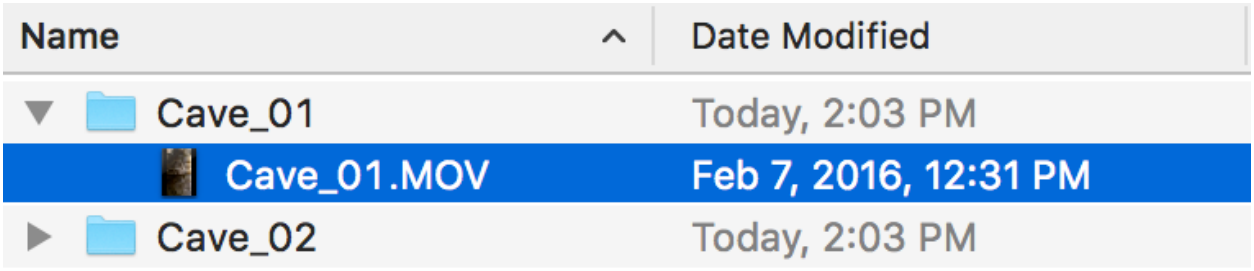
Photogrammetry from Video

Ingredients:

- Agisoft Photoscan 1.2.4
- ffmpeg
- High quality video*

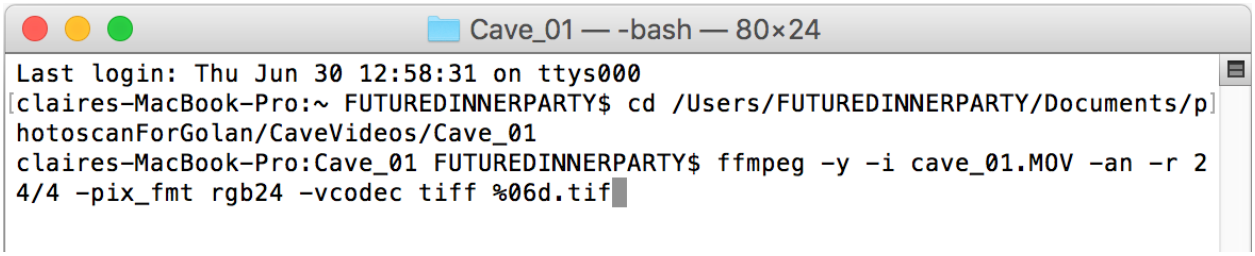
Directions:

1. Install command line tool ffmpeg. Documentation can be found here.
2. Place video in a folder



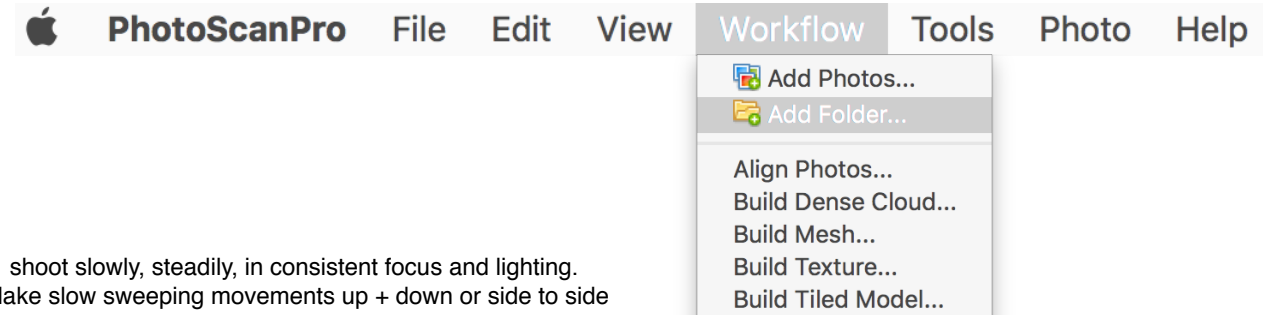
3. Open command line and direct to the folder containing video. Use ffmpeg to **pull still images from video every x frames** per second. In this case I am pulling every 4th frame. (Less frames = less processing time = less detail) I am using the following command to pull 4 frames every 24 fps and am saving them as tiff files in the original folder:

