

Can 3D models be used for Geological Studies?



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~1 m

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What do geologists do?

- Measure changes in landscape
- Find ages of rocks
- Forecast earthquakes



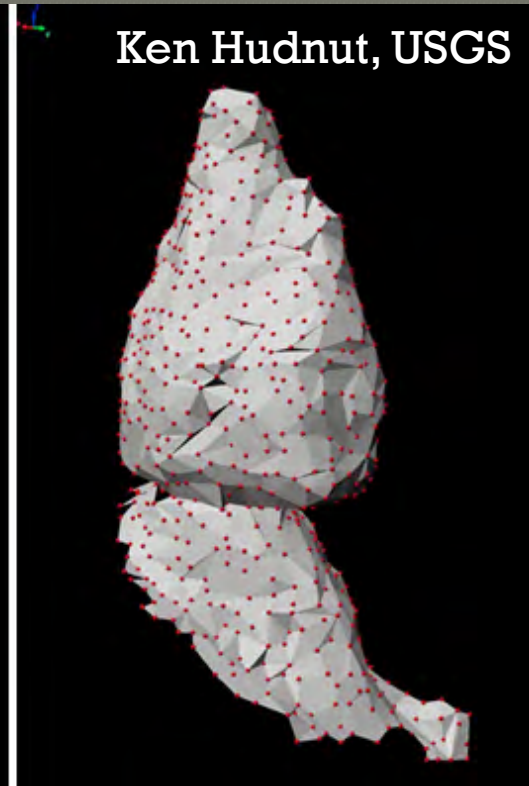
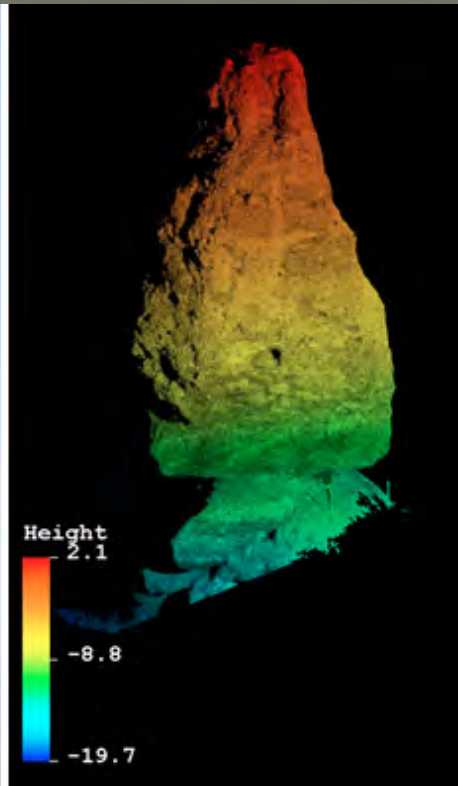
$$\text{Fault offset} = \text{fault slip rate (speed)} \times \text{age}$$



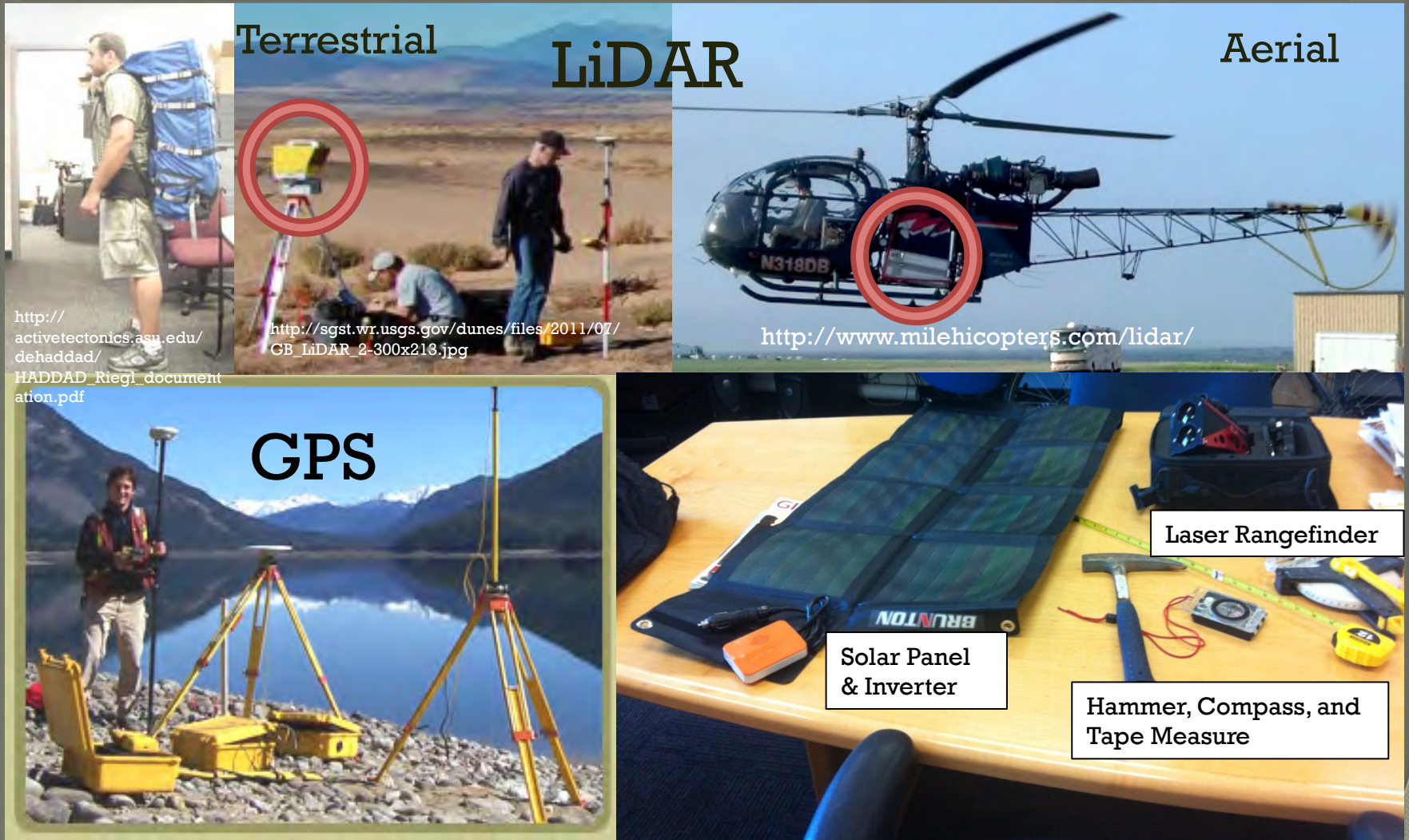
Wallace Creek

What do geologists do?

- Precariously Balanced Rocks (PBRs) using Terrestrial Laser Scanning
- Link to fault activity beneath Los Angeles



What tools do geologists use?



<http://www.monasheesurveying.com/images/gps.jpg>

Emergence of new software

- Modeling software used by engineers to design
- New free programs
 - Opportunity to experiment with possible applications

The screenshot displays the MeshLab website. On the left, the '123D' logo is prominent, with navigation tabs for 'apps', 'gallery', 'fabricate', 'how-to', and 'my corner'. Below the logo, the text 'Autodesk 123D Catch' is followed by links for 'get the apps', 'at-a-glance', 'tutorials', and 'forums'. The main heading 'Take and make.' is accompanied by the tagline 'Take ordinary photos and turn them into extraordinary 3D models.' A central image shows a computer monitor displaying a 3D model of a man's face, with a physical 3D model of the same face and a pile of colorful markers in the foreground. A 'Get Started with 123D Catch' button is located below the image.

