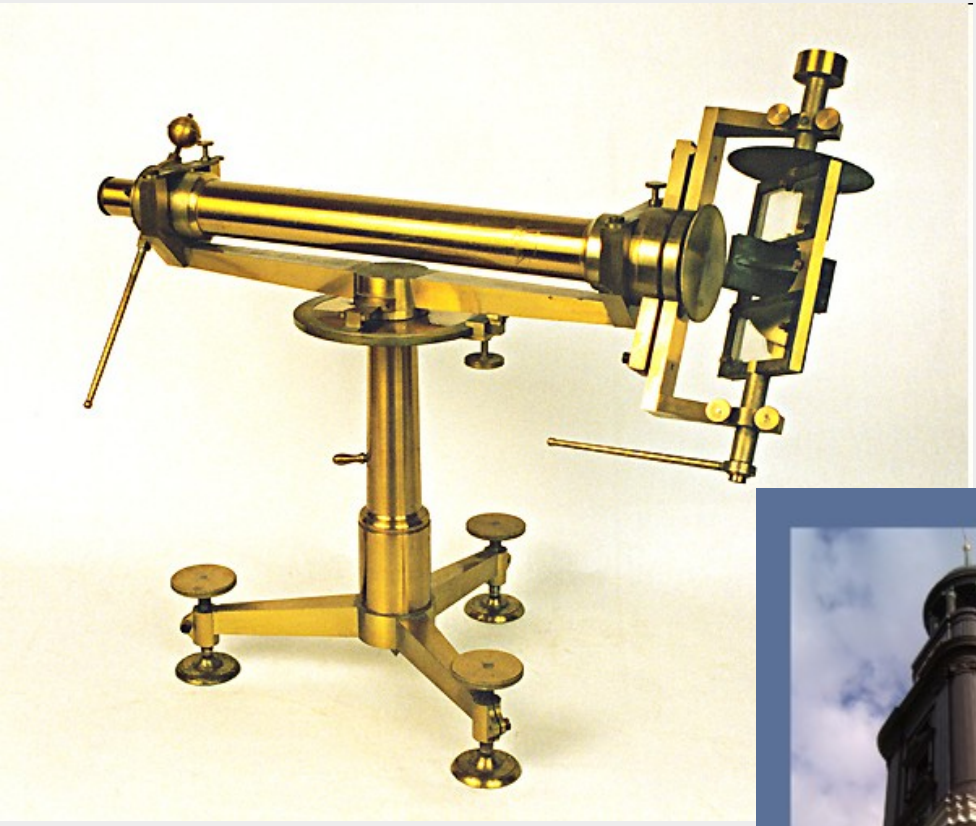
Gauß as inventor



- The heliotrop is an measurement device to measure angles to objects by using sun light reflections and the bisecting line of an angle.