ffmpeg -y -i cave_01.MOV -an -r 24/4 -pix_fmt rgb24 -vcodec tiff %06d.tif



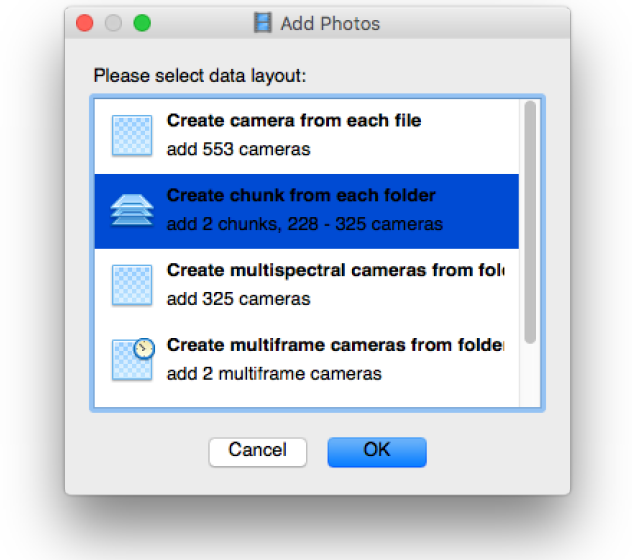
Agisoft accepts PEG, TIFF, PNG, BMP, PPM, OpenEXRand JPEG åMulti-Picture Format (MPO)

4. Open Agisoft Photoscan and import the folder containing the still frames. **Workflow -> Add Folder.** (Photoscan will ignore any other files in the folder, like the video)

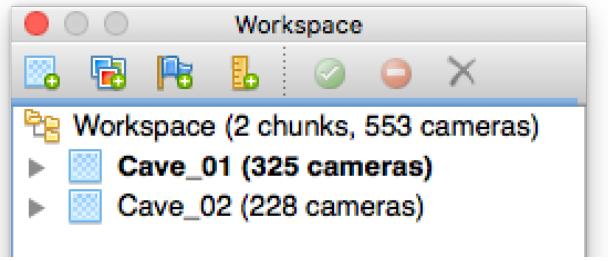


* shoot slowly, steadily, in consistent focus and lighting. Make slow sweeping movements up + down or side to side

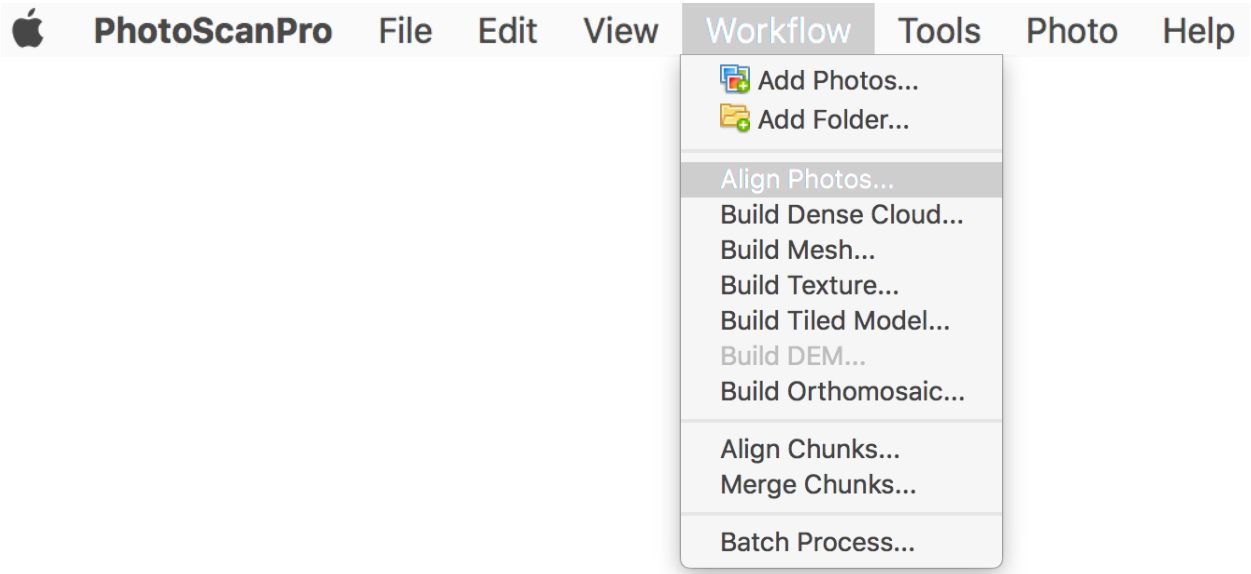
4a. If you are working with multiple videos, nest folders in one main folder and import that. Select “create chunks” on import, and this will split the images into their subsequent folders.