On the right side of the screenshot, the 'MeshLab' section is visible. It features the title 'MeshLab' and a detailed description of the software as an open-source system for processing and editing unstructured 3D triangular meshes. A 'Download Latest Version (16 February 2011) V1.3.0a (changes)' button is present. Below this, there is a 'Remember that, whenever you use MeshLab...' section with a list of guidelines for users. The 'Adopted License, acknowledgments and other legal issues are detailed here.' link is also visible. The 'Features' section lists various capabilities such as interactive selection, painting, import/export, mesh cleaning, remeshing, and 3D scanning tools.

At the bottom of the screenshot, there are three columns for different platforms: 'for your PC' with a 'Download 123D Catch' button, 'on your iPad' with an 'Available on the App Store' button, and 'try it online' with a 'Launch the web app' button.

What if all you needed in the field



was a camera?



Can software be used to convert pictures into 3D models useful to geologists?

● Can we do it?

● If so, what is the best strategy?

- Start small and work up to geological scale
- Incorporate findings into new models
- Develop a procedure for geologists to follow to produce successful models

From 2D to 3D using 123D Catch



Input: 53 pictures

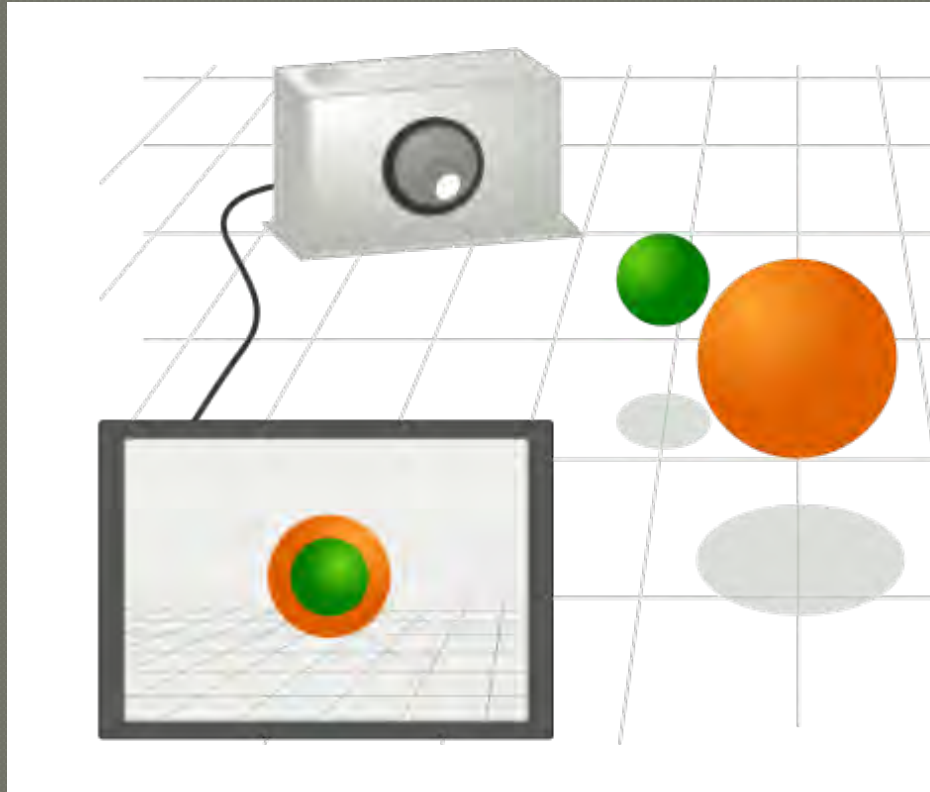


Output: 3D model

Getting started with 123D Catch

The screenshot displays the Autodesk 123D Catch software interface. The main window shows a 3D scene of a large, gnarled tree in a landscape. A circular path of camera icons is overlaid on the scene, indicating the path of the virtual camera. The interface includes a top menu bar with 'File', 'Edit', 'View', 'Marketplace', and 'Help'. Below the menu is a toolbar with various icons for camera control and rendering. On the right side, there is a 'Gallery' panel with a search bar, a 'Publish to the Gallery' button, and sections for 'Featured' and 'Popular' items. At the bottom, there is an 'Animation Path' timeline showing a sequence of frames. The Windows taskbar at the bottom shows the system clock as 1:21 PM on 7/31/2012.

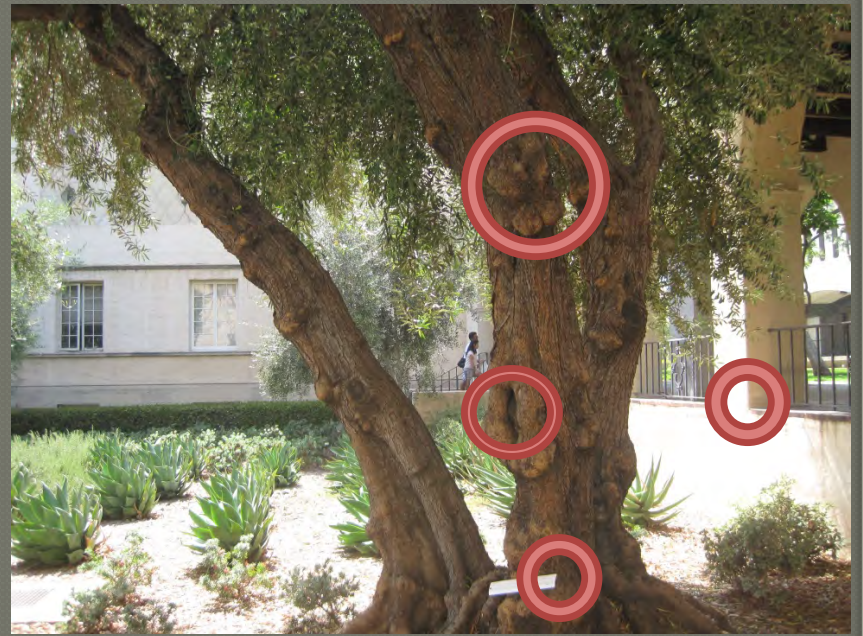
Two perspectives



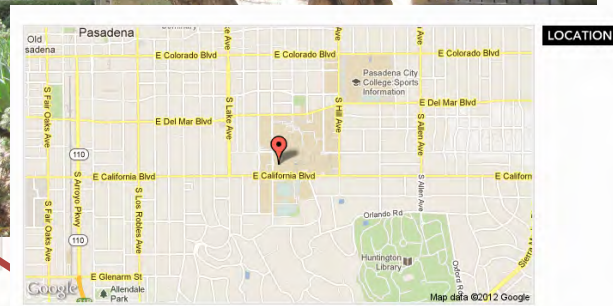
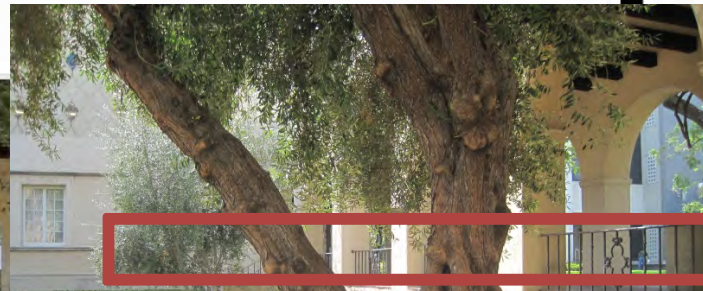
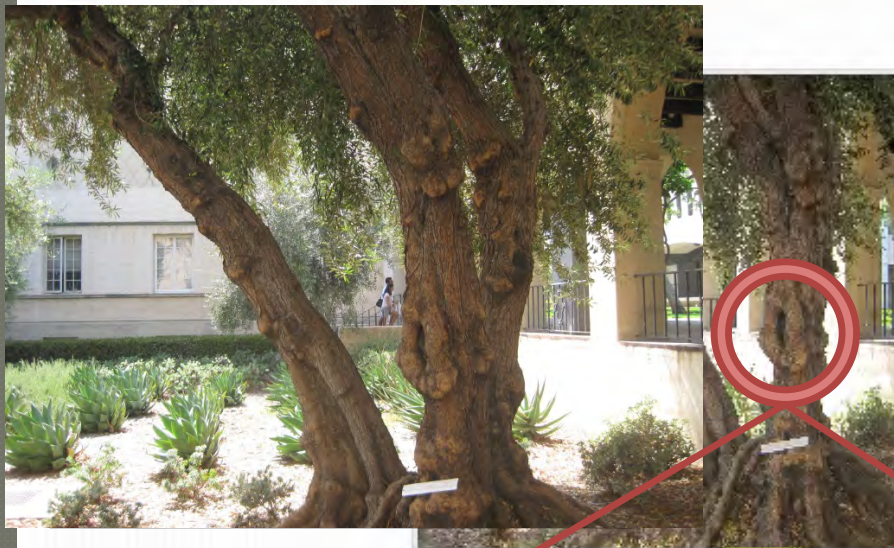
http://upload.wikimedia.org/wikipedia/commons/7/7c/Aufnahme_mit_zwei_Kameras.svg

