



Digitale Objekterfassung

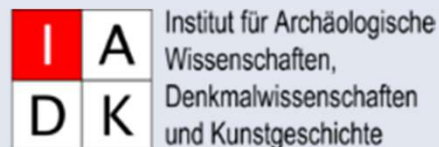
Digital object acquisition/ digital object recording

Modul 3 / WS 1

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Twitter: @Mona3Dimaging



Inhalte dieser Vorlesung

Statistik, Interferometrie, Low Cost 3D (günstige
Konsumersensoren)

1. Low Cost 3D
2. Indoor Beacons

Monitoring and Sensing (Pass Control)/ Sensoren im täglichen Leben



Digital Imaging for authentic reproduction Bildgebende Verfahren

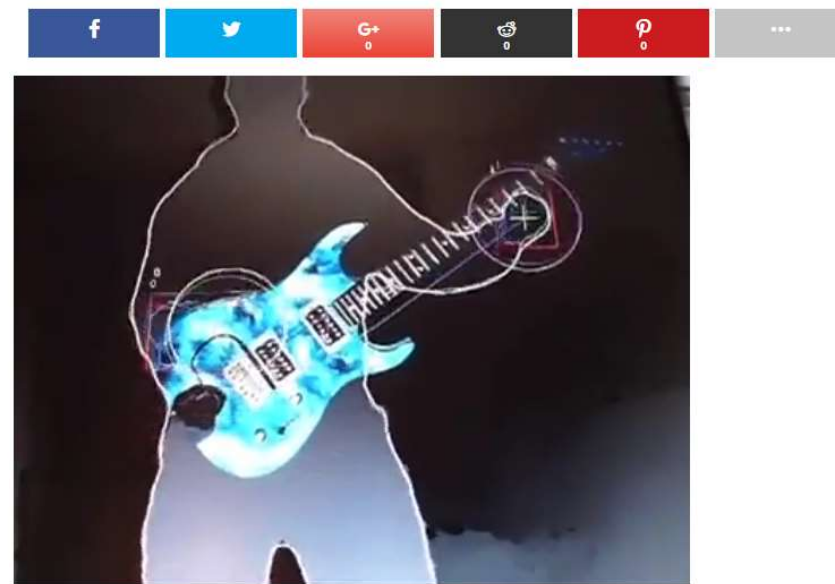


<https://www.artec3d.com/news/president-obama-3d>

Low-Cost Sensoren

Kostengünstige 3D
Gestenerkennung und schnelle
Objekterkennung
Konsumerprodukte und
massenware

Kinect air guitar

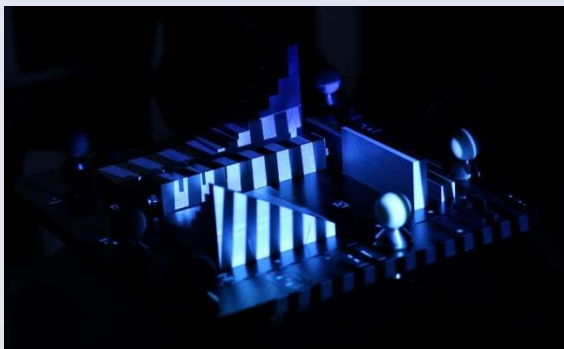


Chris O'Shea emailed in with his super sweet Kinect hack, allowing him to [play air guitar!](#)

Modelle Marke Eigenbau



Example for structured light scanning: Mephisto EX-Pro and EOS (4DDynamics)., The D-SLR camera (middle, EOS system) can be swapped over to the higher-resolution machine vision camera (right, EX-Pro system) to communicate with the projector



Bauen wir einen David Laserscanner

<http://www.gunook.com/david-3d-scanner/>



Lichtoptischer 3D Digitalisierer

Picoscan Technical Specification and Software Interface

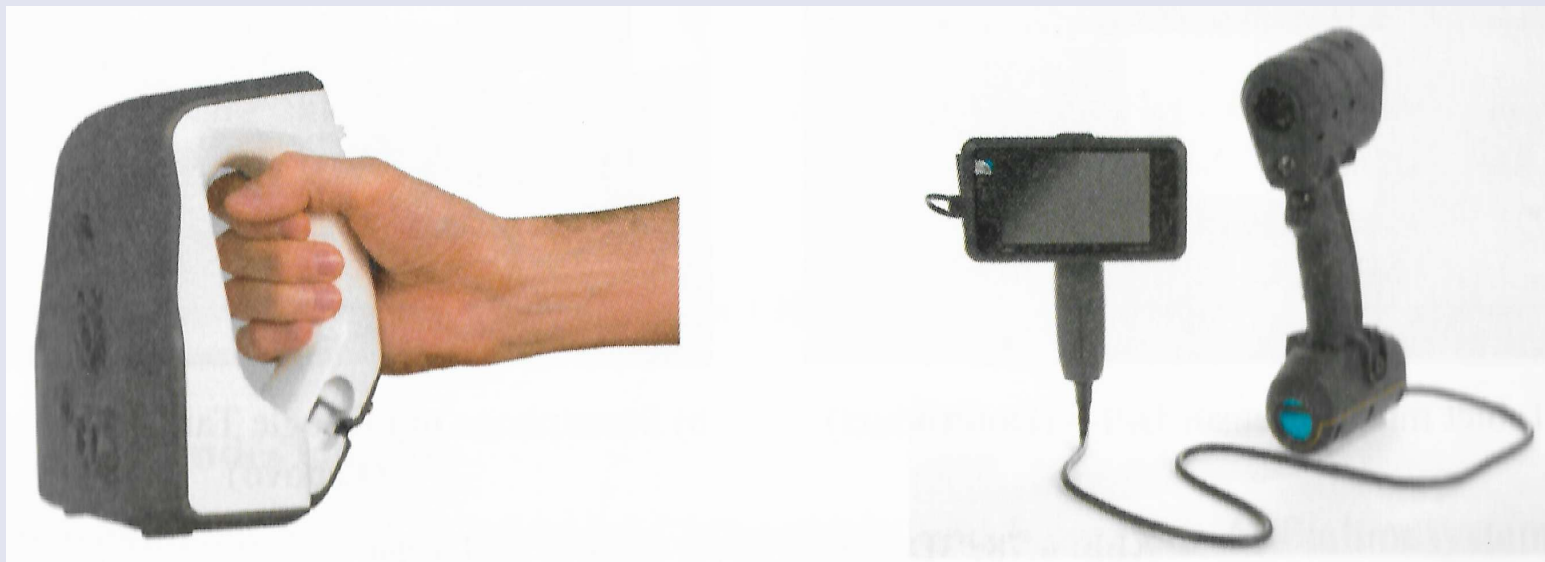
- Canon EOS 1000D, 18-55 mm lens, Pico projector
- Resolution geometry: 968 x 644, 8 bits
- Texture resolution: 1936 x 1288, 8 bits
- Projector resolution: 800 x 600
- Working range: 0.15m - 0.8m
- Point to point distance : 0.16 mm
- Point accuracy: 0.1 mm (average)
- Acquisition time: 20 Sec
- Mephisto 3D Scan engine software
(Calibration, processing and reconstruction)

