

RTX Internship & Laser Scanning

Adventures of Trent Riek, Fall 2021

Presentation prepared by Trent Riek and Brent Dingle

Special Thanks to:
Nick Castillo
&
Brent Dingle, PhD

What To Talk About

- Summery of an Internship
- Introduction to Laser Scanning
 - Technology Used
 - Physical Process
 - Digital Processing to Modeling
- Future Opportunities

Immersive Design Center

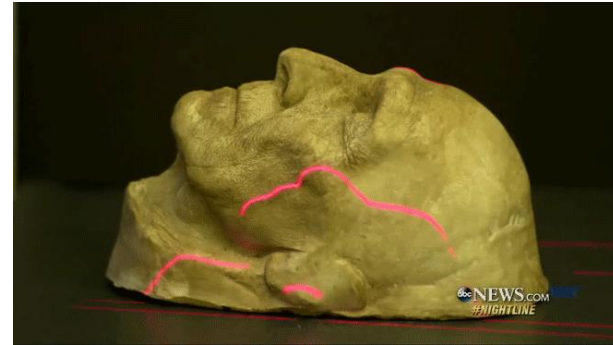
- Raytheon Intelligence & Space specializes in developing advanced sensors, training, and cyber and software solutions
- I was an intern in the RIS's Immersive Design Center for the 2021 summer
- The IDC is composed of a cross functional team focused on using and advancing visualization technology



Image from Feb 12, 2020 CSCE 680 presentation by Brent Dingle, PhD
https://calendar.tamu.edu/cse/view/event/date/20200212/event_id/159689

Intern Tasks = I did what?

- Extended Reality Modeling
 - USDZ, GLTF, OBJ files
 - Online floating heads
- Head models generated from physical scans



Concept similar to that used for Tarkin in Rogue One:

- Physical Cast Model of Peter Cushing
 - from movie Top Secret
- was scanned to create a digital model

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- Artec Eva scanners make scanning simple
- 2014 President Obama was scanned to create a bust, to be displayed in the Smithsonian

Intern Tasks = I did what?

- Extended Reality Modeling
 - USDZ, GLTF, OBJ files
 - Online floating heads
- Head models generated from physical scans
 - http://docdingle.com/models/Brent_LowPoly.usdz
 - QR Codes to link to them



No need to be famous

- Work for IDC at Raytheon
- Scan of Brent Dingle 2021, for XR display



Intern Tasks = I did what?

- Floating XR heads was a side project
- Laser Scanning (Terrestrial)
 - Occupied most of my time



Trent Riek
Performing scans
of new house
construction

Scanning Tech

- **Business Objective:**
 - Capture accurate as-built shapes of
 - Objects, buildings, landscapes...
- **Business Motivation:**
 - Enhance Design Process
 - Faster, less error in the data collected
- **Two major steps**
 - Step 1: Physically perform the laser scan
 - Step2: Post-Process the 3D point cloud data

Hardware

- Terrestrial Scanner (by Faro shown)
 - Provides no-contact 3D measurement
 - Digitally documents an object's outer surface
 - Field of View
 - 360 degree horizontal and about 320 degree vertical
- Distance measured by laser pulses reflecting back to the scanner
 - creating a cloud of points
- Scanner is safe for humans
- Requires no extra protective equipment



Step 1: Physical Scan

- Go onsite and scan
 - Enter settings for each scan
 - Keep track of where
- May do over 100 scans
 - Each takes 3 to 6 minutes
- Move data off scanner for processing
 - Decompress data
 - Scanner uses HW proprietary
 - Well compressed binary
 - Need data more manageable
 - XYZ-RGB or similar
- Register point clouds
 - Clean & Align them

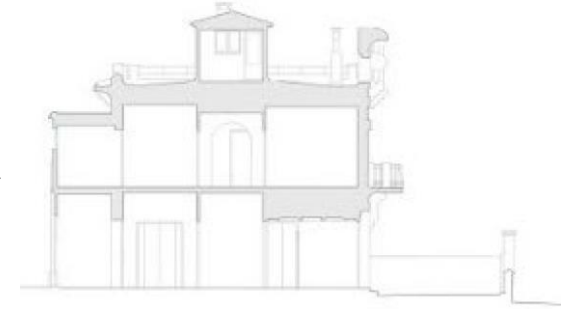
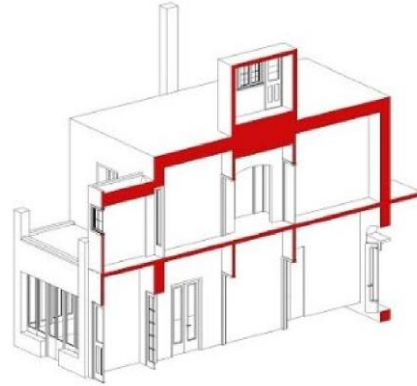


Step 2: Post Process



Registered Point Cloud

- Composed of multiple aligned scans

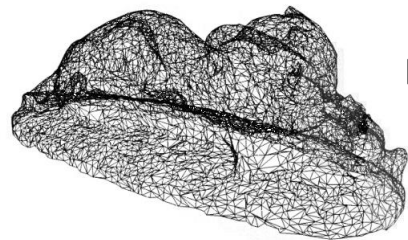


2D Vector Plans

BIM

- Building Information Modeling
 - BIM model includes architectural features such as: walls, floor, ceiling
 - BIM can be exported as a 3D assembly model for equipment of furniture layout and design
 - Or can be exported as a vector drawing for
 - real estate blueprints, facilities management, or similar

Alt Step 2: Cloud 2 Mesh



Registered Point Cloud

- Composed of multiple aligned scans

Surface Mesh

- 2016, Survey of Surface Reconstruction from Point Clouds
Berger et al. Computer Graphics Forums, Wiley, pp. 27
- 2020, 5 Step Guide to generate 3D meshes from point clouds with Python
POUX, <https://towardsdatascience.com/5-step-guide-to-generate-3d-meshes-from-point-clouds-with-python-36bad397d8ba>

Rendering

Details Matter

- Two steps seem easy
 - What about sub-steps?
- Step 1:
 - Physical Scan – straightforward
 - Decompress – HW provides SW for this
 - Cleaning – Remove noisy and ‘far away’ points
 - Register/Align – More details needed

Registering

- Each scan creates its own point cloud
 - Aligning each scan with each other requires skill
- Skill in physically doing the scans
 - Overlap in scans is good, but requires time and data storage
 - Setting up so each scan sees features other scans can see also helps
 - Keep track of physical location of scanner for each scan
- Help may come in automation algorithms
 - But results depend on many factors
- Skill in using software to align features
 - Talk more about this



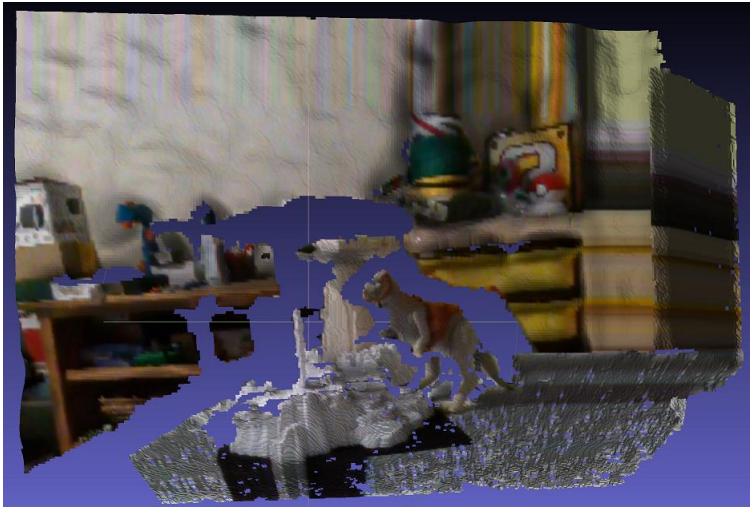
<https://ms-my.facebook.com/precisionpropertymeasurements/videos/669661730141821/>