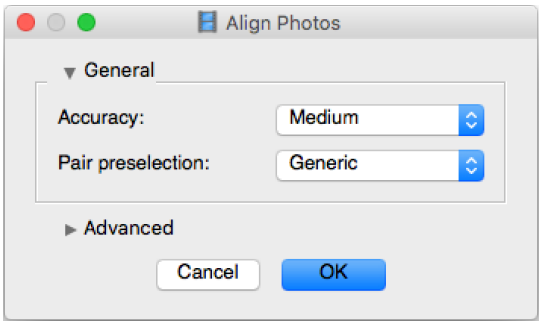
5. Select by double clicking on the image set to be processed in the “Workspace”



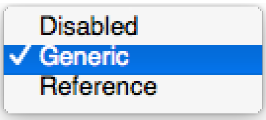
6. Begin alining your images for the selected set. **Workflow -> Align Photos**



7. A dialog box will present some options for alignment.



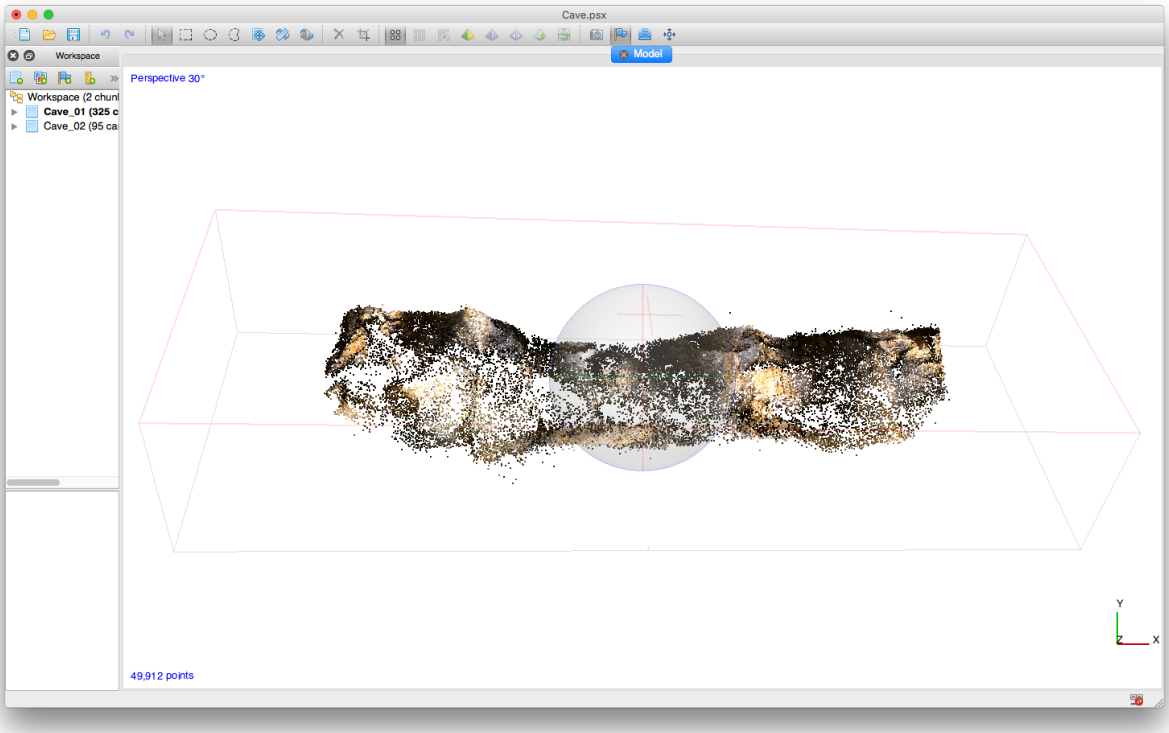
Accuracy: Higher accuracy settings help to obtain more accurate camera position estimates. Lower accuracy settings can be used to get the rough camera positions in a shorter period of time.



Pair preselection: Matching detected features across photos can take a long time. To speed this process, select “Generic” preselection. Overlapping pairs of photos are then selected by matching photos using lower accuracy setting first.