<https://www.rsi-3dsystems.com/3d-scanner/pico-scan/>

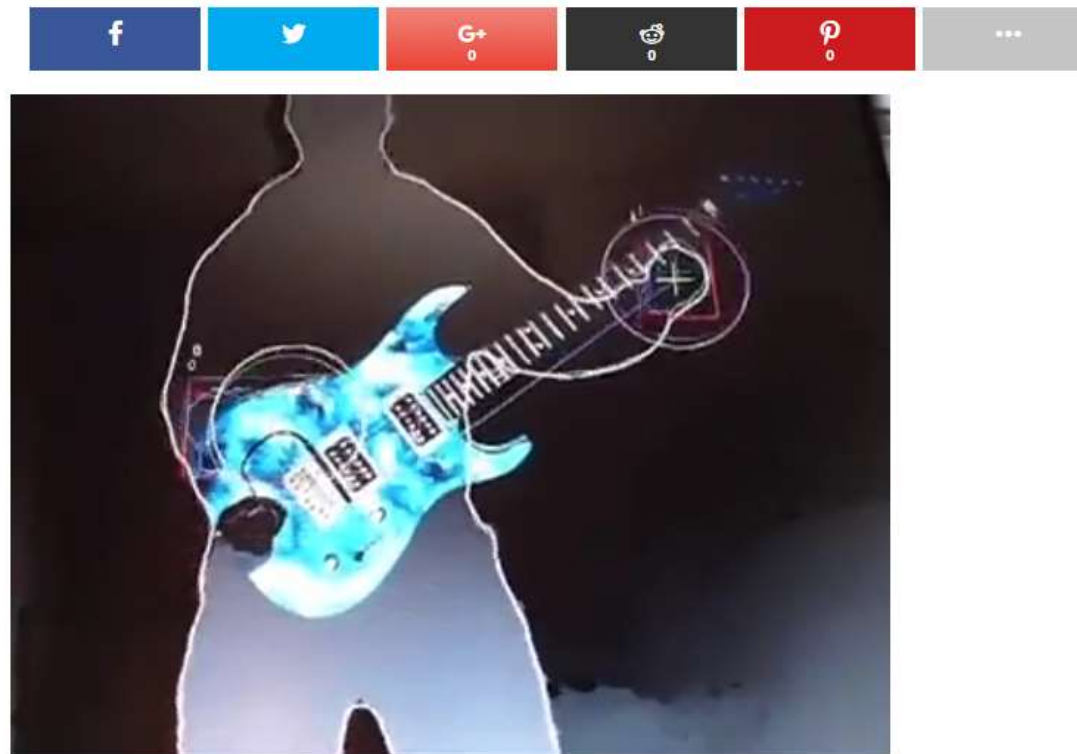


3D Handscanner

- Spider
- Eva
- Mantis Vision F5 Short Range



Kinect air guitar

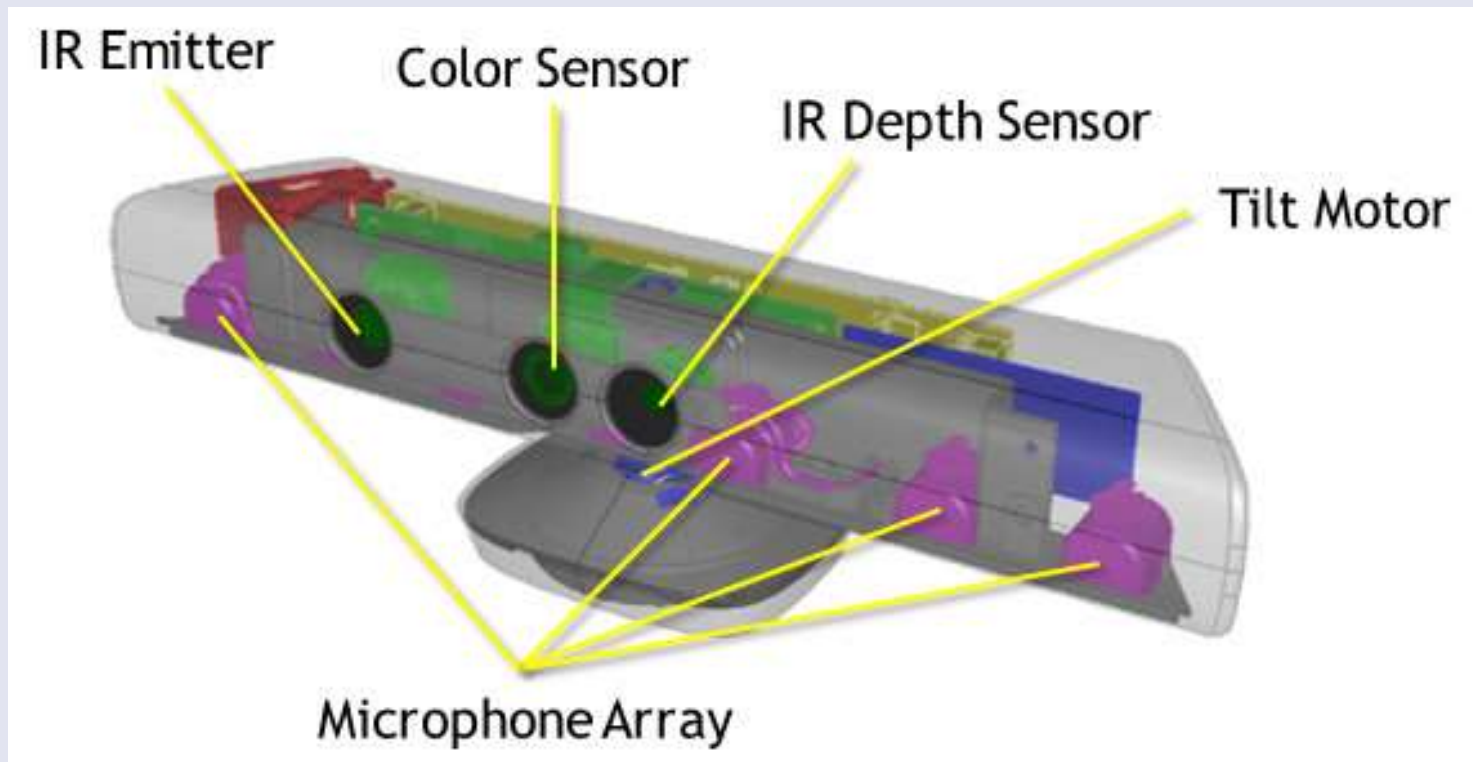


Chris O'Shea emailed in with his super sweet Kinect hack, allowing him to [play air guitar!](#)

[Im Jahr 2010 : https://makezine.com/2010/12/10/kinect-air-guitar/](https://makezine.com/2010/12/10/kinect-air-guitar/)

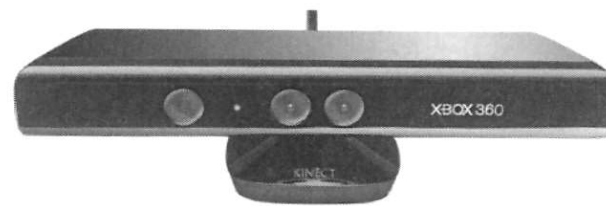
Messsysteme zur Gestenerkennung

Kinect 1 (640*480 Pixel)



Messsysteme zur Gestenerkennung

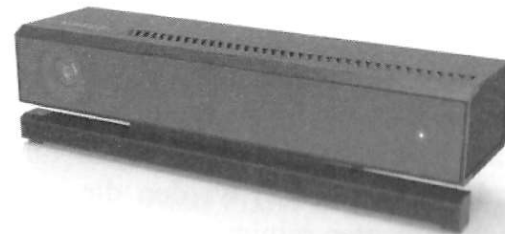
- Kinect



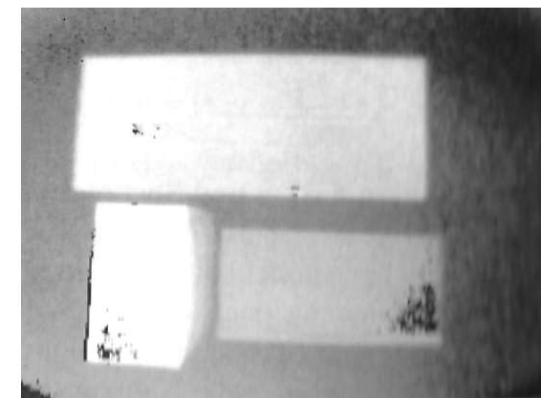
Kinect 1 basierend auf PrimeSense ChipSet



Projiziertes Punktmuster



Kinect 2 basierend auf ToF-Prinzip



Distanzbild



Low cost 3D: Structured light using a fixed pattern projection

P 253-254 Low Cost Consumer-grade range 3D cameras Luhmann, Thomas, Stuart Robson, Stephen Kyle, and Jan Boehm. *Close-Range Photogrammetry and 3D Imaging*. 2nd ed. Berlin, Boston: De Gruyter, 2013. <https://doi.org/10.1515/9783110302783>.