Software

- Software options exist to load and manipulate point clouds
- Free is good (for students)
 - *Note:
Raytheon uses licensed software, most of which costs money
For the sake of larger audience applicability, focus now goes to free-to-use software
Process also deviates in detail from what Raytheon uses, but general steps are same*
- Two free options
 - Meshlab
 - <https://www.meshlab.net/>
 - CloudCompare
 - <https://www.danielgm.net/cc/>

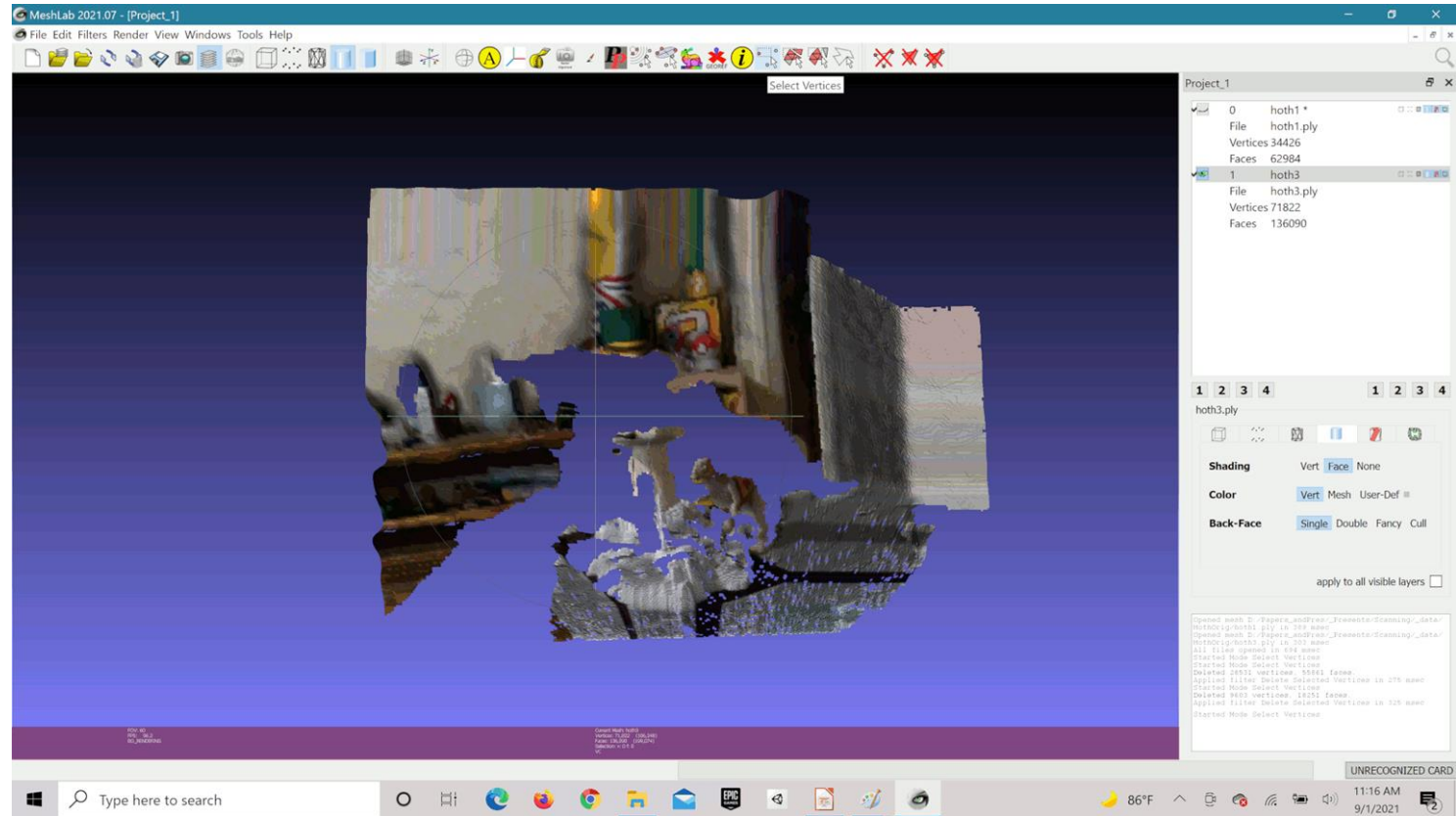
Meshlab

- Assume you have 2 point clouds saved as PLY files



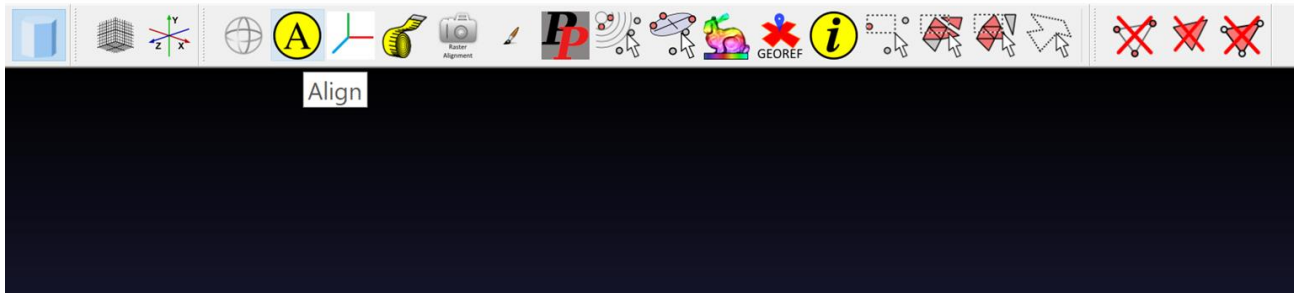
Meshlab

- Clean them by selecting and deleting points



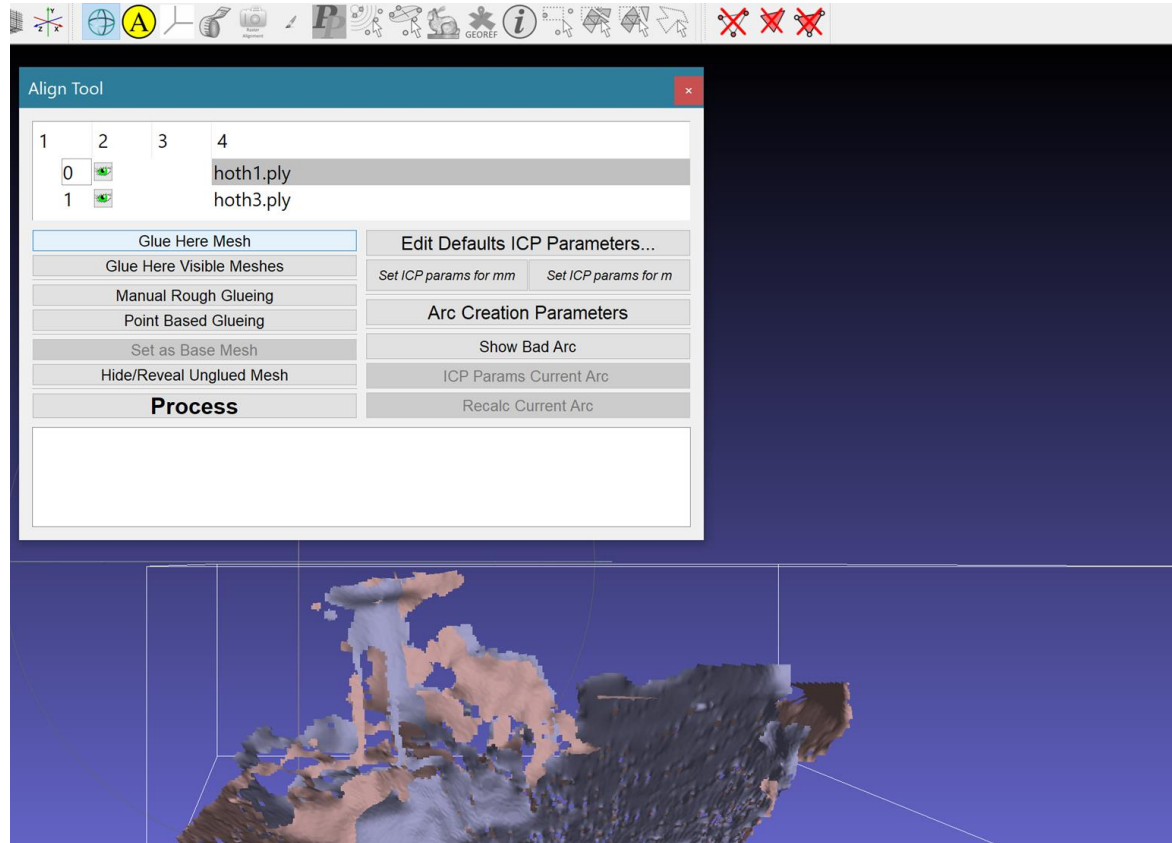
Meshlab

- Once cleaned, Select the A menu option for Align



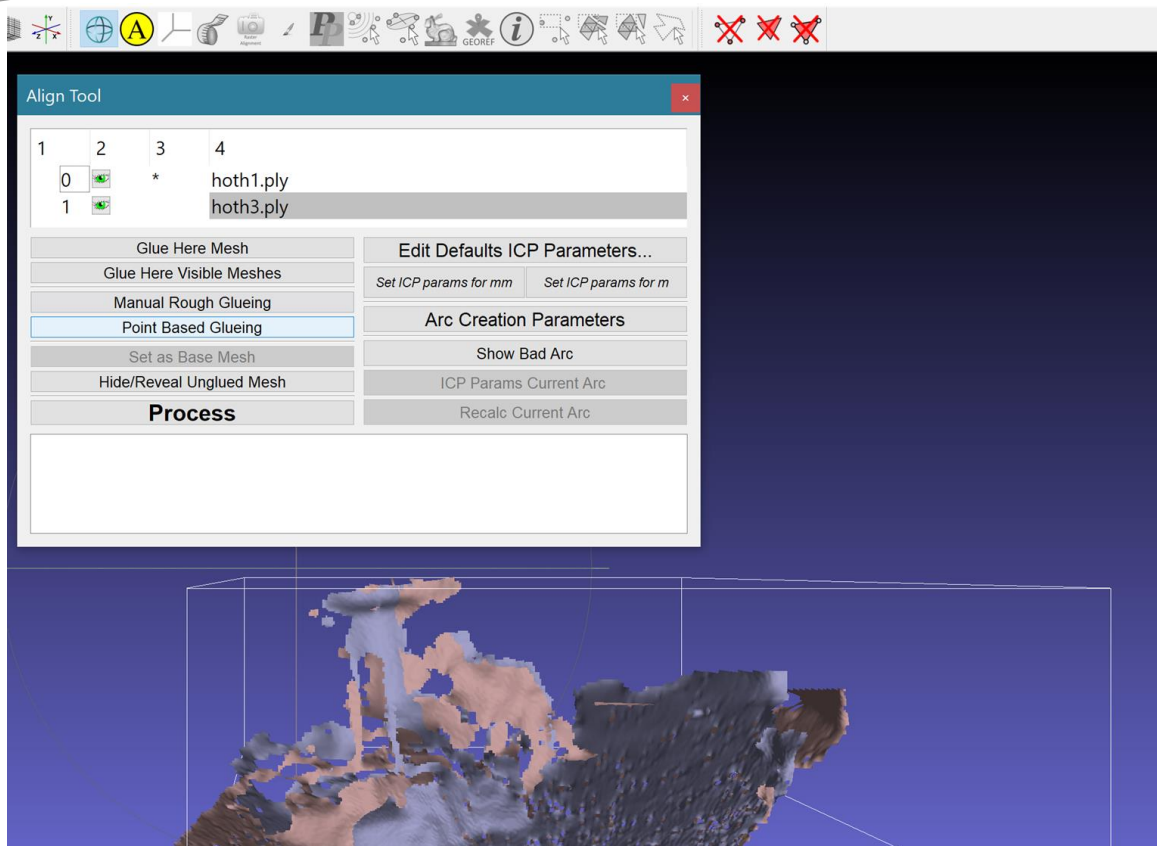
Meshlab

- This pops up the Align Tool
- Select the first point cloud and Choose:
Glue Here Mesh