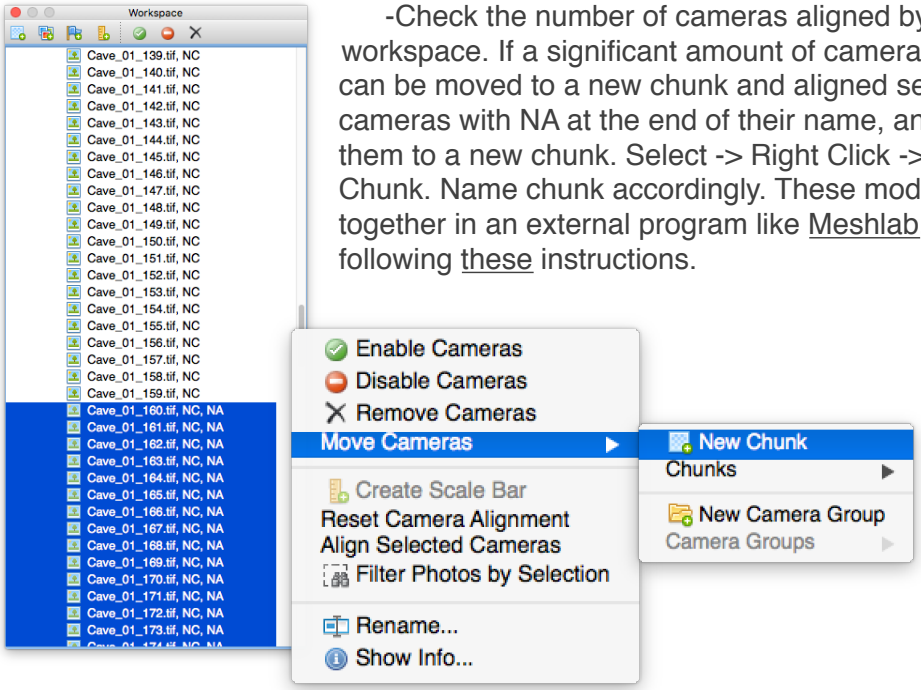
In the advanced options, the maximum amount of features per image & tie points between images can be changed, though I would recommend only adjusting these if the first attempt produced undesirable results.

8. Align images and after processing is complete, a sparse point cloud will appear in your main interface.



9. Things to check after your first sparse point cloud is complete.

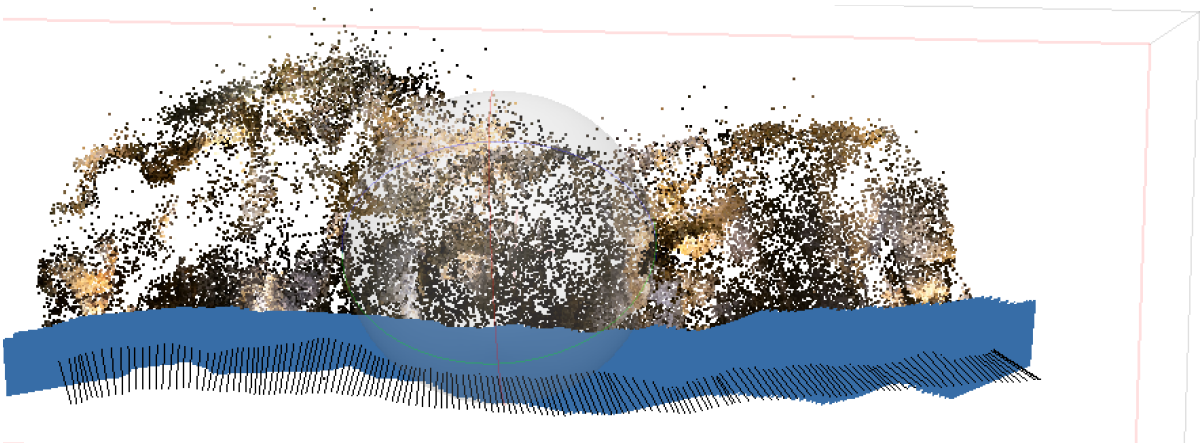
How many “Cameras” (images) were aligned?



-Check the number of cameras aligned by expanding the folder in workspace. If a significant amount of cameras were not aligned, they can be moved to a new chunk and aligned separately. Select all cameras with NA at the end of their name, and right click to move them to a new chunk. Select -> Right Click -> Move Cameras -> New Chunk. Name chunk accordingly. These models can then be brought together in an external program like Meshlab, or in Photoscan, following these instructions.