Boehm, J. "Natural User Interface Sensors for Human Body Measurement." *ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences XXXIX-B3* (August 1, 2012): 531–36. <https://doi.org/10.5194/isprsarchives-XXXIX-B3-531-2012>.

ASUS Xtion Pro

[http://www.asus.com/
Multimedia/Xtion PR
O LIVE/](http://www.asus.com/Multimedia/Xtion_PRO_LIVE/)

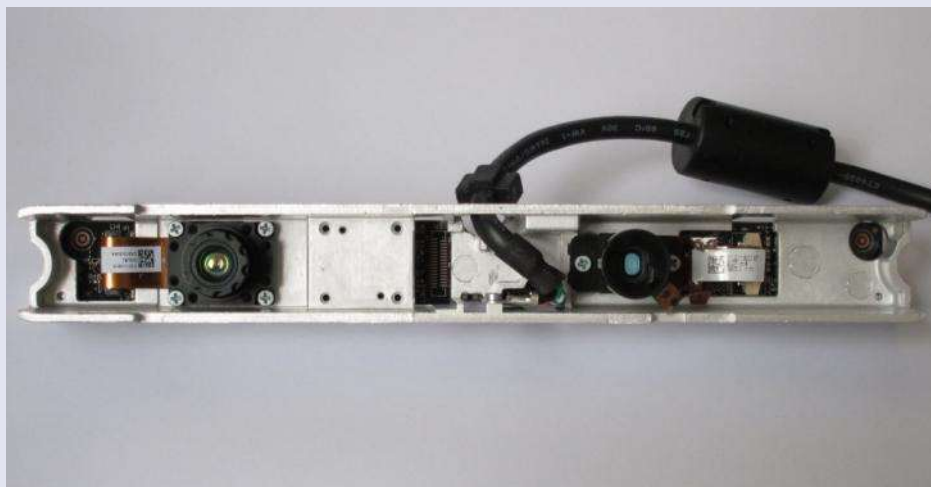


Image: Jan Boehm , Senior Lecturer, UCL CEGE

NUI Sensor Packages

- Microsoft Kinect
 - PrimeSense PSDK 5.0
 - ASUS Xtion Pro Live
 - ASUS Xtion Pro
-
- “Mechanical”
packaging differs



Slide: Jan Boehm , Senior Lecturer, UCL CEGE



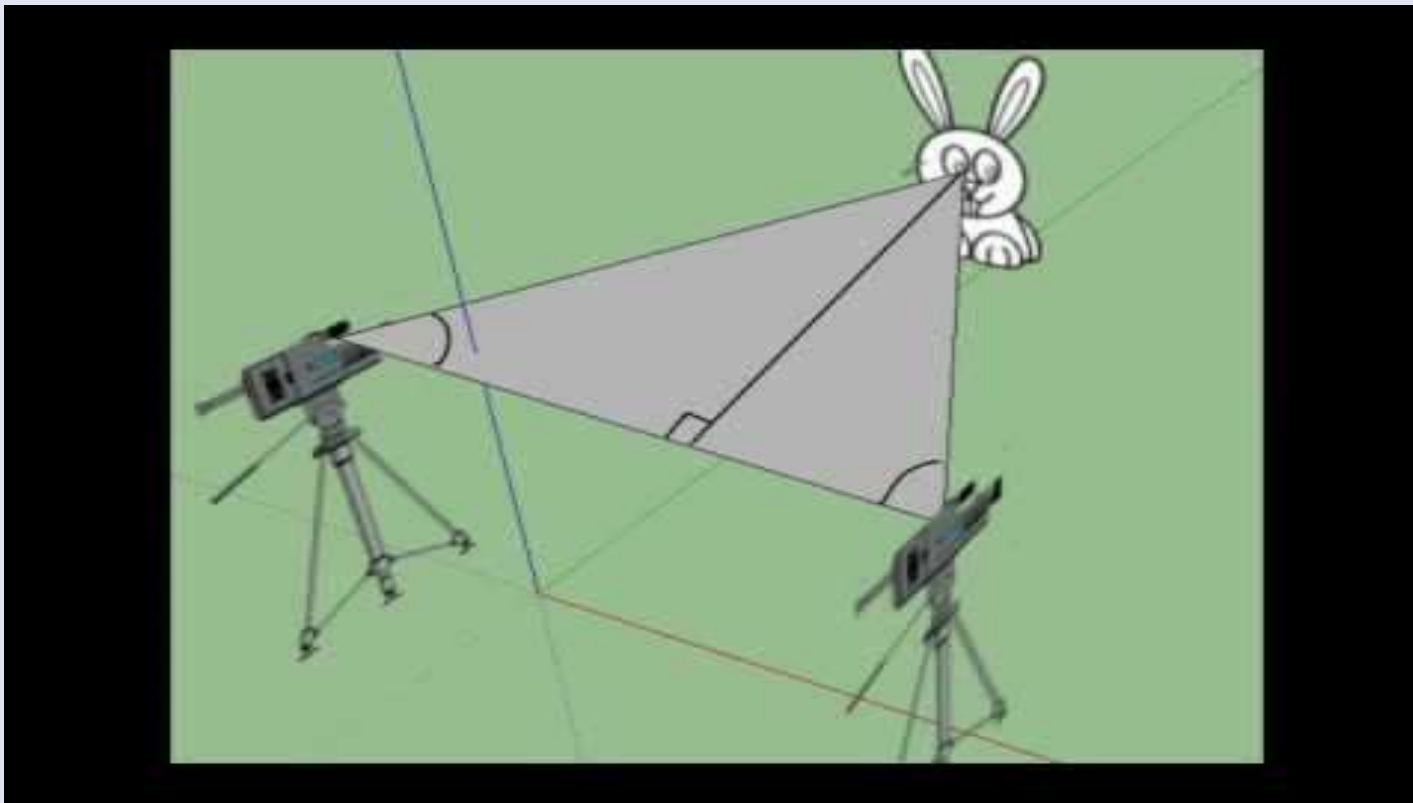
Field of View (Horizontal, Vertical, Diagonal)	58° H, 45° V, 70° D
Depth Image Size	VGA (640x480)
Operation range	0.8m-3.5m
Spatial x/y resolution (@2m distance from sensor)	3mm
Maximal image throughput (frame rate)	60fps

Table 1. Specifications of the PrimeSense reference sensor design as given by the manufacturer.

...single depth frame is quite low at only VGA resolution (640 x 480), this number has to be seen in relation to the frame rate. If we multiply the number of points of a single frame with the frame rate of 30 frames per second we receive a sampling rate of 9.216.000 points per second. This outperforms current terrestrial laser scanners by an order of magnitude.

Artec Spider > 1 Mio points/sec
 Breuckmann /Zeiss T-scan is 210.000 points/sec
 Breuckmann/ Zeiss L3D

Speckle pattern.