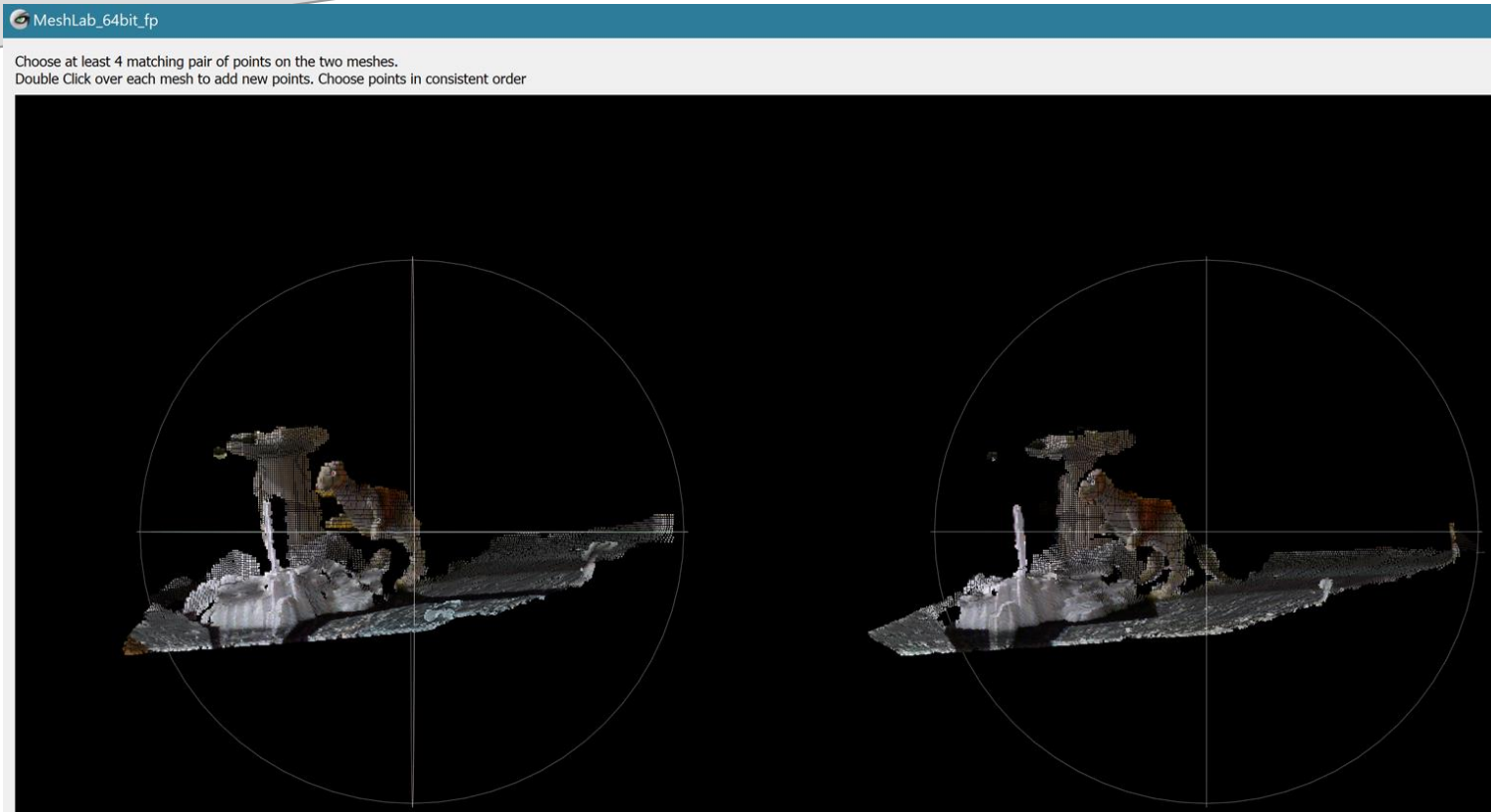
Meshlab

- Select the 2nd Point Cloud
- Choose: **Point Based Glueing**



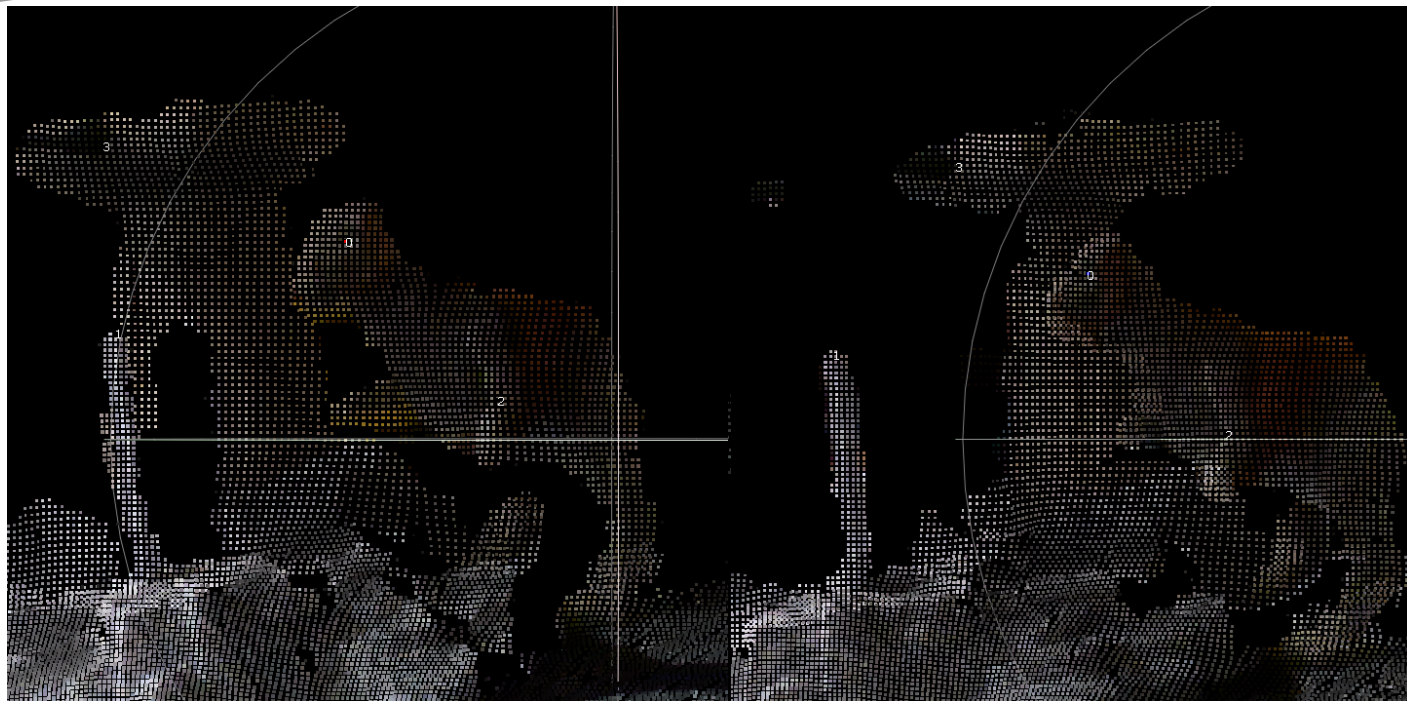
Meshlab

- Another window will pop up
 - Double-Click selects a point
- Select 4 points in each point cloud
 - Order matters



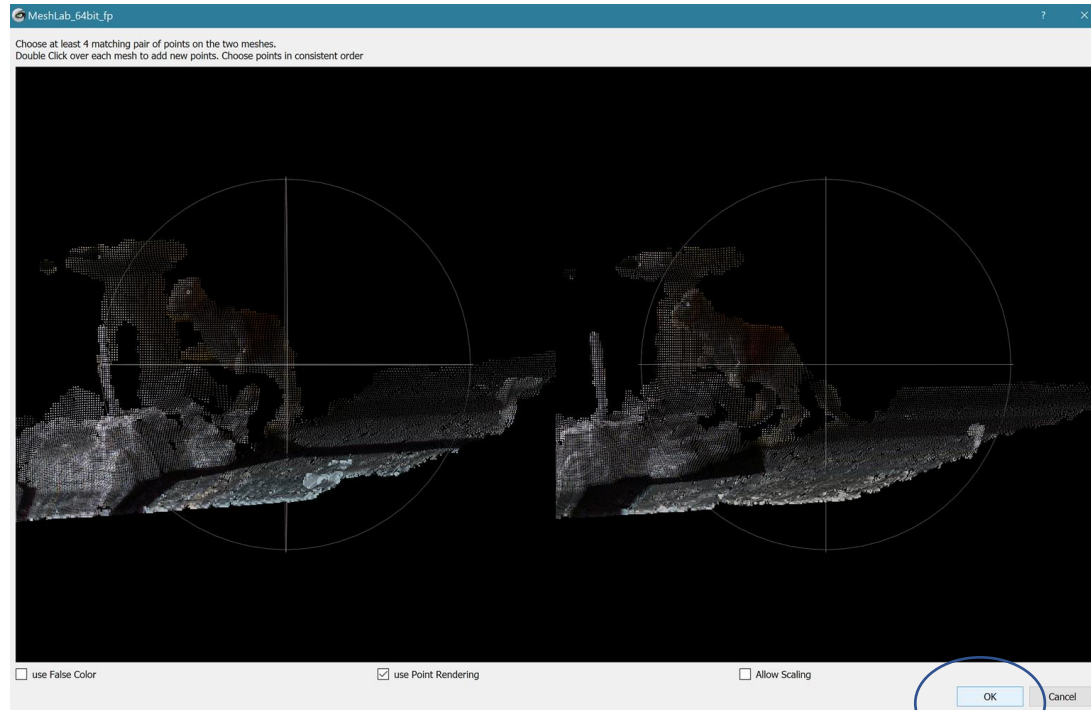
Meshlab

- Look closely
 - See the 0, 1, 2, 3 in each point cloud
- The 'eye' is our first selected match point (pt 0)
- Turret Cannon base is the 4th (pt 3)