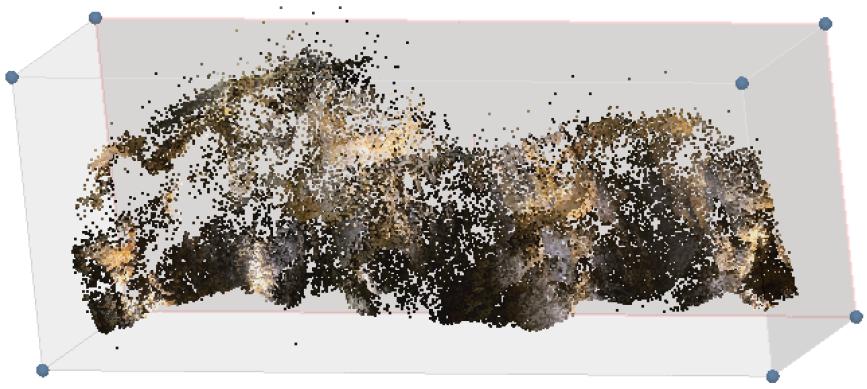
Do the Camera locations logically make sense?

-Toggle camera location icon in the toolbar and each camera is represented as a blue square in the primary interface. Because you are processing from video, these blue squares should be in a sequential line, as they represent the path the camera took when filming. If they are not in a line, something went wrong. Try using a higher accuracy for alignment.

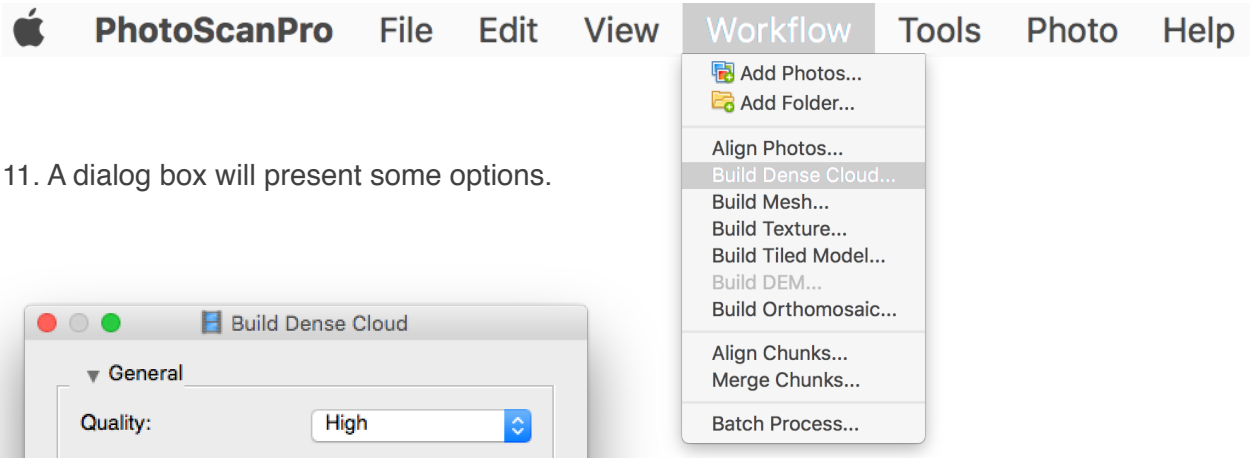


Is my bounding box properly fit to my point cloud?

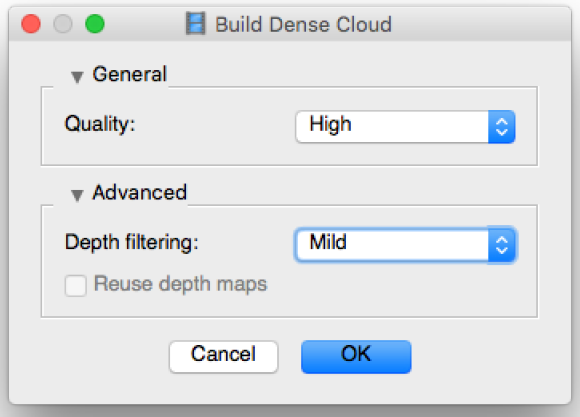
-In the next steps, any points outside of the bounding box will be thrown away, and all points inside the bounding box are kept. The perimeters of the bounding box can be adjusted using the bounding box tools in the toolbar. The size and orientation of the bounding box should perfectly encompass the model you are trying to make. Seemingly random // irrelevant // distant points should be cropped out, as they will hinder the quality of the model later on.