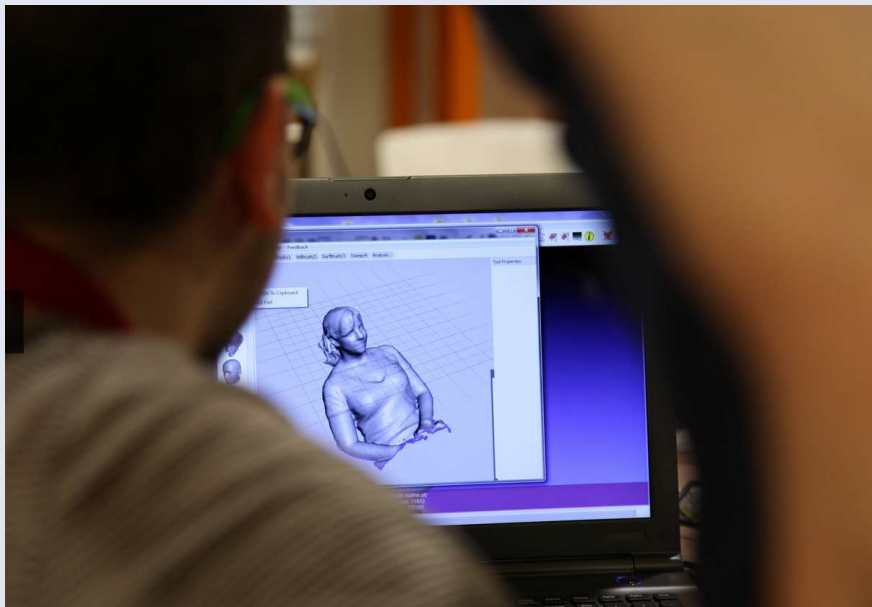


The camera uses a single LED to emit sinusoidal infrared light.
A synchronised imaging chip takes four samples of one period of the sinus signal.
This allows the computation of the phase shift and subsequently depth for each pixel.

Low



Low cost laser scanning



Yesterday (Thursday 8th November), with Jeremy Bentham's Auto Icon taken out of its display case for cleaning, the UCL Geomatics [Photogrammetry, 3D Imaging and Metrology Research Group](#) took the opportunity to add to their portfolio of scanning case studies using a low-cost Kinect-type sensor to capture JB's 3D geometry. As 3D Imaging experts, they could not resist creating a quick 3D model! A first rendering can be viewed on YouTube via the following link: <http://www.youtube.com/watch?v=Gy7muFzA1e0>



(Photo taken by Subhadra Das)

The team left to right: [Jan Boehm](#), [Mona Hess](#), John Hindmarch, Ali Hosseinaveh Ahmadabadian , Ben Sargeant.



Primesense 3D Scanning



Isaac Newton Death Mask and Xbox



<https://pictures.royalsociety.org/image-rs-8492>



Sir Isaac Newton Deathmask possibly Original



Low cost 3D

- **Jeremy Bentham in 2 x 3D!**
- <https://uclgeomatics.com/2012/11/09/jeremy-bentham-in-3d/>
- **Sir Isaac Newton in Digital 3D**
- <https://uclgeomatics.com/2014/02/07/sir-isaac-newton-in-3d/>

Bodyscanning with 8 primesense sensors

<http://www.ucl.ac.uk/3dim/bscanner>

Body Scanning



media coverage:

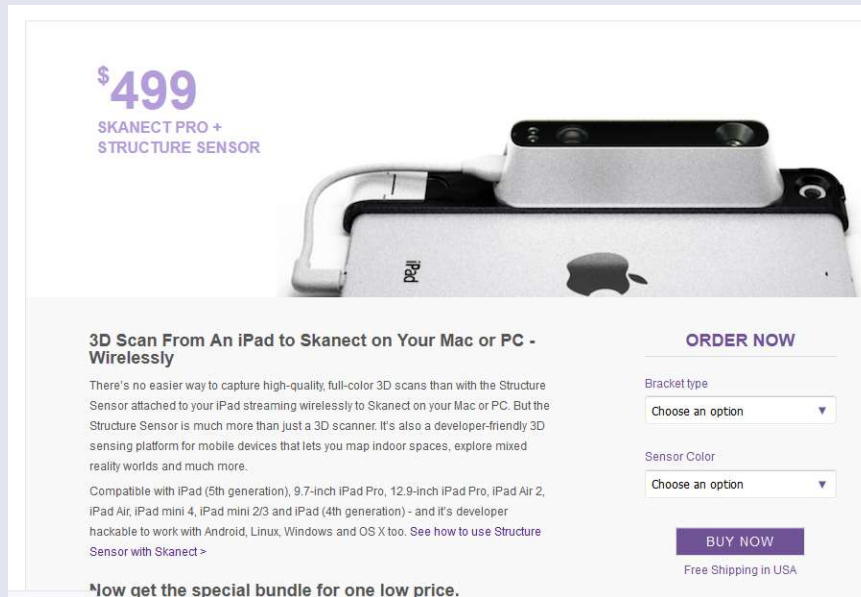
- > [Forbes](#) - press article
- > [NewLookTV](#) - YouTube Video
- > [Gizmodo](#) - internet article
- > [Daily Mail](#) - press article
- > [3D News](#) - internet news (Russia)

Bodyscanning with 8 primesense sensors



<https://gizmodo.com/5853065/clothing-store-body-scanners-know-your-every-curve>

Software für die Nutzung von Primesense/ Kinect Sensoren



\$499
SKANECT PRO +
STRUCTURE SENSOR

3D Scan From An iPad to Skanect on Your Mac or PC - Wirelessly

There's no easier way to capture high-quality, full-color 3D scans than with the Structure Sensor attached to your iPad streaming wirelessly to Skanect on your Mac or PC. But the Structure Sensor is much more than just a 3D scanner. It's also a developer-friendly 3D sensing platform for mobile devices that lets you map indoor spaces, explore mixed reality worlds and much more.

Compatible with iPad (5th generation), 9.7-inch iPad Pro, 12.9-inch iPad Pro, iPad Air 2, iPad Air, iPad mini 4, iPad mini 2/3 and iPad (4th generation) - and it's developer hackable to work with Android, Linux, Windows and OS X too. See how to use Structure Sensor with Skanect >

Now get the special bundle for one low price.

ORDER NOW

Bracket type
Choose an option ▼


Sensor Color
Choose an option ▼


BUY NOW
Free Shipping in USA

- <http://skanect.occipital.com/download/>
- <http://reconstructme.net/>


Tracking Camera / SLAM

click here to view and email us a web page.

A photograph showing the Intel RealSense Tracking Camera T265 mounted on a tripod. In the background, a laptop screen displays a 3D scene with two figures, and a pen holder with pens is visible on the desk.



Tracking redefined with the standalone Intel® RealSense™ Tracking Camera T265.

A close-up photograph of the Intel RealSense Tracking Camera T265, a small, rectangular, silver and black device with two circular lenses on the front and a USB-C port on the side.