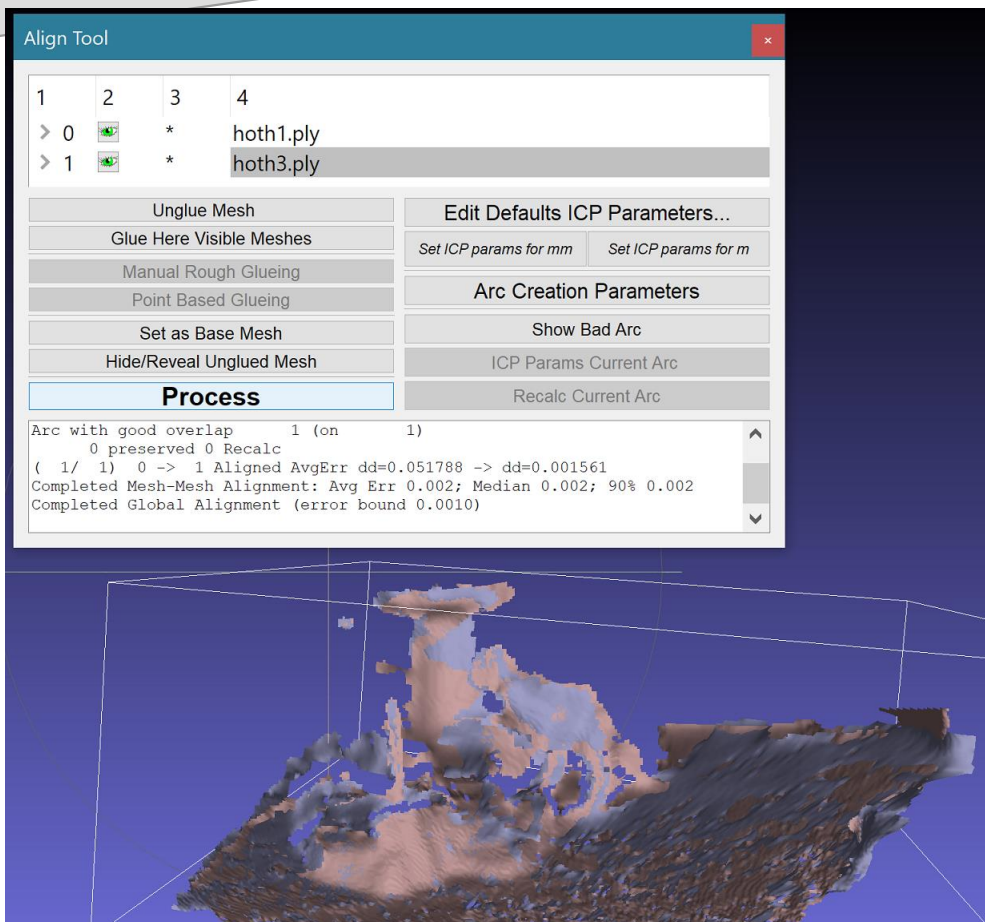
Meshlab

- When all 4 corresponding points have been selected
- Then click: OK



Meshlab

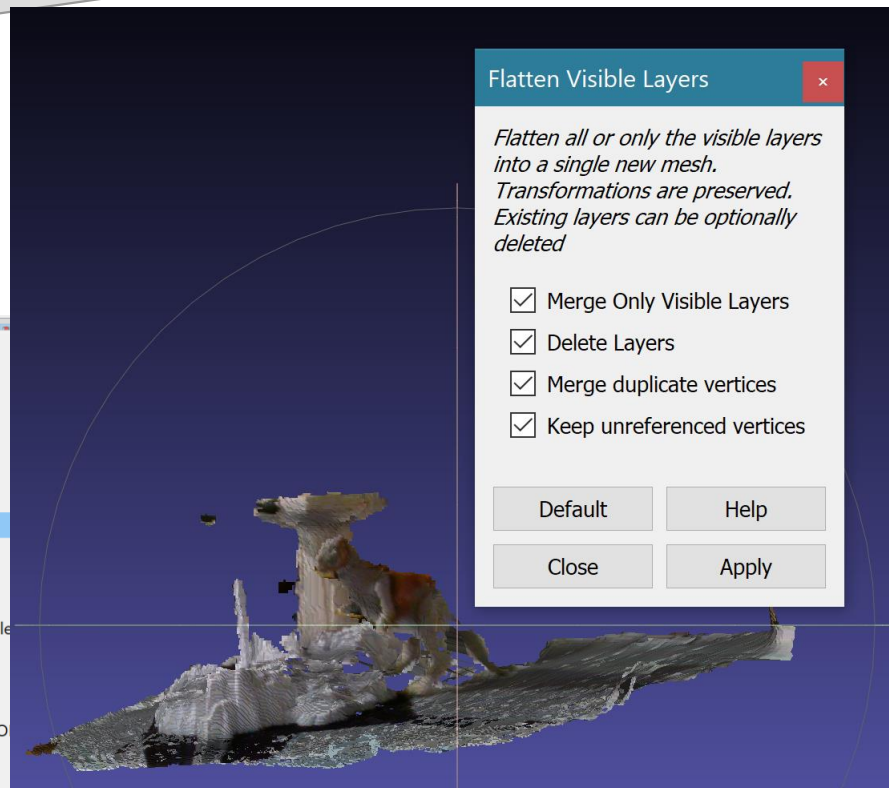
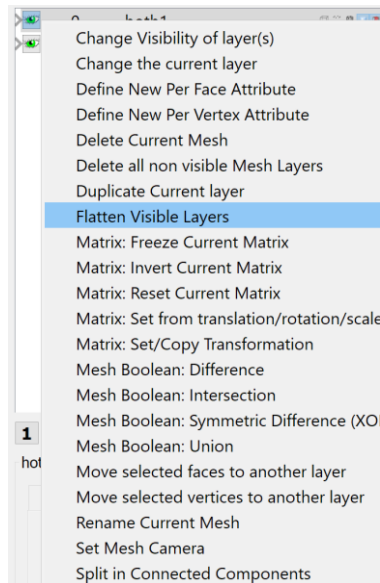
- Returns to the Align Tool window
 - Point Clouds are ROUGHLY aligned
- Can adjust ICP settings if needed
- Then Click: Process
 - This finetunes the alignment