Finding corresponding points between pictures

- Seeing a tree from two angles



123D Catch matches pixels & triangulates camera position

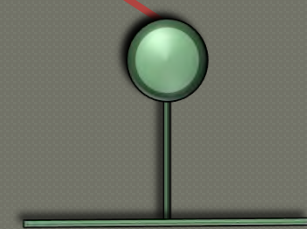
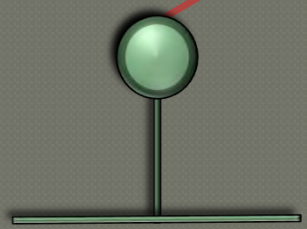


(click for original)

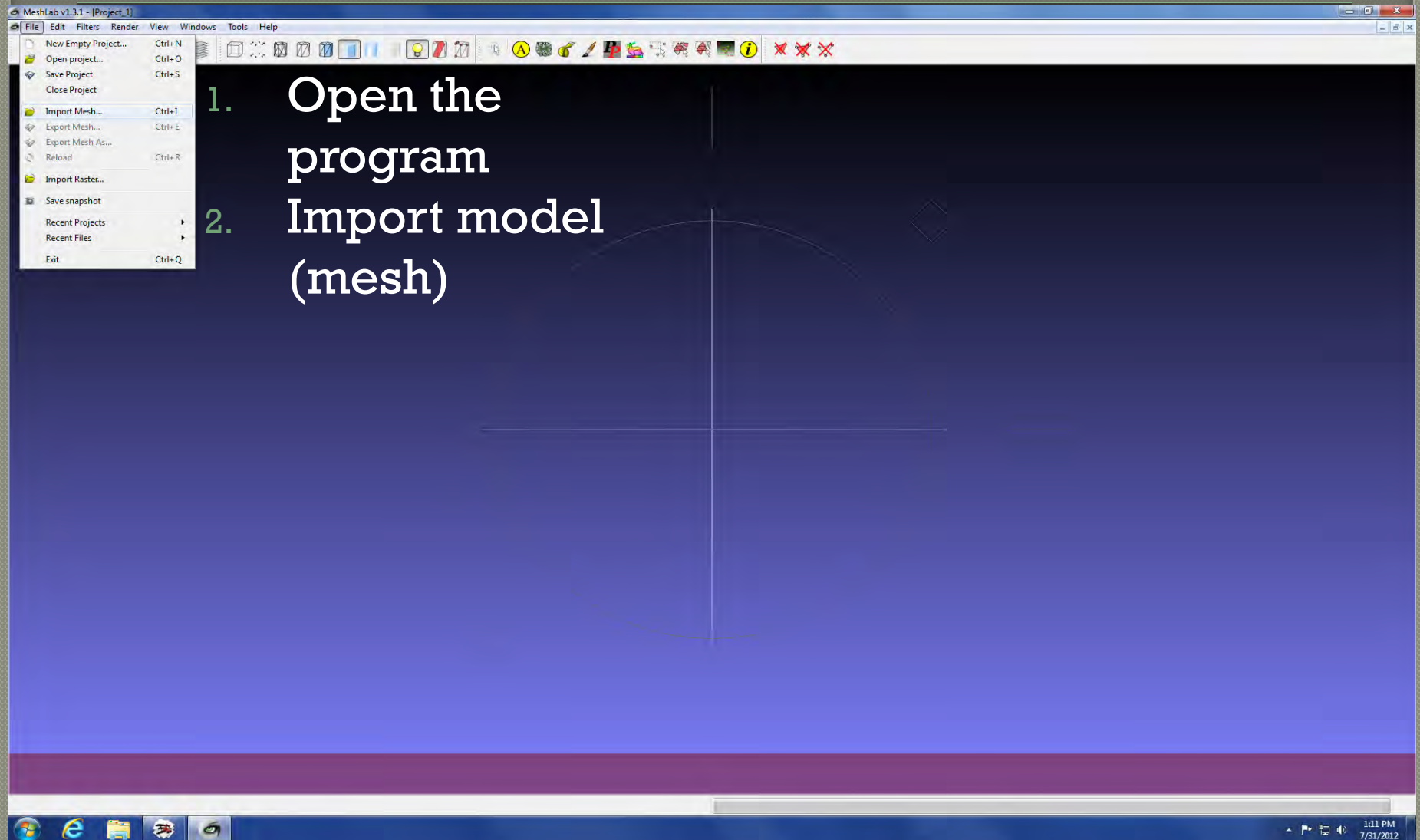
<http://exifdata.com/exif.php>

Detailed GPS data

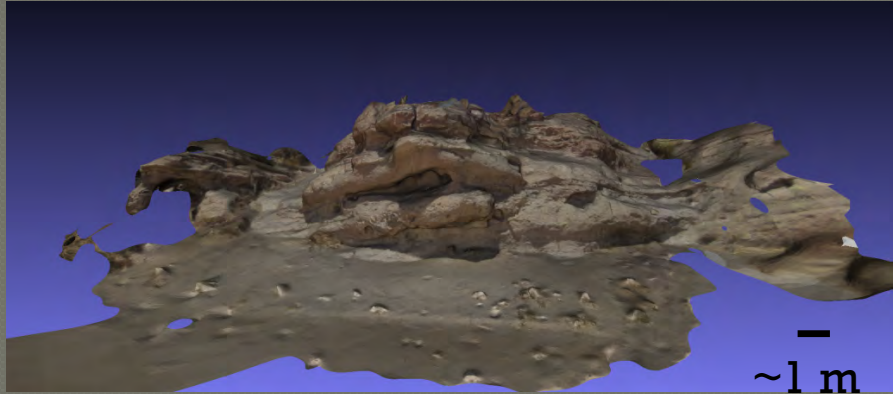
GPS Latitude Ref	North
GPS Latitude	34.136833 degrees
GPS Longitude Ref	West
GPS Longitude	118.127333 degrees
GPS Time Stamp	21.40.02.2
GPS Img Direction Ref	True North
GPS Img Direction	254.3895349