With its small form factor and low power consumption, the Intel® RealSense™ Tracking Camera T265 has been designed to give you the tracking performance you want, off-the-shelf. Cross-platform, developer friendly simultaneous localization and mapping for all your robotics, drone

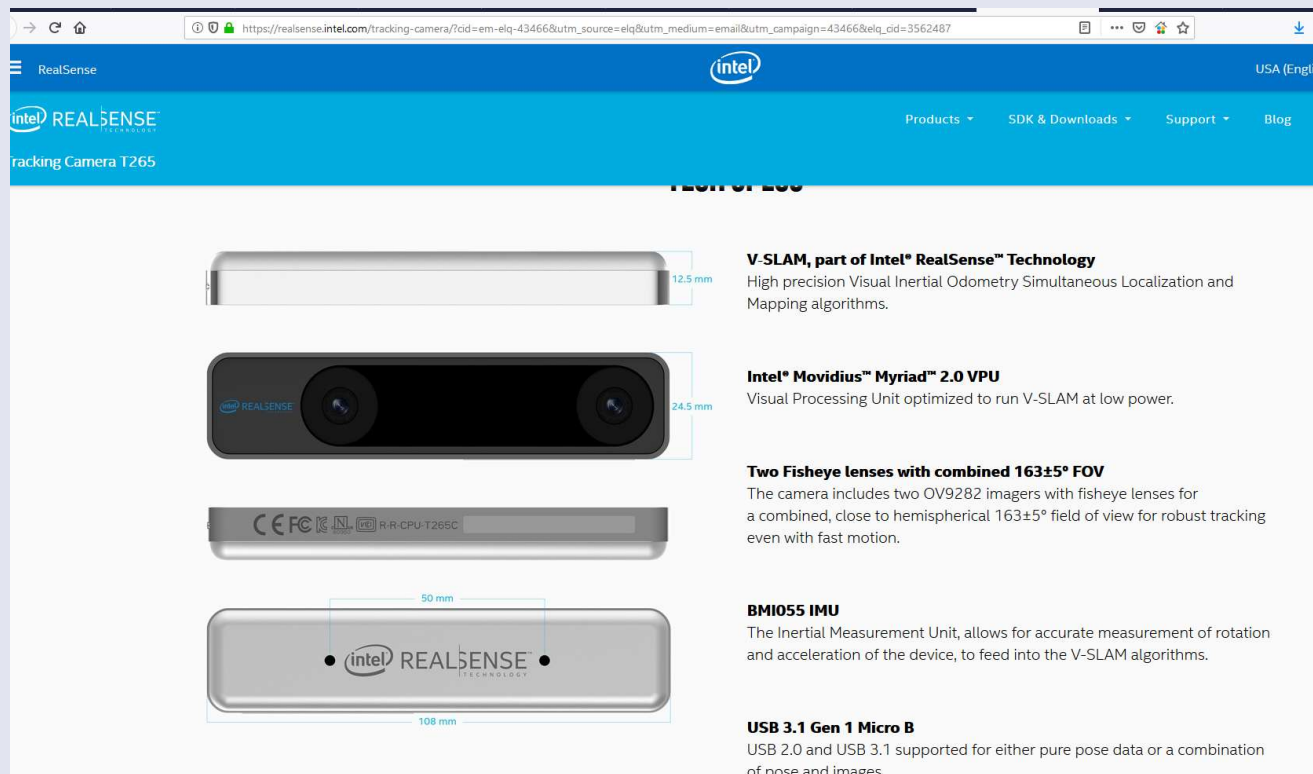


<https://structure.io/>
<https://structure.io/structure-core>

<https://www.intel.de/content/www/de/de/architecture-and-technology/realsense-overview.html>

https://en.wikipedia.org/wiki/Intel_RealSense

Tracking camera / SLAM



V-SLAM, part of Intel® RealSense™ Technology
High precision Visual Inertial Odometry Simultaneous Localization and Mapping algorithms.

Intel® Movidius™ Myriad™ 2.0 VPU
Visual Processing Unit optimized to run V-SLAM at low power.

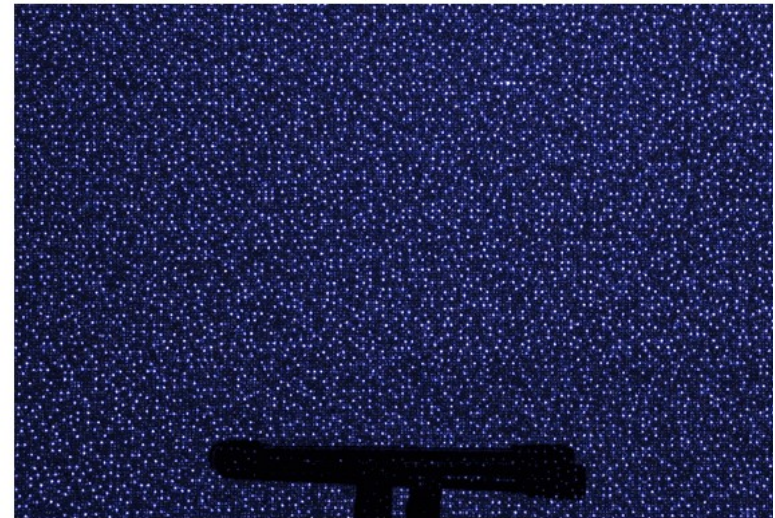
Two Fisheye lenses with combined 163±5° FOV
The camera includes two OV9282 imagers with fisheye lenses for a combined, close to hemispherical 163±5° field of view for robust tracking even with fast motion.

BMI055 IMU
The Inertial Measurement Unit, allows for accurate measurement of rotation and acceleration of the device, to feed into the V-SLAM algorithms.

USB 3.1 Gen 1 Micro B
USB 2.0 and USB 3.1 supported for either pure pose data or a combination of pose and images.

<https://realsense.intel.com/tracking-camera/>

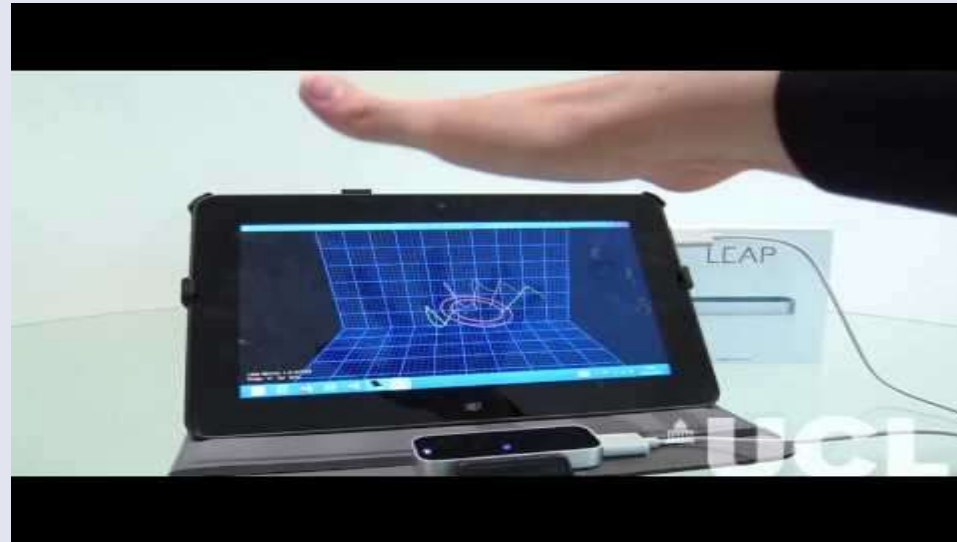
Ambient light sensor
Proximity sensor
Flood Illuminator
Infrared camera
Speaker
Microphone
7MP camera
Dot projector



<https://www.theverge.com/circuitbreaker/2017/9/17/16315510/iphone-x-notch-kinect-apple-primense-microsoft>

Gesture Recognition

Leap Motion



[3dimagingucl](http://www.ucl.ac.uk/3dim/)

Published on 30 Jul 2013



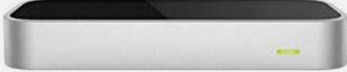
Leap Motion on a Windows 8 Tablet

<http://www.ucl.ac.uk/3dim/>

<https://www.leapmotion.com/>

<https://gallery.leapmotion.com/cat-explorer/>

Gesture recognition

 <p>Leap Motion Universal VR Developer Bundle (VR-UAZ)</p> <p>\$89⁹⁹</p> <p>✓prime ★★★★★ 38</p> <p>ADD TO CART</p>	 <p>Leap Motion Controller for Mac or PC (Retail Packaging and Updated Software)</p> <p>\$91⁷⁸</p> <p>✓prime ★★★★★ 191</p> <p>ADD TO CART</p>	 <p>Leap Motion Controller, Gesture Motion Control for PC or MAC</p> <p>\$90⁰⁰</p> <p>SEE BUYING OPTIONS</p>
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<https://www.leapmotion.com/>
<https://gallery.leapmotion.com/cat-explorer/>

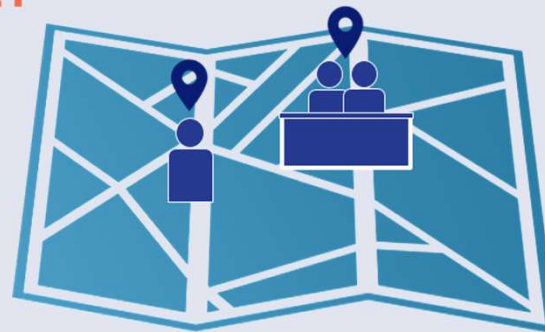
Beacons/ Indoor GPS

1.