ICP is
Iterative Closest Point

Next Steps

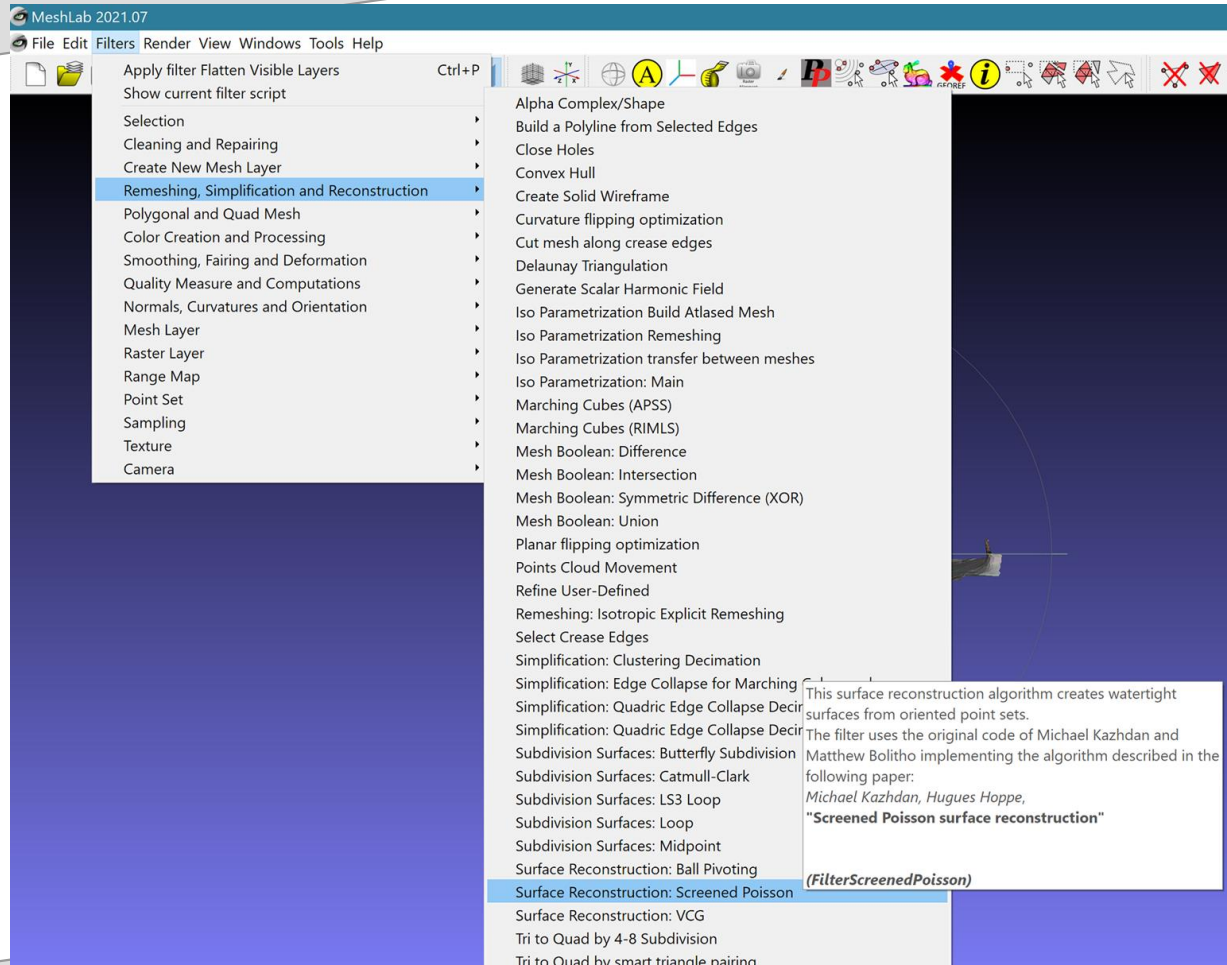
- The point clouds are now aligned
- Merge them into one by Right-Clicking on a layer
Selecting:
Flatten Visible Layers
- Should:
Keep unref'd vertices



Meshing

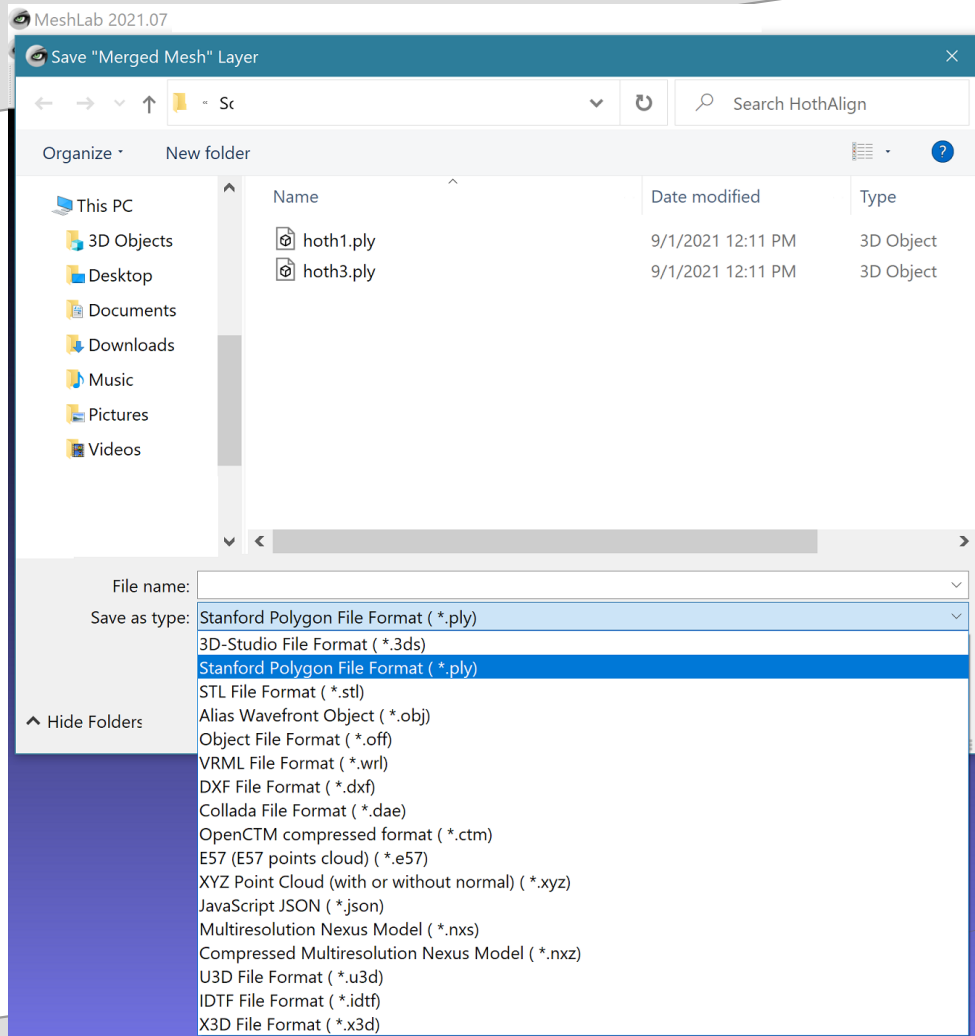
- Repeat as needed to align additional point clouds
- If scans sufficiently cover the object you can create a mesh of the object from the aligned and merged clouds
- Select Filters from the menu as shown