- Invented around 1820 in Hamburg
- Highly accurate

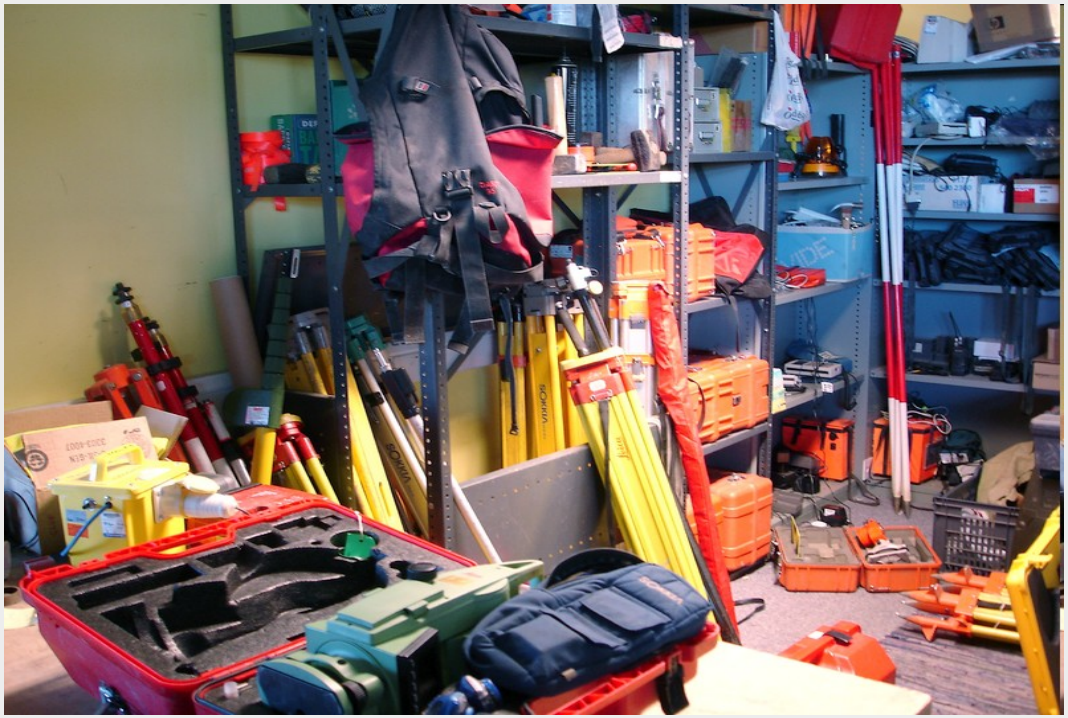
Mapping the **Old** Problem

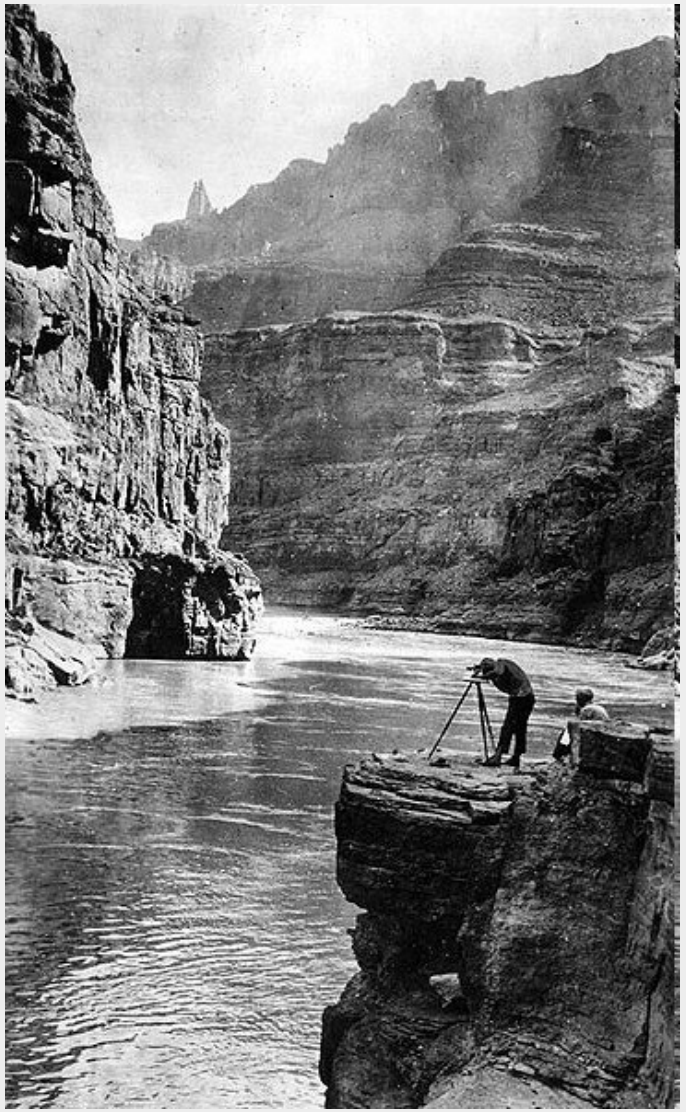
- Carl Friedric
  mathematici
  Professor in

The Gaussian Point in Bremen City

Geodesy / Geodetics / Surveying

- Deals with the measurement and representation of the Earth.
- Devices: tape, theodolite, tachy-meter (total station), leveling instrument, GPS, laser scanner