Icon by Lloyd Humphreys

2.



Icon by John Hyuk Kwon

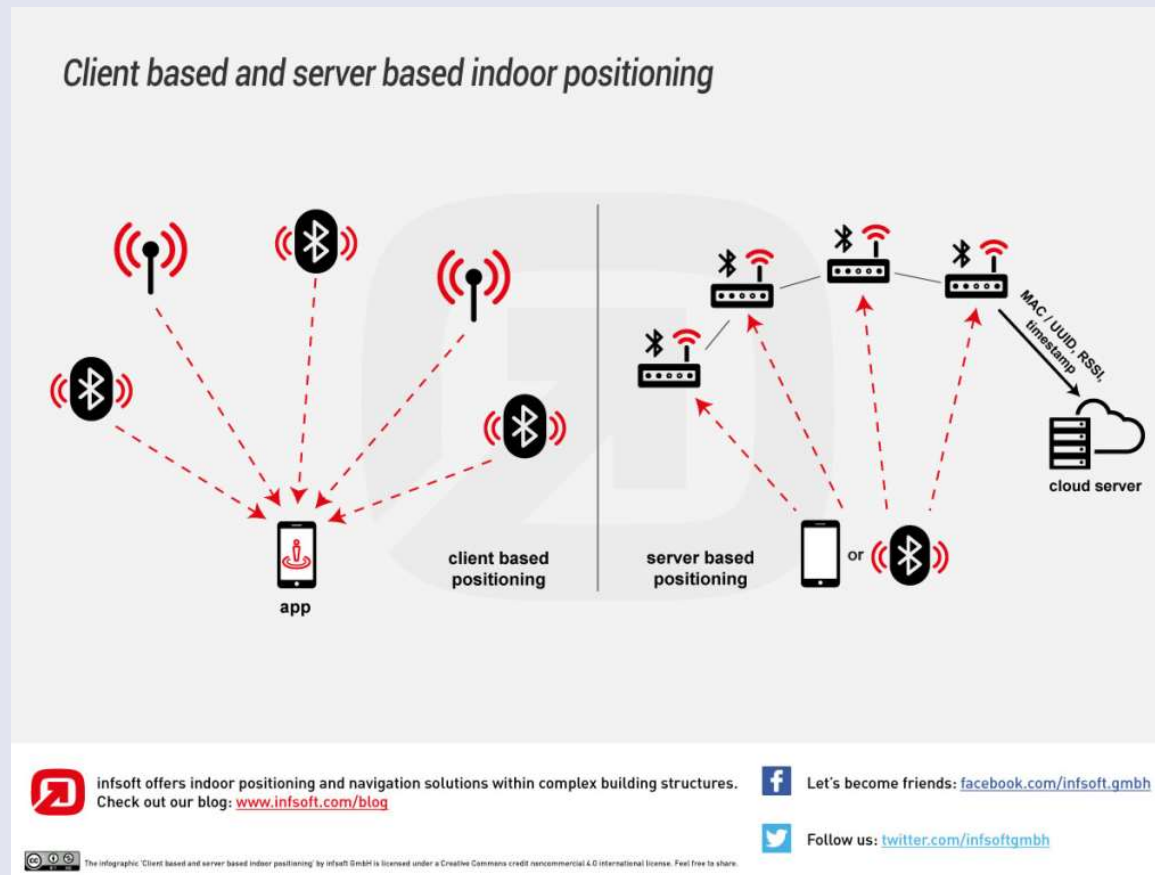
3.



Icon by Wilson Joseph

<http://blog.match-app.de/beacons-kurz-erklaert/>

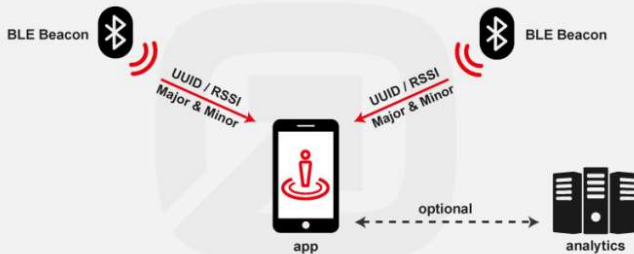
Internet of Things/ Indoor GPS und WLAN or Bluetooth Beacons




<https://www.industry-of-things.de/indoor-positionsbestimmung-funktionsweise-und-technische-informationen-a-561397/>


Internet of Things/ Indoor GPS und WLAN or Bluetooth Beacons


Client based indoor positioning using BLE: pros & cons



pros	cons
<ul style="list-style-type: none"> - cost-effective, unremarkable hardware - low energy consumption - flexible integration - compatible with iOS and Android - high accuracy compared to WiFi (up to 1m) 	<ul style="list-style-type: none"> - additional hardware - app is required for client based solutions - relatively small range (up to 30m)

 infsoft offers indoor positioning and navigation solutions within complex building structures. Check out our blog: www.infsoft.com/blog

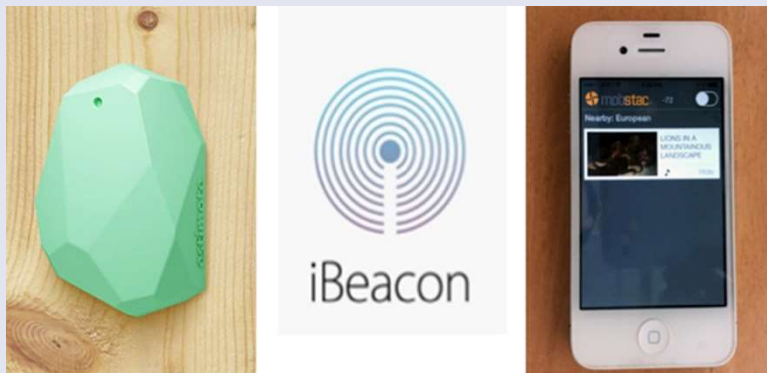
 Let's become friends: [facebook.com/infsoftgmbh](https://www.facebook.com/infsoftgmbh)

 Follow us: twitter.com/infsoftgmbh

The infographic 'How indoor positioning using WiFi works' by infsoft GmbH is licensed under a Creative Commons credit noncommercial 4.0 International license. Feel free to share.

<https://www.industry-of-things.de/indoor-positionsbestimmung-funktionsweise-und-technische-informationen-a-561397/>

Wie sehen Beacons aus?



- <https://estimote.com/pres-s-kit/>



Choose the best SDK for your app

At Estimote, we provide complete Software Development Kits (SDKs) to get you quickly started building context-aware apps. We also equip you with software tools and APIs allowing you to distribute your real-world apps securely and at scale.