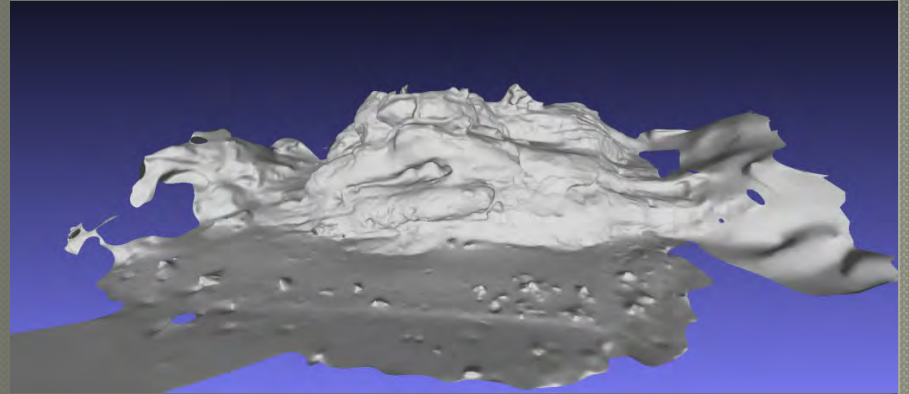
Getting started with Meshlab



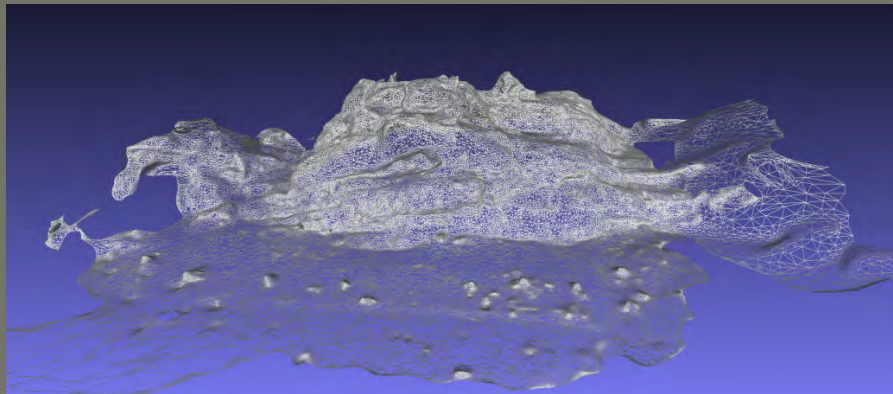
Visualizing models using Meshlab



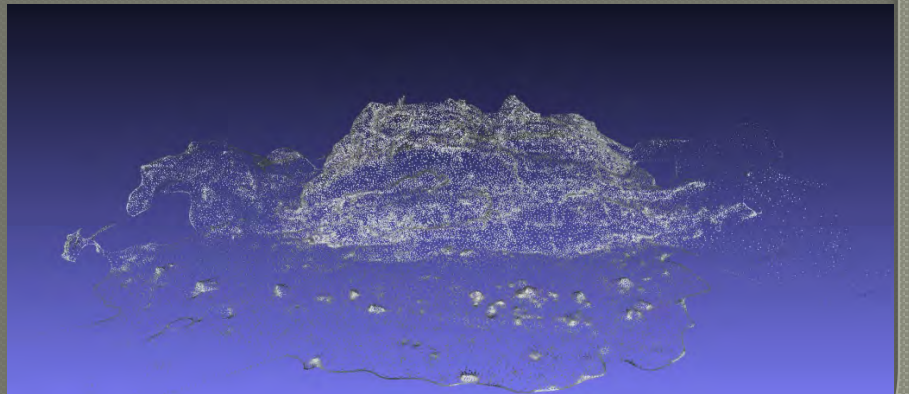
3D Textured Model



3D Texture-less Model



3D Mesh



3D Point Cloud

140 pictures

Getting started making models

- What we were told:
 - Do not use flash
 - Start with small objects
 - Look for varied textures
 - Take pictures from a wide range of angles

Getting started making models

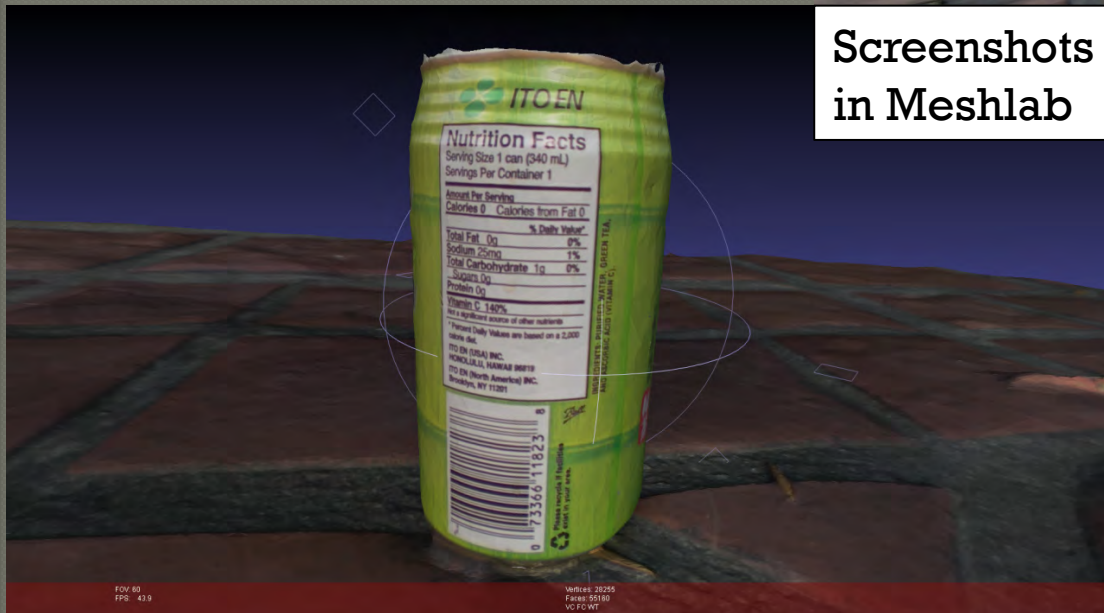
- Questions that needed answers:
 - How many pictures are needed?
 - Where to take the pictures from?
 - How much overlap between pictures?
 - Can you make measurements from the models?
 - Can GPS coordinates be assigned to the model?
- **Q:** Can 123D Catch and Meshlab be used to create 3D models for geological research?

