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".
Goals of this Class

I am aiming at enabling students

• 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
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)
## 3D Scanning Principles

<table>
<thead>
<tr>
<th>Mode</th>
<th>Symbol</th>
<th>Cont. rotating</th>
<th>pivoting</th>
<th>Advantages</th>
</tr>
</thead>
</table>
| Yaw    | ![Yaw symbol] | ![Continuously rotating Yaw scanner] | ![Pivoting Yaw scanner] | + Complete 360° scans  
+ Good point arrangements  
- High point density at top |
- High point density at top  
- Ground not measured |
| Roll   | ![Roll symbol] | ![Continuously rotating Roll scanner] | ![Pivoting Roll scanner] | + Fast scanning (half rot.)  
+ High point density in front  
- Unusual point arrangement |
| Pitch  | ![Pitch symbol] | ![Continuously rotating Pitch scanner] | ![Pivoting Pitch scanner] | - 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_logischen_Scannerkonfigurationen](http://www.rts.uni-hannover.de/index.php/%C3%9Cbersicht_der_logischen_Scannerkonfigurationen)
Professional 3D Scanning

- Professional 3D scanners
  - Structured light (close range)
  - pulsed laser vs. time-of-flight (mid and long range)
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`