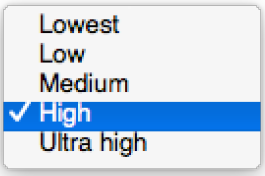


10. Build a dense point cloud from your sparse point cloud. **Workflow -> Build Dense Cloud**

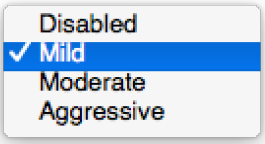


11. A dialog box will present some options.



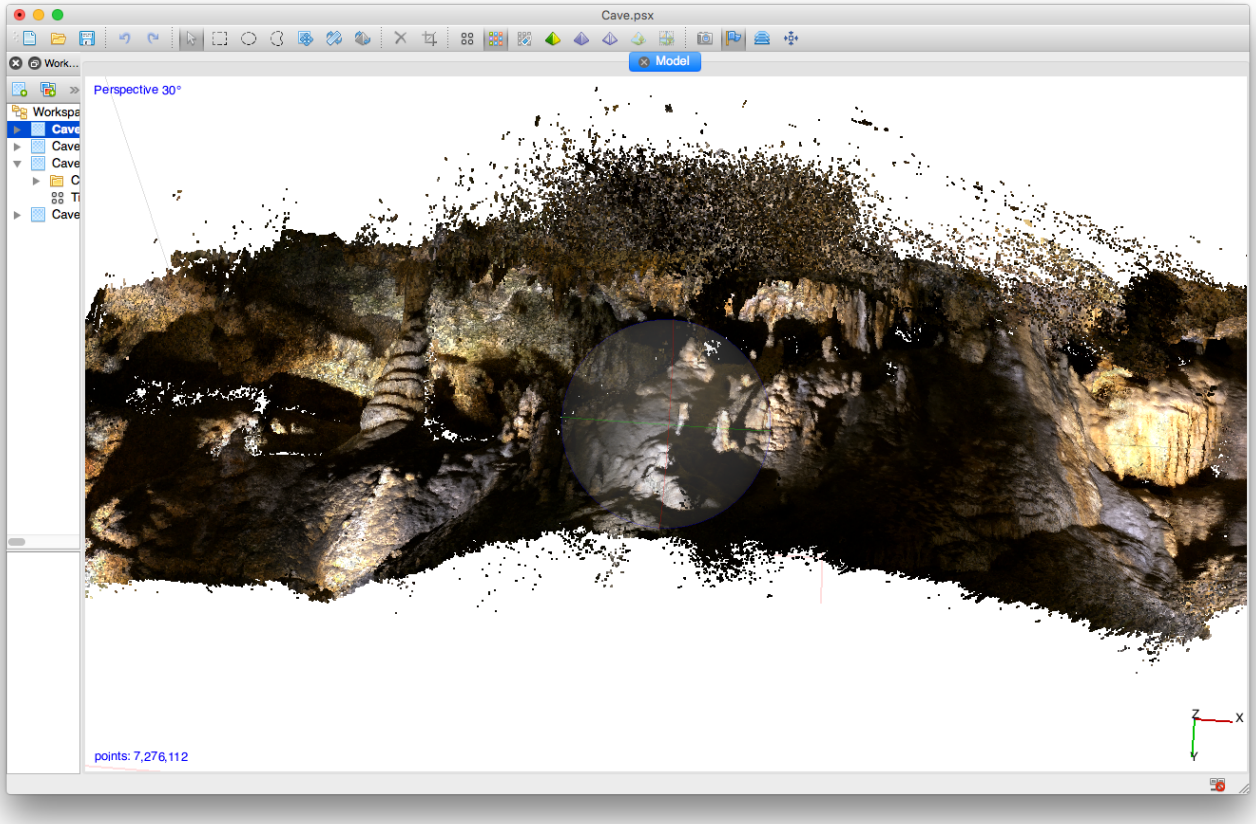


Quality: Specifies the desired reconstruction quality. Higher quality settings can be used to obtain more detailed and accurate geometry, but they require longer time for processing.