Highly detailed model

- 33 Pictures
- 2 concentric circular paths



Screenshots of model
in Meshlab



Best path for pictures is from the outside facing in

- Quad N Mudd – from inside-out vs. a rock pictured from outside-in

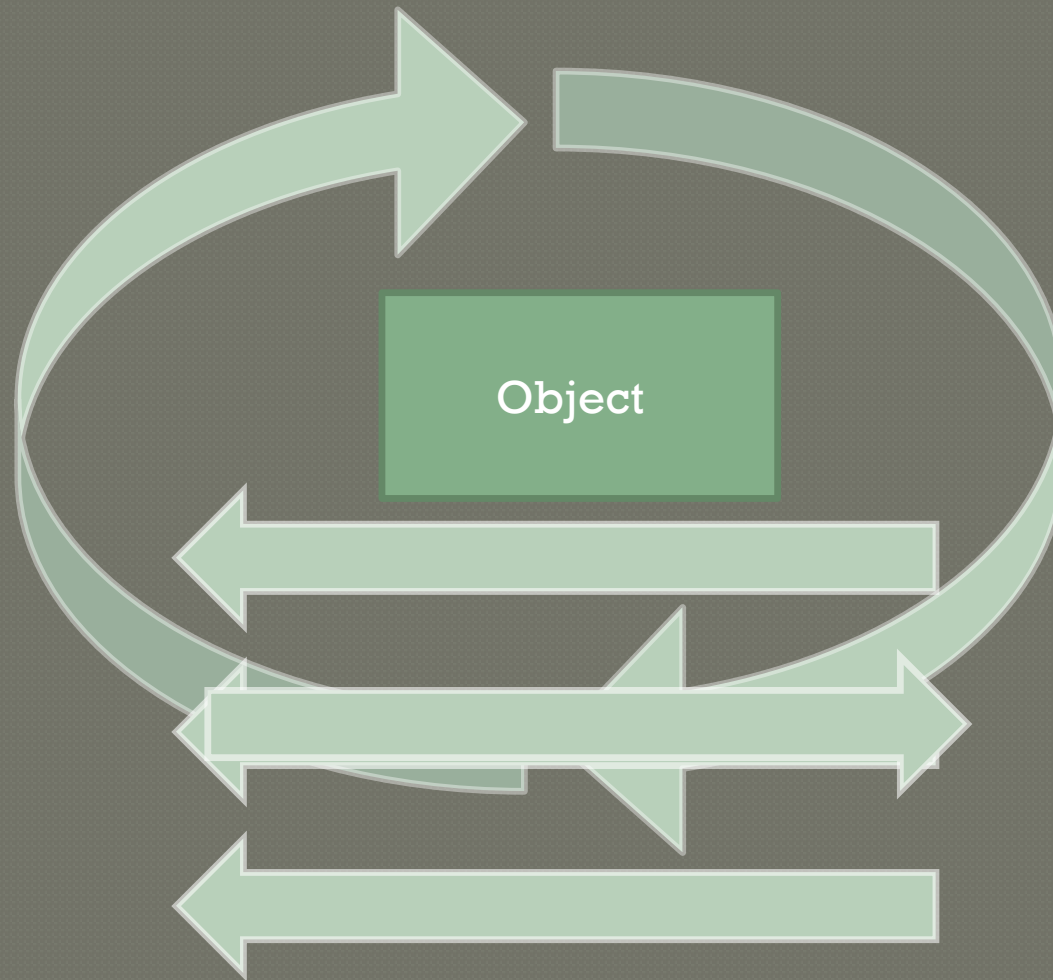


56 pictures

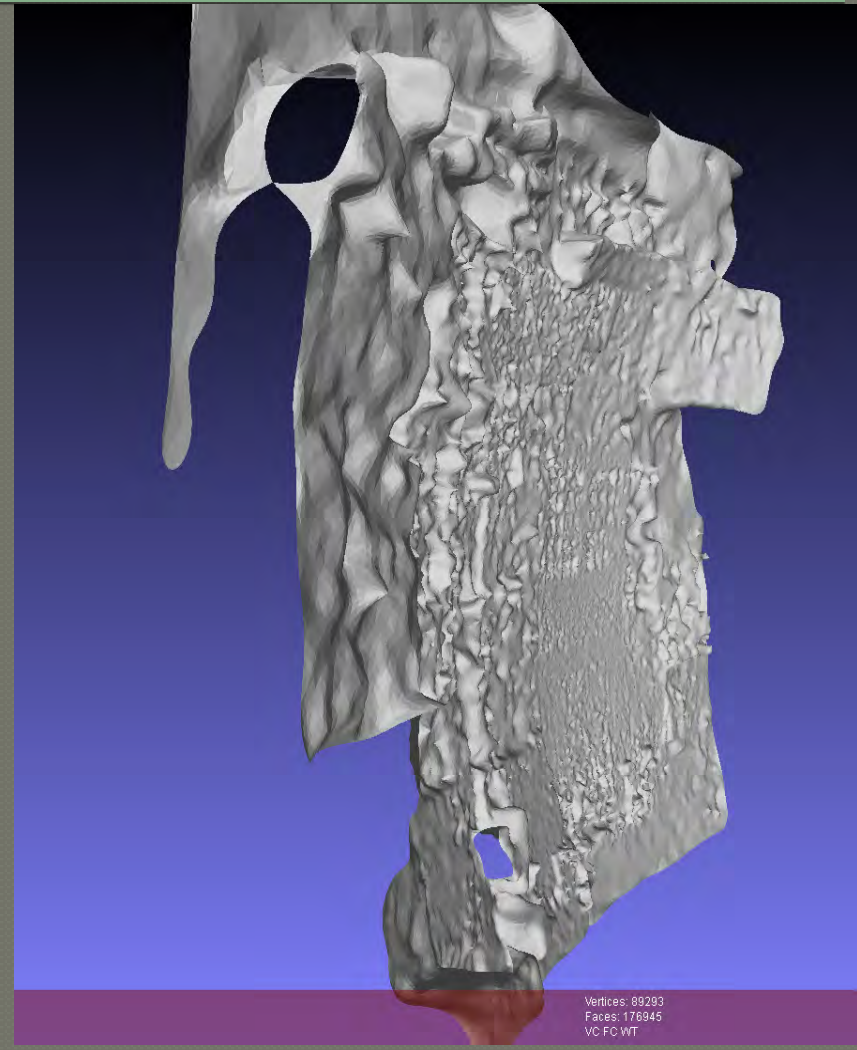


36 pictures

Best path - continuous



Moving to take pictures is necessary



35 pictures

Symmetry confuses 123D Catch

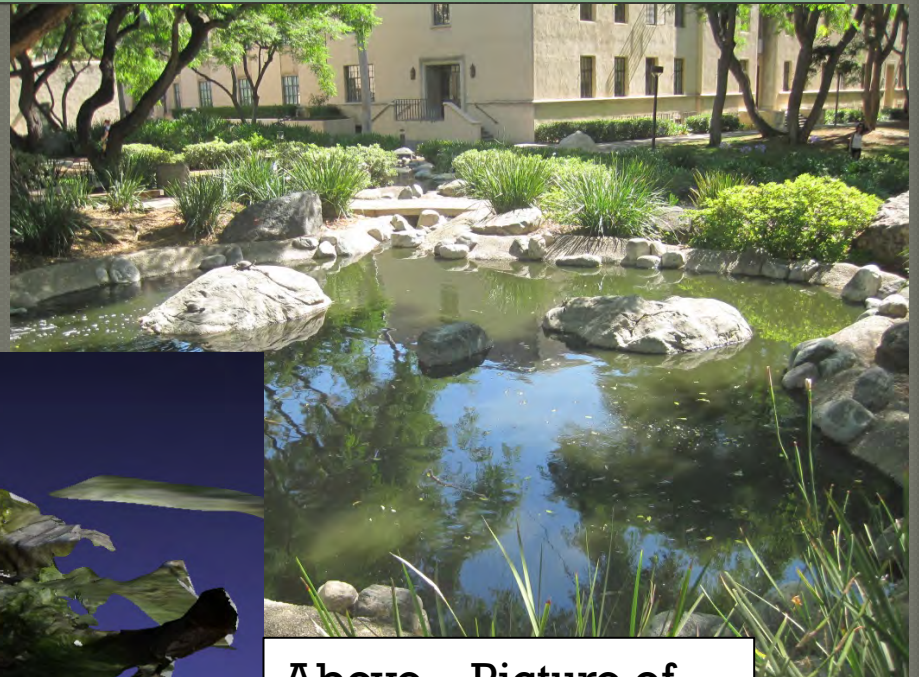
- Pictures taken in “best path” order
- Complete information about all sides provided
- 123D Catch used symmetrical features to generate the model.
- Not a problem for geologists