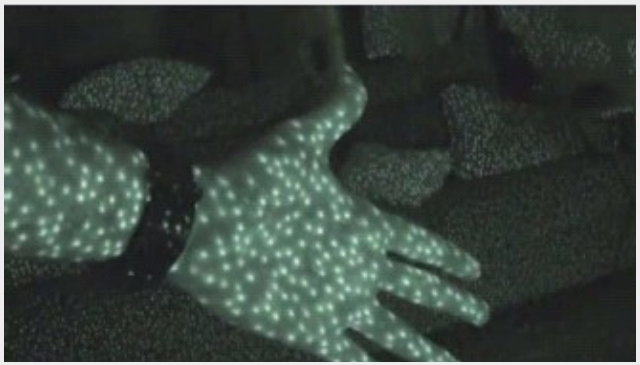


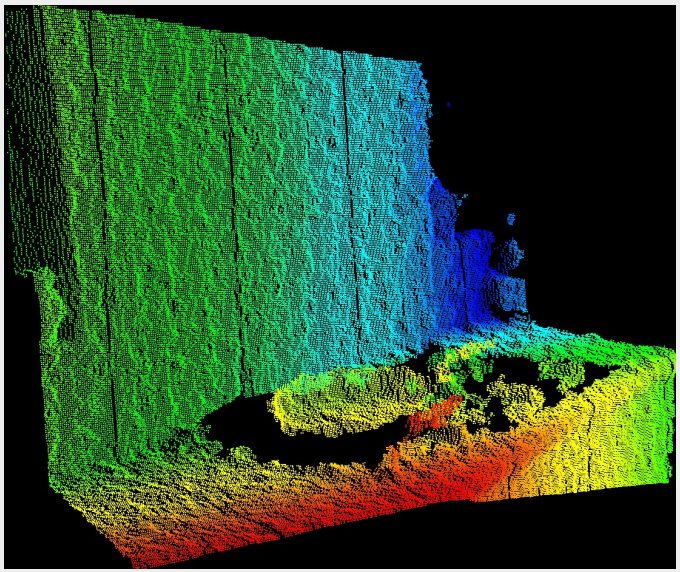


Modern Computer Vision

Microsoft Kinect

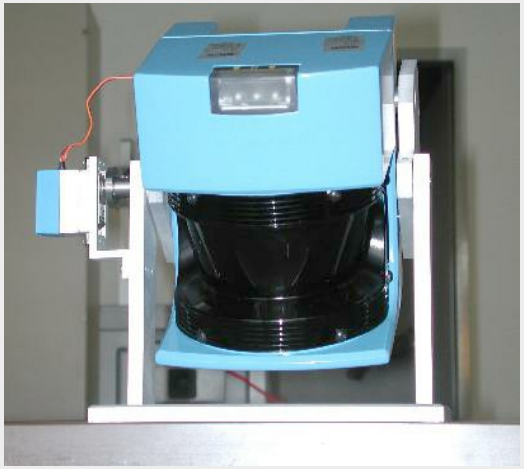
- Video 30 Hz
- RGB video: 8-bit VGA resolution (640 × 480 Pixel)
- Monochrome Video Stream
  (depth information): 11-bit VGA
  2048 depth values
- Depth: 1,2 – 3,5 m, (enhanced: 0,7 – 6 m)
- FOV: 57° (h) × 43°(vert)
- Tilt unit 27°
- Cost effective





A Custom Made 3D Laser Scanner

- 3D laser scanner for mobile robots based on SICK LMS



- Based on a regular (e.g., SICK LMS-200) laser scanner
- Relatively cheap sensor
- Controlled pitch motion (120° v)
- Various resolutions and modi, e.g., reflectance measurement {181, 361, 721} [h] x {128, …, 500} [v] points
- Fast measurement, e.g., 3.4 sec (181x256 points)

Mounted on mobile robots for 3D collision avoidance and building 3D maps.

(Video Crash)

(Video NoCrash)


RoboCup
HOSTED BY
RoboCup
Lenar
EVG
Heri
EVG
Sankt Augustin
Henrik
EVG
Sankt Augustin
Morit
EVG
Sankt Augustin