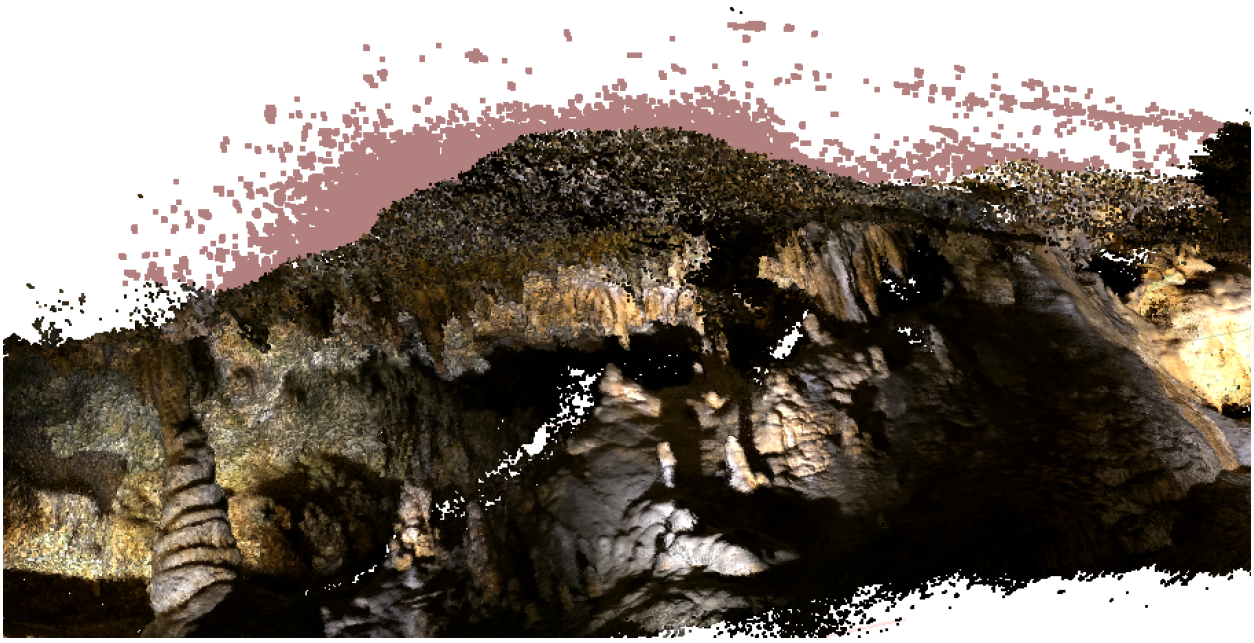
Depth Filtering: Setting a depth filtering reduces the amount of noise in the final point cloud, and can be helpful if images are blurry.

12. Once complete, a dense point cloud will appear in your main interface.



13. Things to check after your dense cloud is complete:

Are there any unnecessary points?

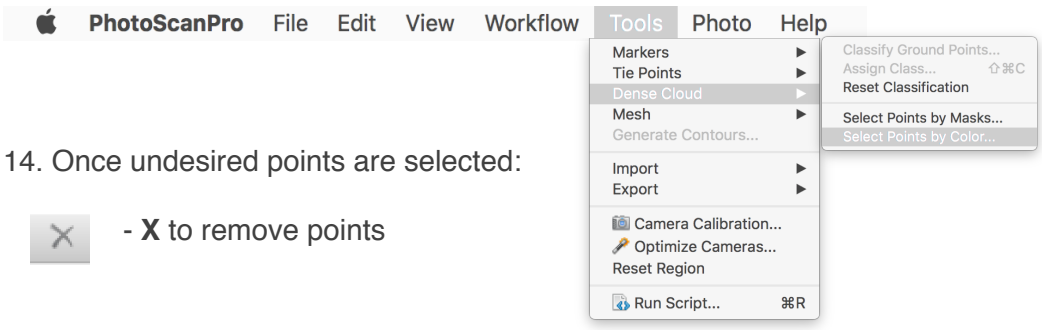


- The next step is building a mesh, and the boundaries of that mesh are determined by the dense point cloud. For this reason, it is important to select and remove any stray or unnecessary points from your cloud. This can be done in a couple ways including:

-**The lasso** allows for freeform selection, and is perfect for selecting points that are out of the bounds of the model you are making. (i.e. static noise, can be the result of a lack of depth filtering or blurry images). This tools is found in the top tool bar.

-**The square** selection tool allows points to be selected with a square, leaving sharp edges and corners. This can be very useful if you are making parts of an architectural space, and want sharp sides to seamlessly bring the elements together at a later point.