*See me afterwards
if you want more meshing details*



NOT Meshing

- May not need a mesh
- Can export aligned point cloud
- For use in other apps

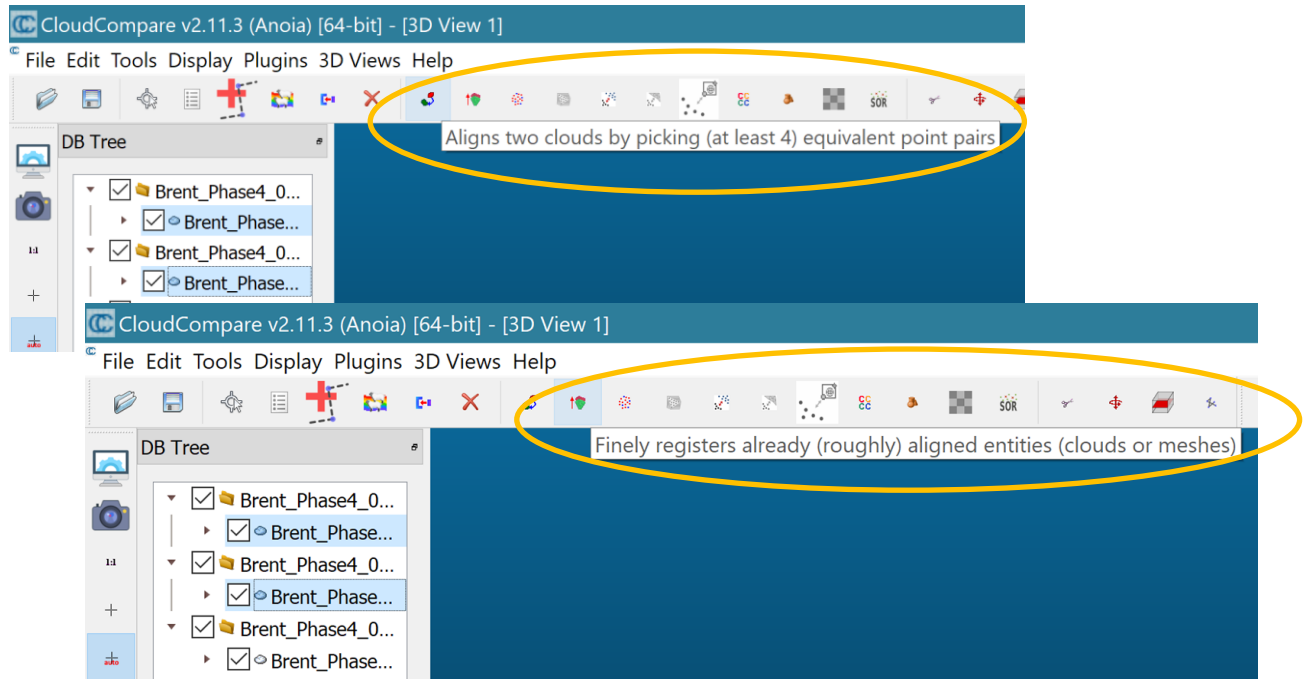


CloudCompare

- Another SW app is Cloud Compare
 - Can import Faro FLS files
 - Handles multiple large point clouds better than Meshlab
- Capable of point cloud
 - Cleanup
 - Alignment
 - Merging
 - More if needed

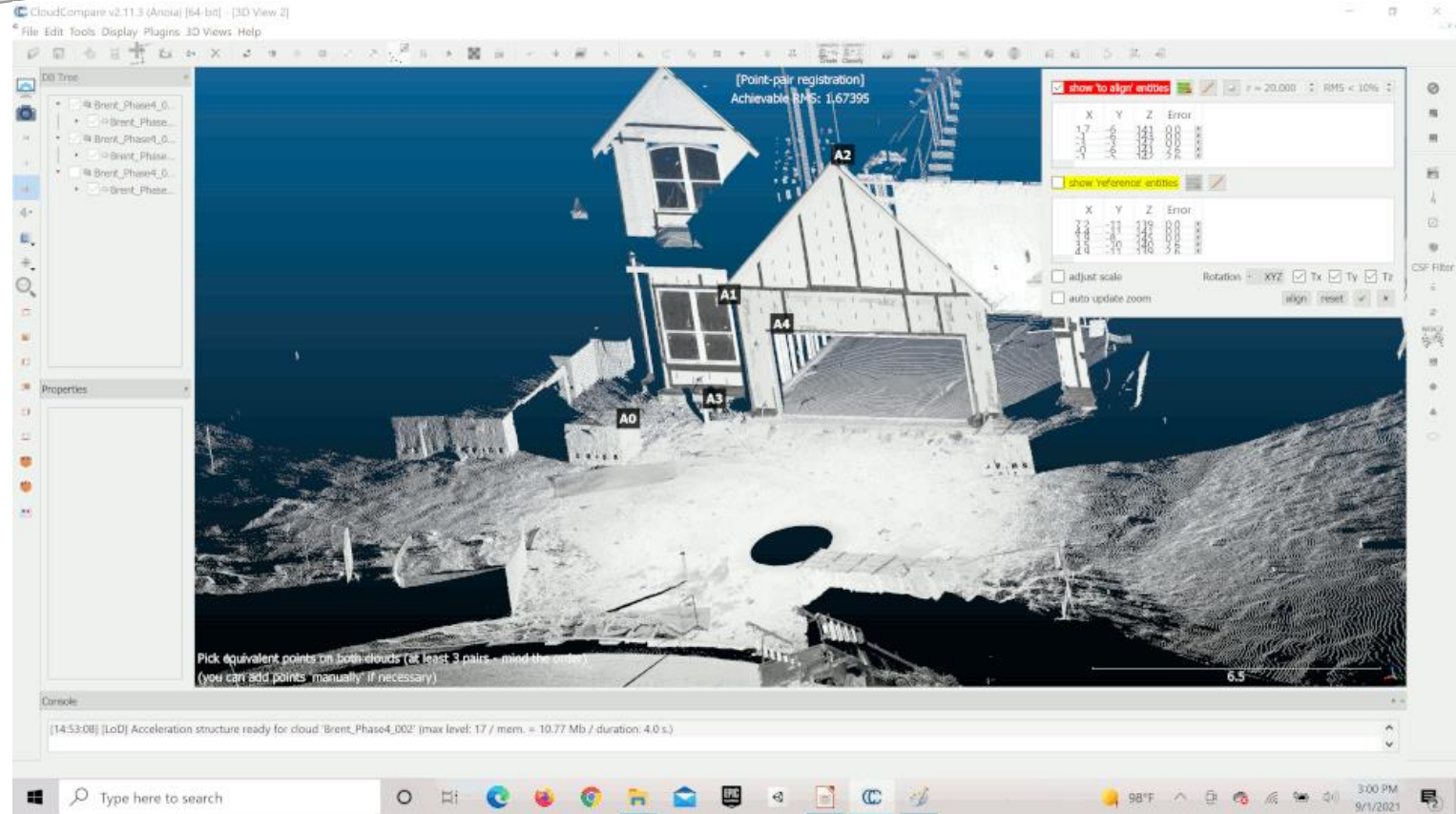
CloudCompare

- Manual Align work similar to MeshLab
- Can select more than 4 points
- Also has refinement afterwards



Example: CloudCompare

- Selected 5 points
- Clicked Align
- Results not good enough
- Select a 6th point
- Clicked Align
- Better Results
- Clicked Green Check Mark

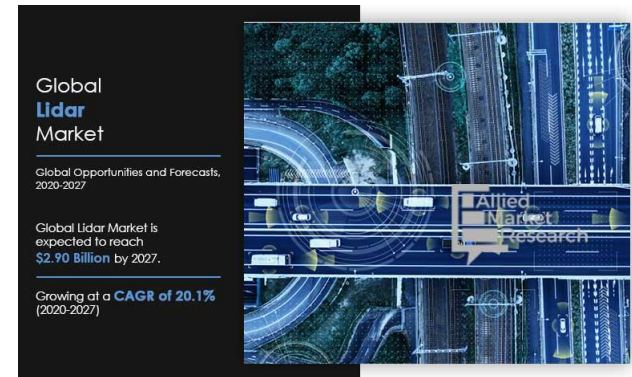


THE Point

- Physical Scanning takes skill and planning,
 - it can be taught and improves with practice
- Manipulating and using point clouds makes heavy use of skills most Viz students (and some CS and ENGR) already have
- Doing both brings better awareness and understanding of how virtual objects can relate to the real world
- Many untapped opportunities to learn, research, apply and improve Scanning Methods



Image from:
<https://www.brainshark.com/ideas-blog/2019/june/calculate-opportunity-win-rate>



<https://www.alliedmarketresearch.com/lidar-market>

Opportunities

- Career
- Architecture / Engineering / Construction
- Motion Pictures & Gaming
- Archaeology
- Art Preservation
- Law Enforcement / Forensics
- Manufacturing
- Medical / Dentistry / Biology
- Training (any field)
- ... and more



Image from <https://www.staigsmith.co.nz/AdvancedDataManagement/3D+Visualisation.html>

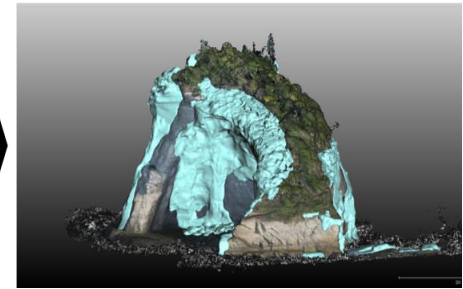


Image from Paper: Volumetric Change Detection in Bedrock Coastal Cliffs
Using Terrestrial Laser Scanning and UAS-Based SfM
by Yuichi S. Hayakawa