41 pictures

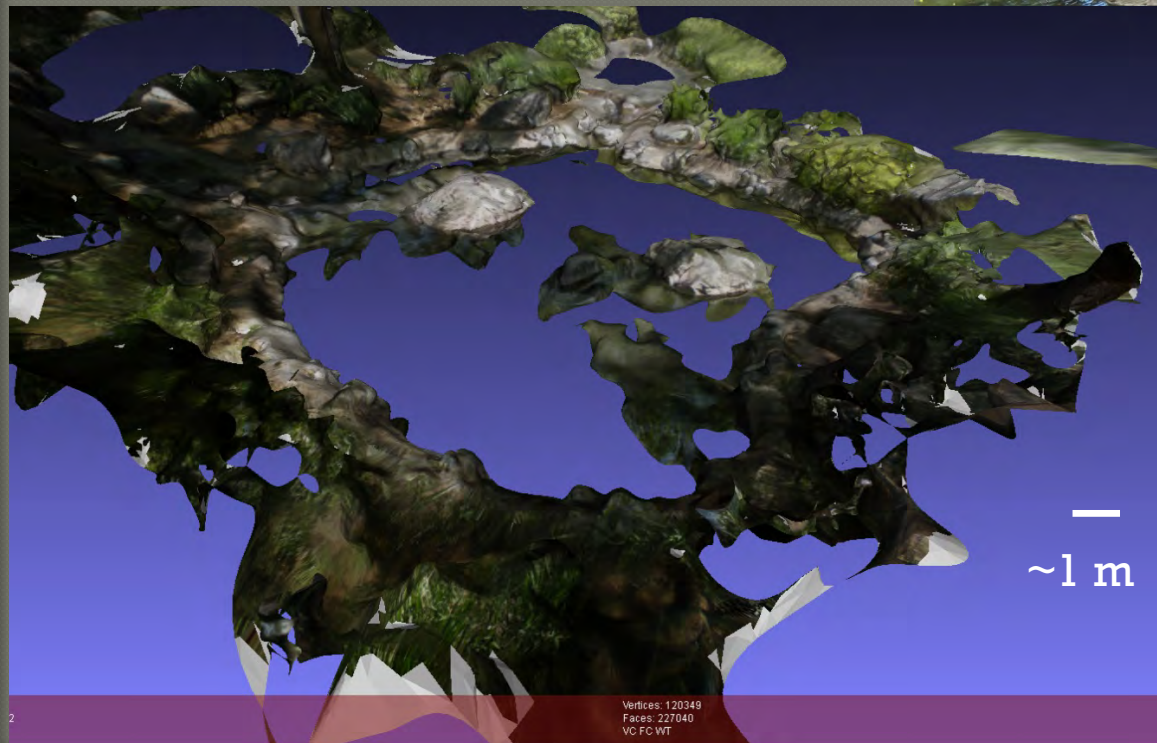
Measuring from bank to bank

- Water does not show in mesh
- Can still measure bank-to-bank



Above – Picture of Turtle Pond

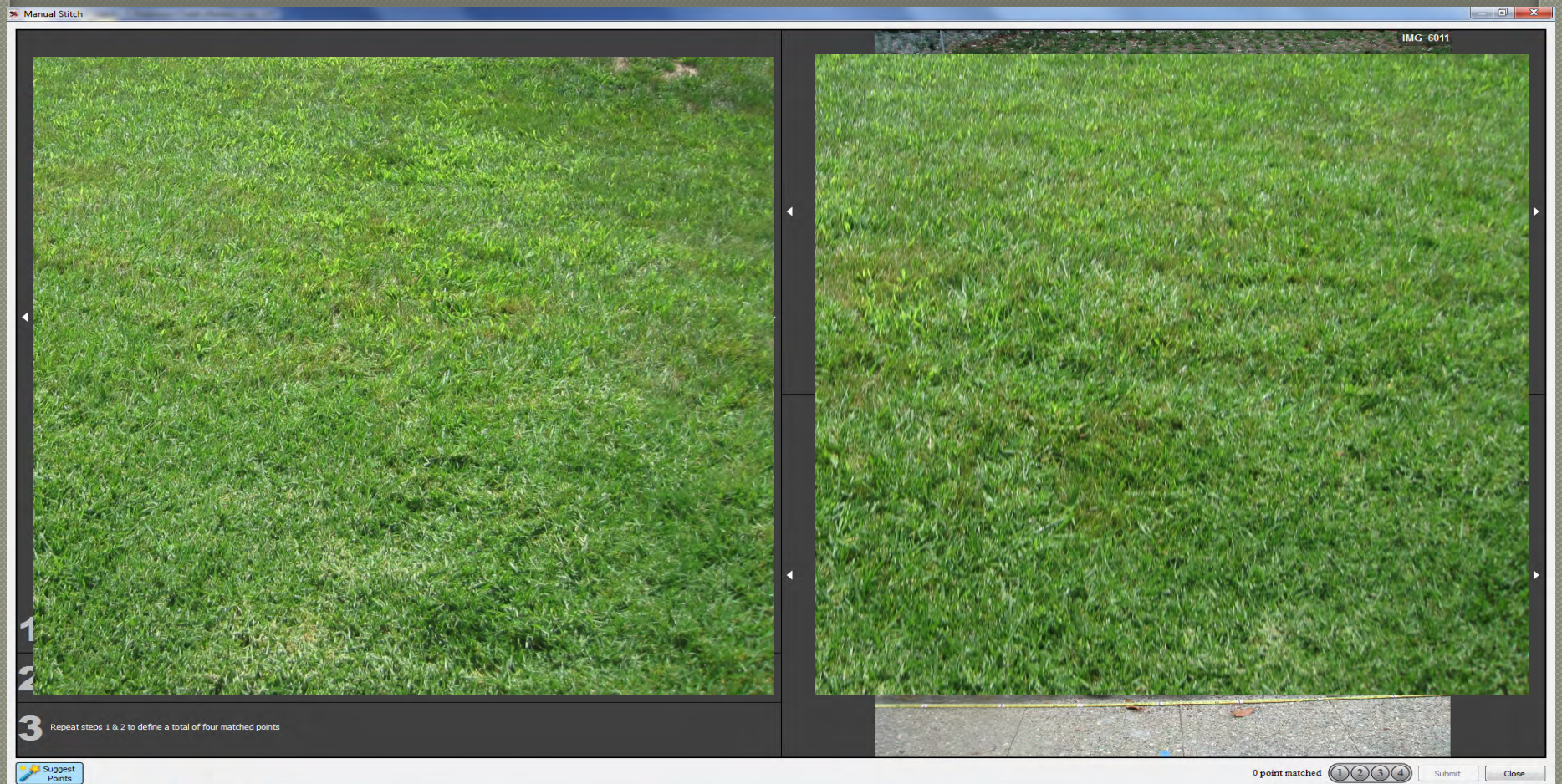
Left - Screenshot of model in Meshlab



46 pictures

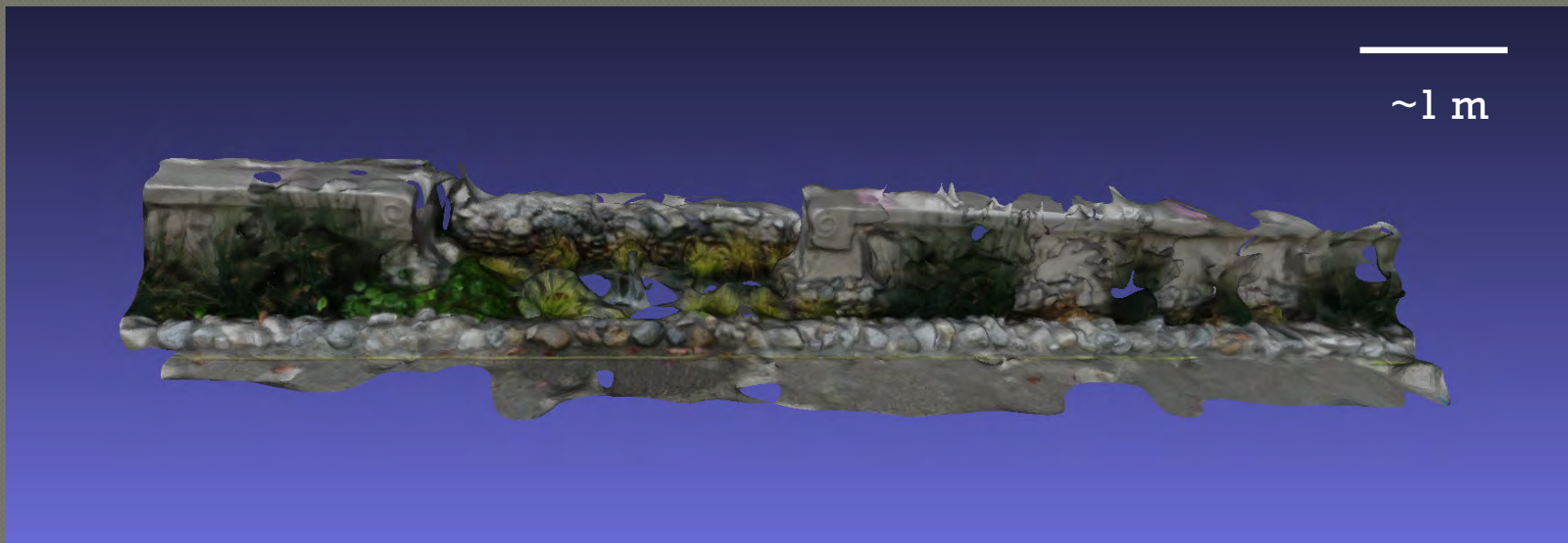
Stitching emphasizes the need to have 4 distinguishing features

- Pictures are left out of models because 123D Catch cannot recognize where it fits in.