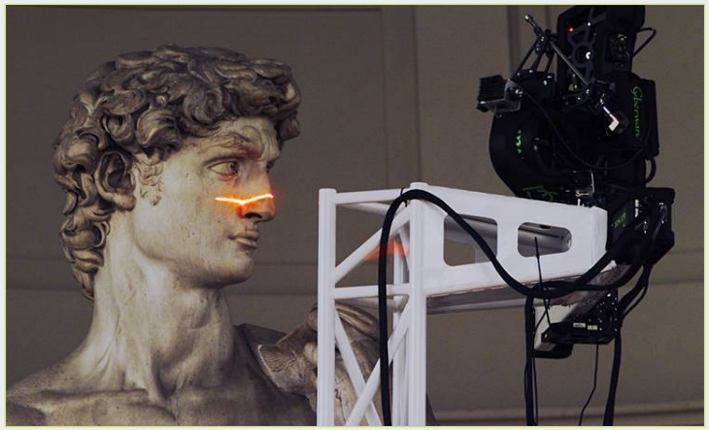
3D Scanning Principles

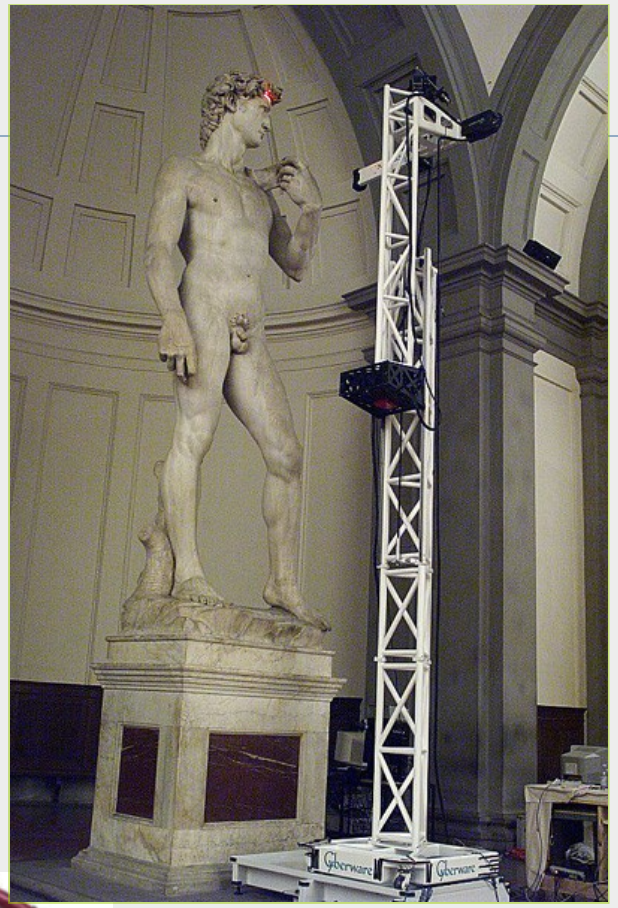
Mode	Symbol	Cont. rotating	pivoting	Advantages
Yaw				+ Complete 360° scans + Good point arrangements - High point density at top
Yaw-Top				+ Fast scanning (half rot.) - High point density at top - Ground not measured
Roll				+ Fast scanning (half rot.) + High point density in front - Unusual point arrangement
Pitch				- High point density at the sides - Small apex angle + Good point arrangements + Easy to build

http://www.rts.uni-hannover.de/index.php/%C3%9Cbersicht_der_m%C3%B6glichen_Scannerkonfigurationen

Professional 3D Scanning

- Professional 3D scanners
  - Structured light (close range)



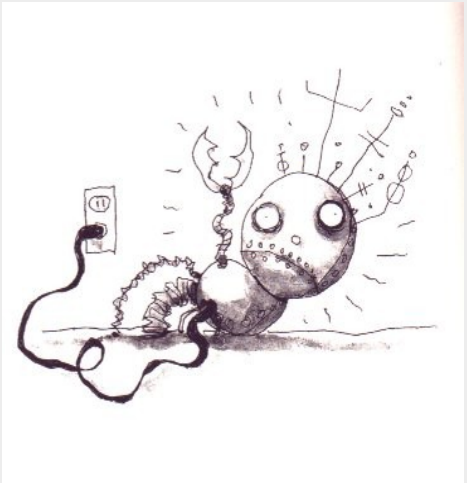


  - pulsed laser vs. time-of-flight (mid and long range)

Laserscanner
LEICA HDS3000

3DTK – Hands-on-experience

- What you should learn now, using the **show** program
  - Most robotic data sets acquired by a rotating SICK scanner contain some outliers (it is worse with the kinect)
  - Data sets of professional scanners can be very large



- Things to try
  - Viewing a single small 3D scan acquired in Schloß Dagstuhl (this data set comes with the svn checkout)

```
bin/show –s 1 –e 1 dat
```

  - Viewing a high resolution outdoor 3D scan

```
bin/show –s 0 –e 0 –f riegl_txt --reflectance bremen_city
```