Film

- **Film production is the art of data capture**
- When the Lumière brothers pointed their primitive camera at a locomotive and recorded *Arrivée d'un train en gare de La Ciotat*, aka Train Pulling into a Station
 - They were capturing data
- In the 1927 movie *The Jazz Singer* the first full-length feature film to use synchronised sound, when Al Jolson told the crowd, "You ain't heard nothing' yet!" what was the microphone doing?
 - Capturing data



https://commons.wikimedia.org/wiki/File:Arriv%C3%A9e_La_Ciotat.gif

Film Opportunities

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Scanning Models is common



<https://polhemus.com/case-study/detail/gentle-giant-studios-chooses-the-polhemus-fastsan>

July 31, 2021

<https://www.scantechsurveys.co.uk/laser-scanning-for-film-sets/>

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July 31, 2021

<https://www.scantechsurveys.co.uk/laser-scanning-for-film-sets/>

Scanning People is becoming common



*Excerpt from video by CoSA VFX
Gotham Season 2 - VFX Reel
<https://vimeo.com/167931020>*

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Scanning may soon be



Alex Shvartzman uses a handheld structured light device to scan a horse
Image from: <https://cinefex.com/blog/lidar/>

Movie & Game

- Laser scanning is used in the film and gaming industry for
 - Pre-visualization of scenes
 - or in post-production, to create stunning CGI & visual effects



LIDAR scanning of a Moroccan market set

Image from:
www.renishaw.com/en/3d-laser-scanning-helping-bring-games-and-movies-to-life--19955

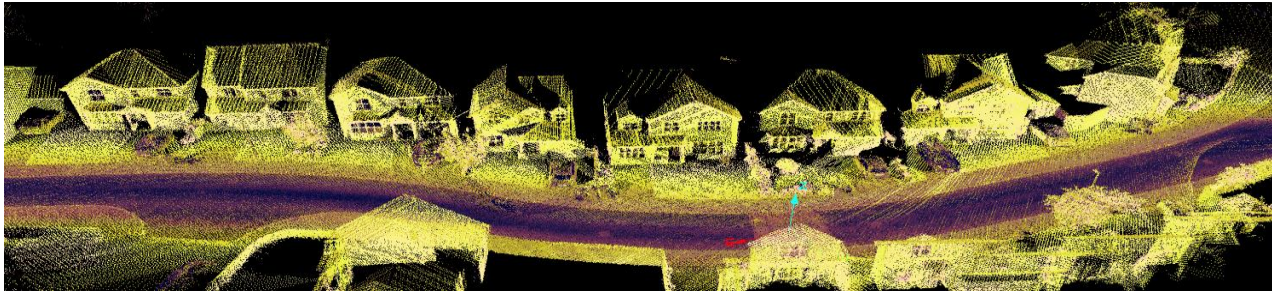


Image from: <https://www.renishaw.com/en/3d-laser-scanning-helping-bring-games-and-movies-to-life--19955>

Unreal Engine

- Real-Time In-Camera VFX for Next-Gen Film-making
 - <https://www.youtube.com/watch?v=bErPsg5kPzE>
- Laser Scans can be used with real world display of scenes that have been captured elsewhere
 - Using Unreal Engine
 - that captured scene can be modified as needed
 - in real time
- Many people make models
 - Fewer can use laser scans to enhance the process

Watch the Set Background



Virtual Camera moves with real world camera
Background is rendered from correct perspective

Forensic Opportunities

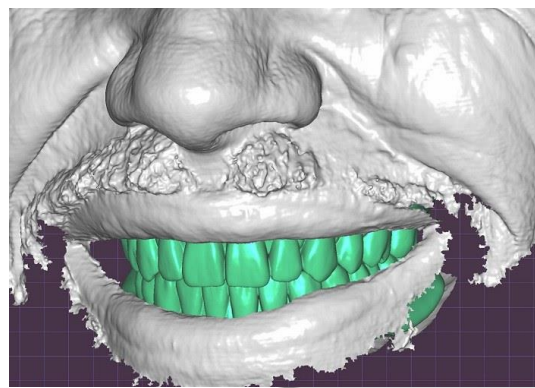
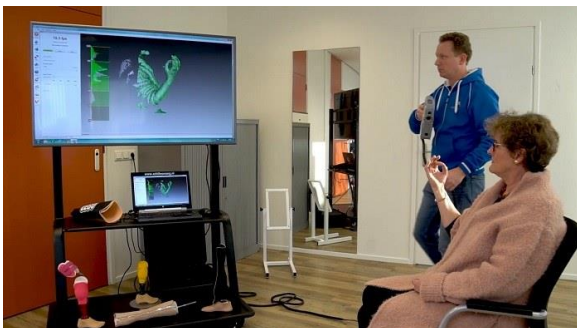
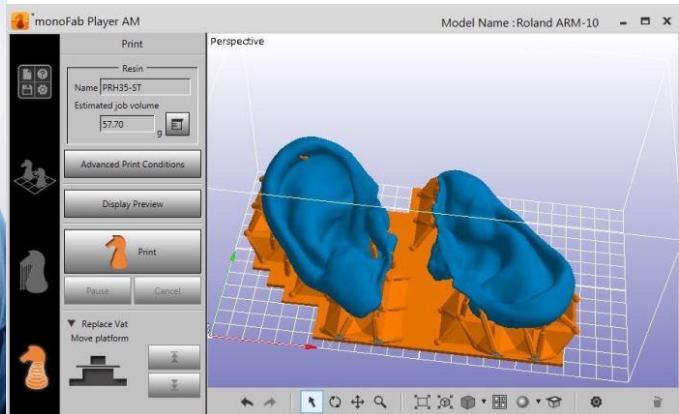
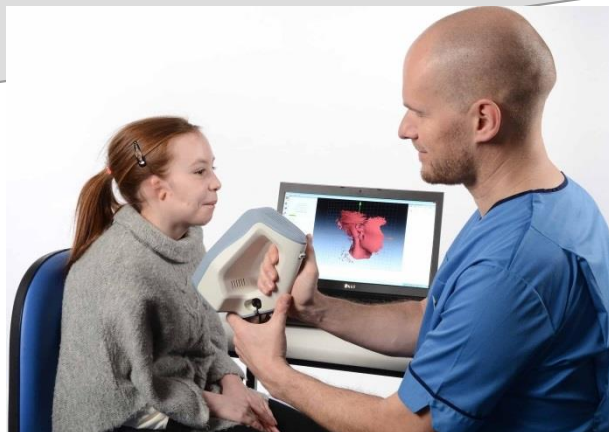
- Laser scans
 - Provide detailed models of investigation scenes
 - Accurate
 - Identify exact measurements and placements of items
 - Very fast
 - Replace creating physical mock-up models by hand
 - Allow for a virtual walk-through of the scene
 - Anytime, repeatable
 - Scene stays in “as-found” state
- This significantly improves the experience and reliability of information



<https://www.pbs.org/newshour/science/virtual-reality-tamir-rice-3d-laser-scans-shootings-san-bernardino>

Medical Opps

- Orthopedics
- Prosthetics
- Plastic Surgery
- Dental
- ... more



Other Fields

- Art Preservation
- Automotive
- Reverse Engineering
- ... more



Summary

- Laser Scanning is useful and interesting
 - Enhances the modeling process when working with real objects
- Can be used in multiple fields and businesses
- Uses skills common to Viz students
- Many open opportunities
 - Employment
 - Research