Fine tuning models: Stitching

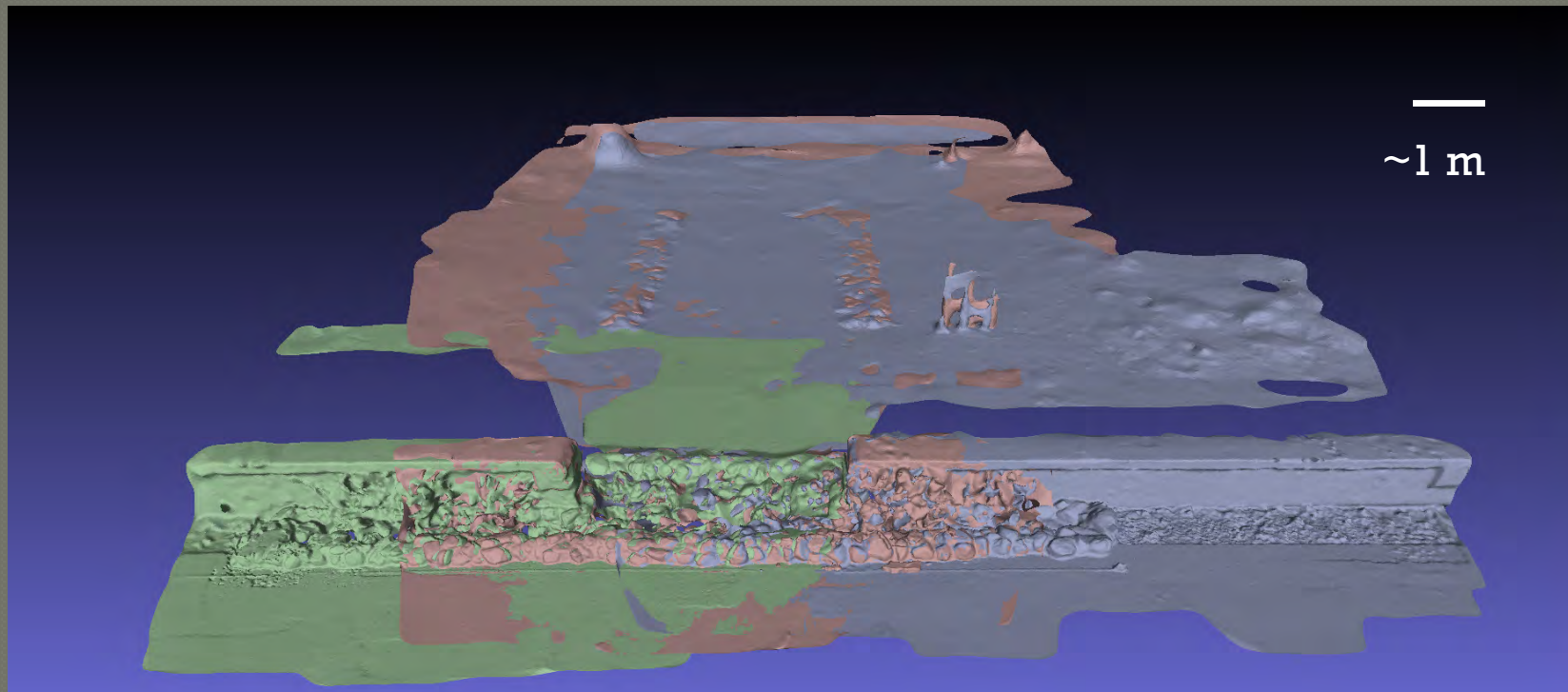
- Can “stitch” pictures into the model by manually matching pixels
 - Time consuming
 - Introduces new errors



102 pictures

Fine tuning meshes: Merging

- For larger projects, merging helps:
 - Reduce picture load per person
 - Reduce processing time



65 pictures

68 pictures

100 pictures

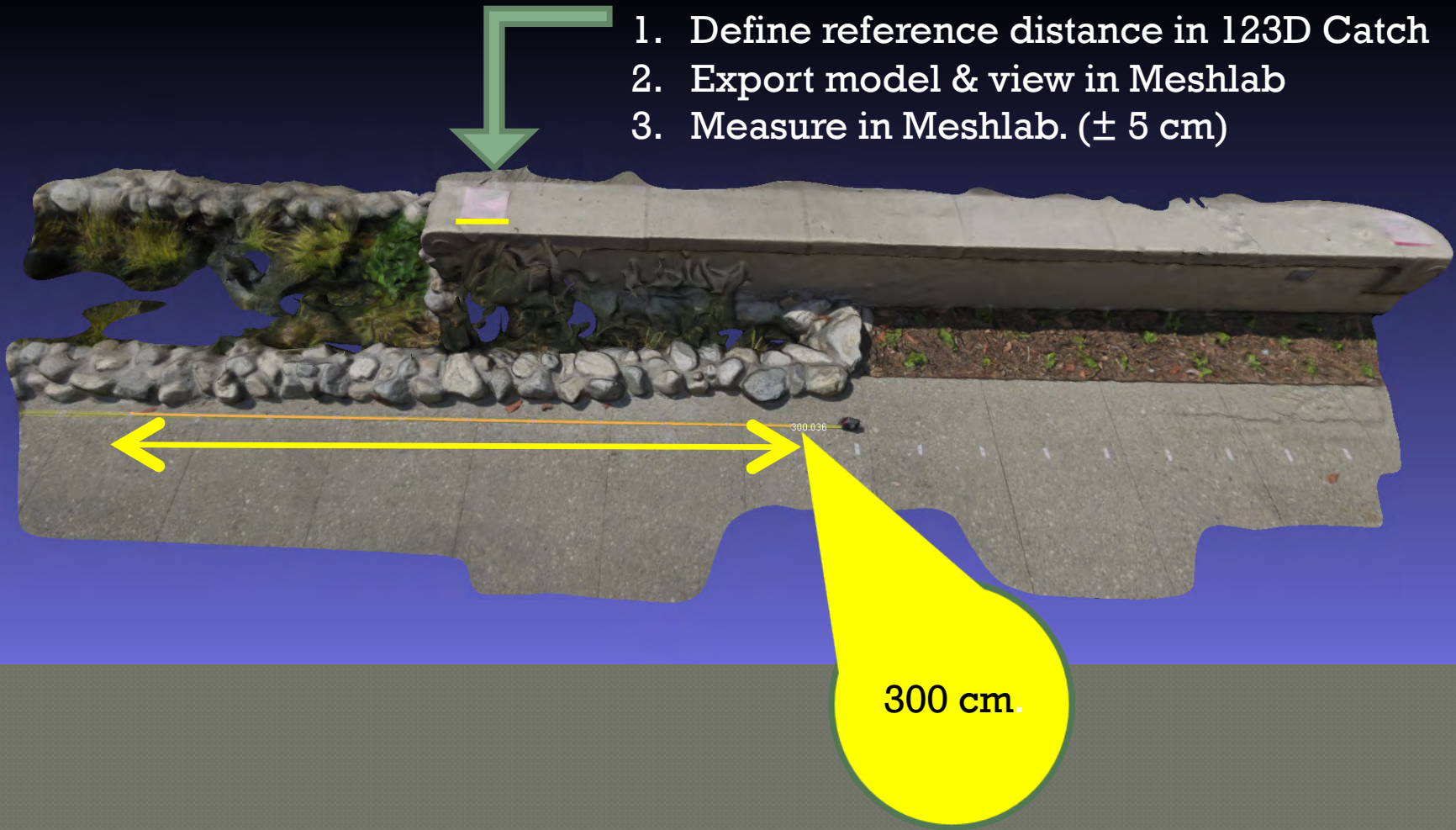
Fine tuning meshes: Merging

- Merging can be used to increase detail.