Presence authentication, proximity marketing, and automation


If you find that GPS technology is not accurate enough for your indoor or outdoor applications then choose our **Estimote Proximity SDK**. It is optimized for reliable entry and exit events and it will allow you to authenticate presence, send contextual notifications, display proximity-based content, or create software automations.

Works best with Estimote Proximity Beacons. Their default lifetime is approx. 2 years.

Buy 3 Proximity Beacons for \$59

If you want a longer battery life, then use our Location Beacons for proximity applications.

Buy 3 Location Beacons for \$99



Beacons im Museum

- <https://www.metmuseum.org/blogs/digital-underground/2015/beacons>
- <https://www.metmuseum.org/visit/met-app>
- Design an app
<http://www.beacondo.com/>
-

Software

To compare the variety of tools that are available to use with beacons, two solutions were employed: an app developed by [Mobstac](#), and a free app, SDK, by [Beacondo](#). The Beacondo app alone was used for the subsequent follow-up testing in the galleries and other demos in the Museum (fig. 6).

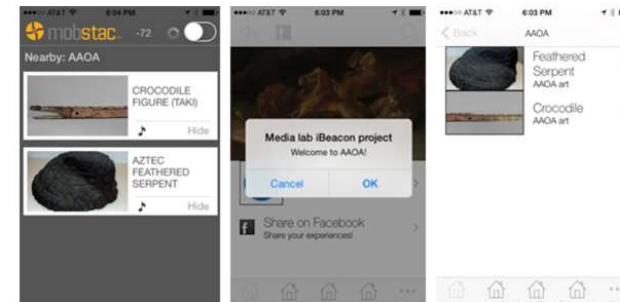
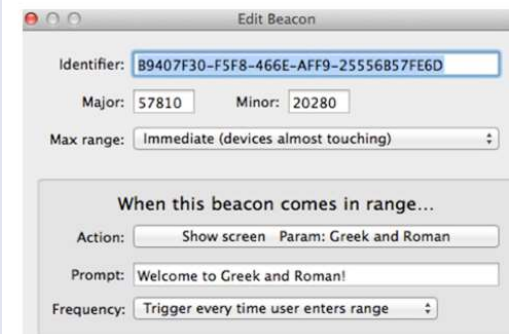


Fig. 6. To compare the variety of tools to use with beacons, two technology solutions were employed: an app developed by Mobstac (left), and a free app, SDK, by Beacondo (center and right).

Beacon Setup in Beacondo

Each beacon's unique information (UUID, major and minor values) was added in the beacons section of the Beacondo editor (fig. 7).



Favendo Bamberg

- Bamberger Firma (auf der ERBA)
 - <https://www.favendo.com/indoornavi/>
 - <https://www.favendo.com/modules/beacons/>
 - *Lichttechnologie/Visual Light Communication (VLC) und das auf ihr basierende Indoor Positionierungssystem (IPS) erlauben eine noch genauere Positionierung und Navigation. Die Positionierungsgenauigkeit liegt bei ca. 30 Zentimetern und entspricht den Anforderungen einer produktgenauen Navigation im Lebensmitteleinzelhandel. Erkauft wird diese Genauigkeit mit dem Nachteil, dass das Smartphone ständig „Sichtkontakt“ zur Lichtquelle haben muss. Durch eine Kombination mit Beacon-Technologie kann dieser Nachteil aufgehoben und die Positionierungs-Genauigkeit beibehalten werden.*



Favendo

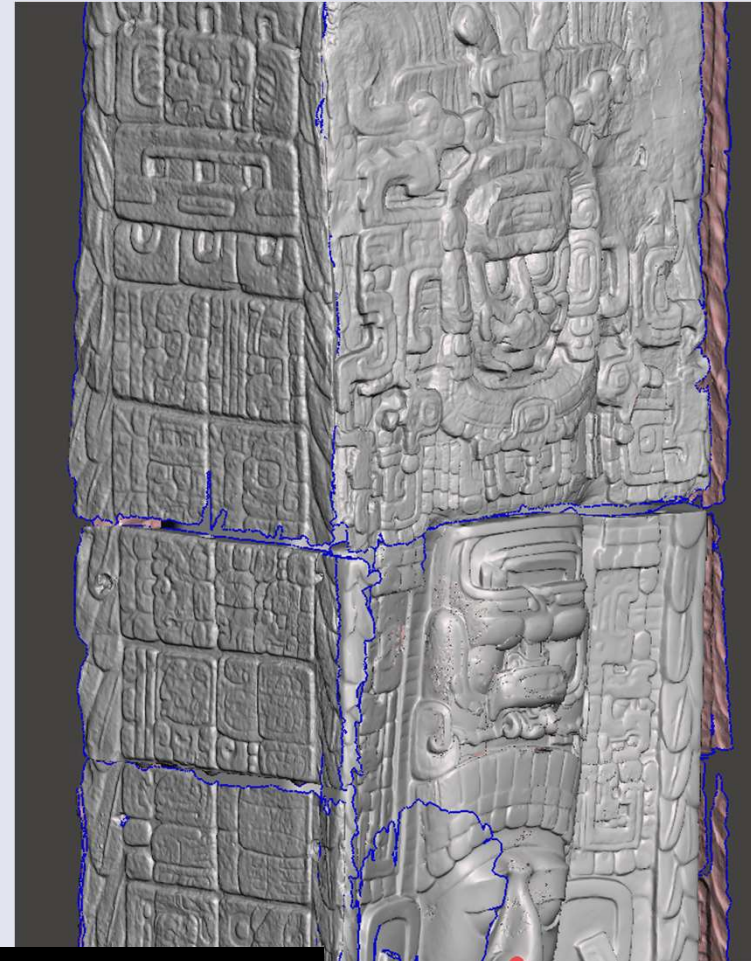
Favendo Beacons Blackwell Bluetooth Low energy indoornavigation

Weiterführende Links

- <http://blog.match-app.de/beacons-kurz-erklaert/>
- <https://www.industry-of-things.de/indoor-positionsbestimmung-funktionsweise-und-technische-informationen-a-561397/>
- Sehr ausführliche Technische Arbeit : Bachelorarbeit, anton Anders, März 2016, Indoor-Positionsbestimmung mit Hilfe von Bluetooth-Low-Energy-Beacons und Pedestrian Dead Reckoning
- https://cse.cs.ovgu.de/cse-wordpress/wp-content/uploads/2016/08/BA_Anton_Anders.pdf