Measuring in Meshlab

1. Define reference distance in 123D Catch
2. Export model & view in Meshlab
3. Measure in Meshlab. (± 5 cm)



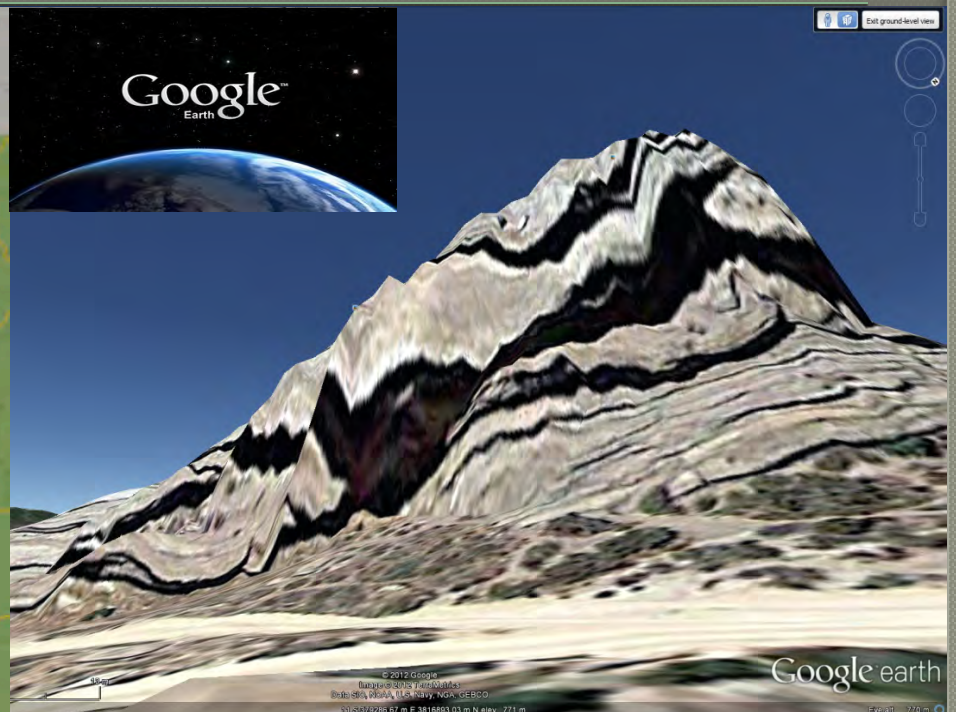
100 pictures

Moving into the field

Vasquez Rocks County Park



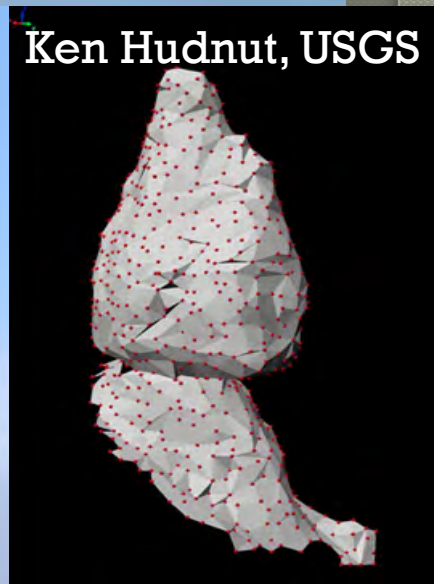
Vasquez Rock model



153 pictures

Google Inc. for Google Earth pictures, www.google.com

An almost complete model of a 5 m tall rock at Vasquez Rocks



Ken Hudnut, USGS

36 pictures

Conclusions

- Yes we can use the free software
 - Different cameras ✓
 - Different users ✓
 - GPS Coordinates ✗
 - Measure features ✓
 - **Geological features** ✗

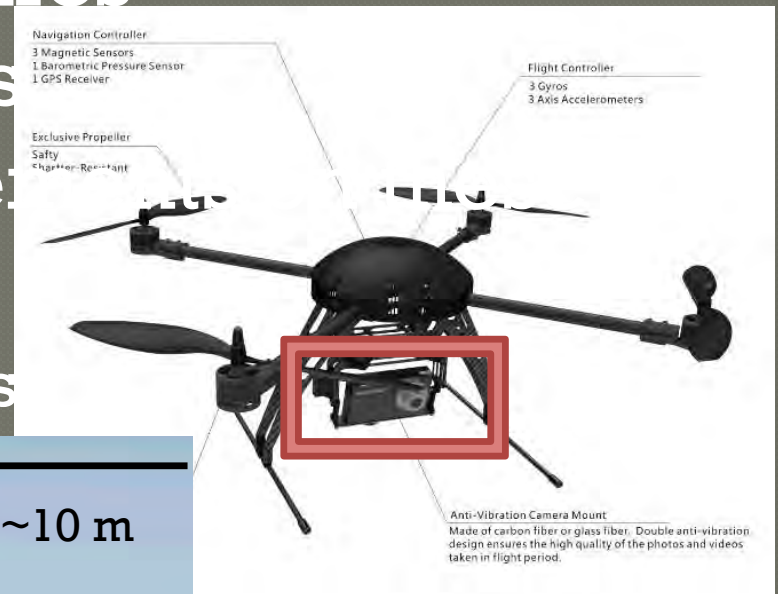


Conclusions

- A General Protocol:
 - No flash
 - Carefully plan photograph pathway (occlusions, vegetation, circular path)
 - 4+ Distinguishing features between every other picture
 - Start far away, move closer for additional detail
 - More photos, can discard later

Future directions

- Incorporate aerial pictures
- Attach GPS Coordinates
- Make detailed measurement models
 - Profiles, slopes, and curves



<http://www.infmetry.com/wp-content/uploads/2010/08/XAircraft-X650-QuadCopterQuadRotor-cool-photo.jpg>

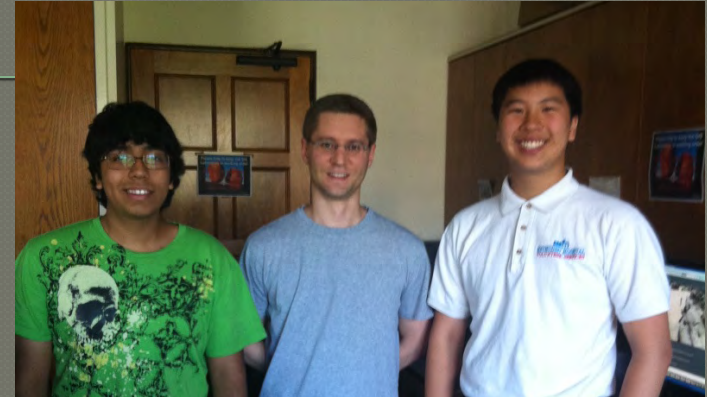


140 pictures

Acknowledgements

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