Anwendungsbeispiel



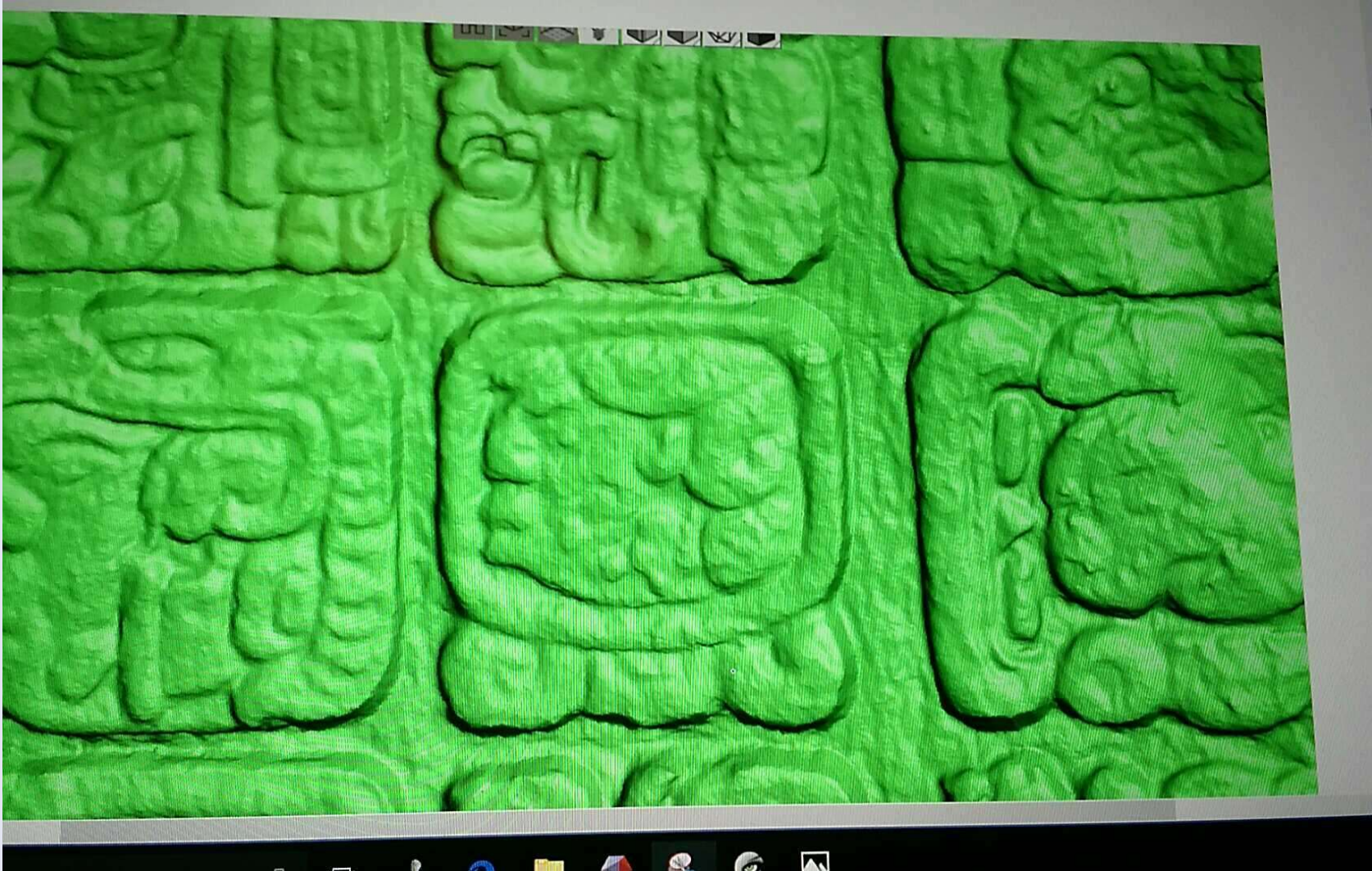
Film 1 Processing

Film 2 Virtual reconstruction

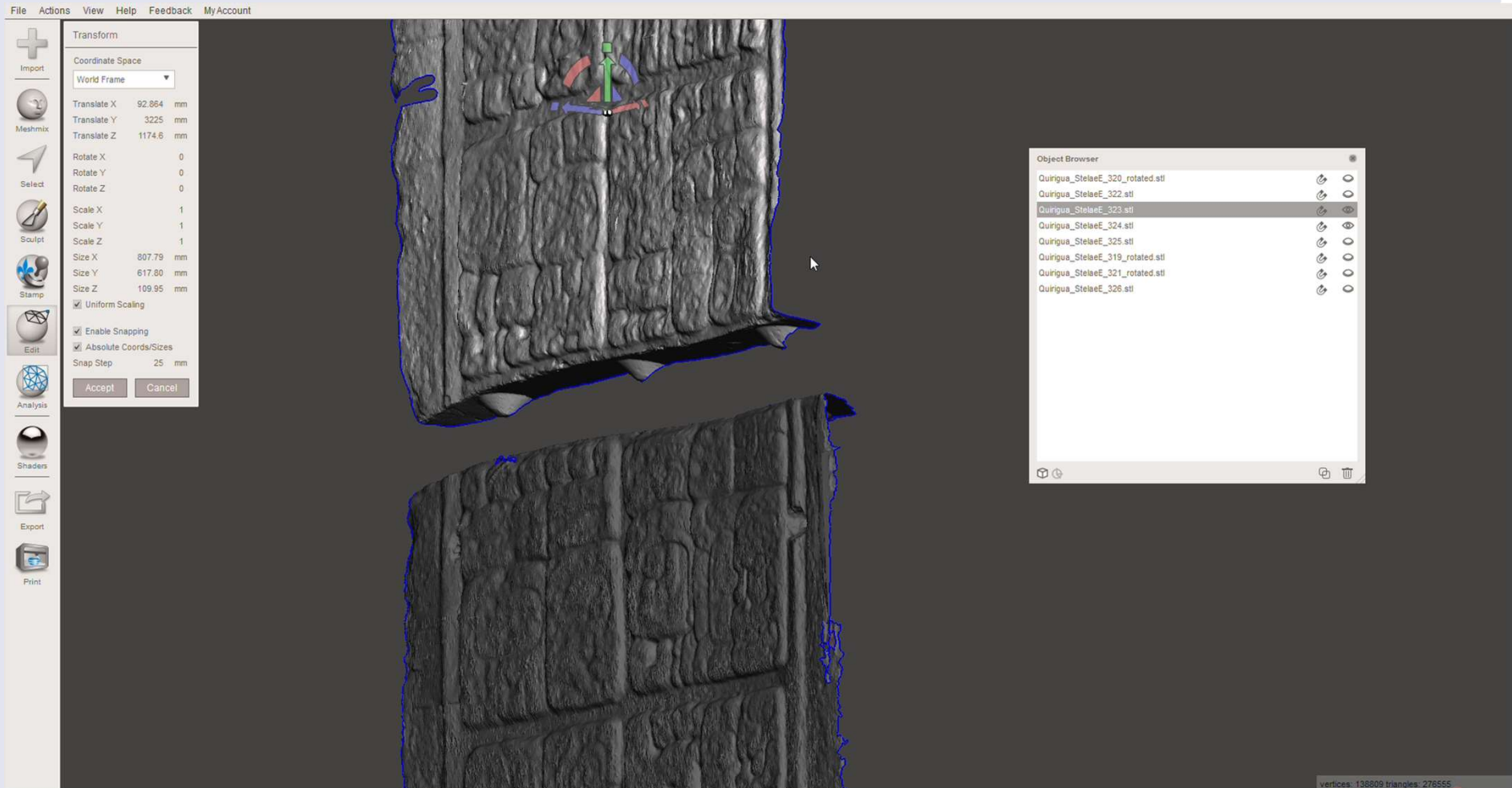
Film 3 Length of reconstruction











Literatur

- Omelanowsky D, Kersten T, Lindstaedt M Untersuchungen von Low-Cost Systemen zur 3D-Rekonstruktion kleiner Objekte. 13
https://www.researchgate.net/profile/Thomas_Kersten/publication/259639479_Untersuchungen_von_Low-Cost_Systemen_zur_3D-Rekonstruktion_kleiner_Objekte/links/00b7d52d78c5535634000000.pdf
- Boehm, J. “Natural User Interface Sensors for Human Body Measurement.” *ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences XXXIX-B3* (August 1, 2012): 531–36. <https://doi.org/10.5194/isprsarchives-XXXIX-B3-531-2012> .
- Luhmann T. Nahbereichsphotogrammetrie: Grundlagen, Methoden und Anwendungen. 3 edition. Berlin: Wichmann, H; 2010. 668 p.
 - Kapitel 6.8 Low-Cost-3D-Sensoren, S.594-596
- Stylianidis, Efstratios; Remondino, Fabio (2016): 3D recording, documentation and management of cultural heritage. Caithness: Whittles Publishing. Available online at <https://ebookcentral.proquest.com/lib/ub-bamberg/detail.action?docID=4710342>