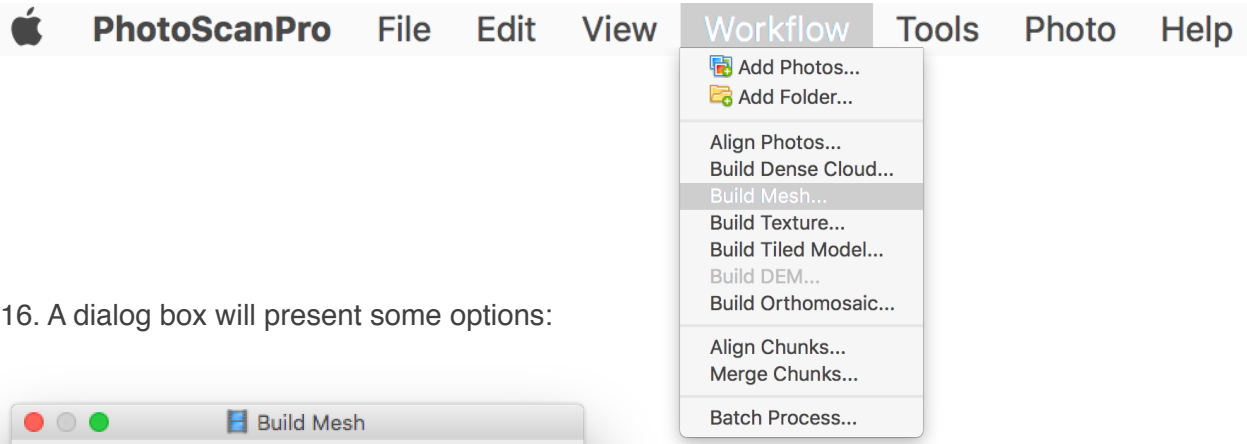
-**Select by Color** is a great way to remove any points that represent the space around your desired model. For example, if the photos you took for reconstruction were against a blue background, and you notice some blue in your dense point cloud, you can select all points with this color for removal.



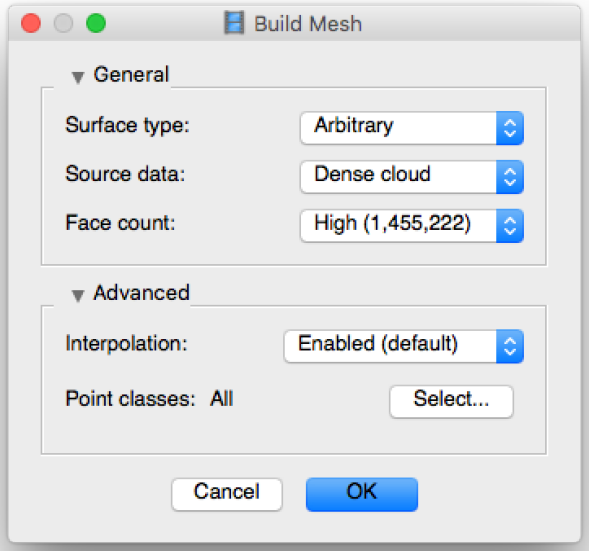
14. Once undesired points are selected:

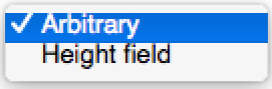
- **X** to remove points

15. Time to build that mesh. **Workflow -> Build Mesh.**

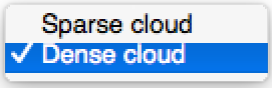


16. A dialog box will present some options:

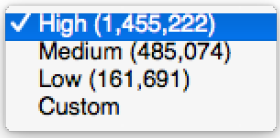




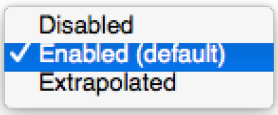
Surface Type: We are using Arbitrary Surface type for modeling becasue it accounts for any kind of object. It should be selected for closed objects, such as statues, buildings, etc. It doesn't make any assumptions on the type of the object being modeled, which comes at a cost of higher memory consumption. Height field surface type is optimized for modeling of planar surfaces, such as terrains or bas-reliefs.



Source Data: Specifies the source for the mesh generation procedure. Sparse cloud can be used for rapid prototyping // super fast 3D model generation based solely on the sparse point cloud. We are using Dense cloud the setting. It will result in longer processing time but will generate high quality output based on the previously reconstructed dense point cloud.



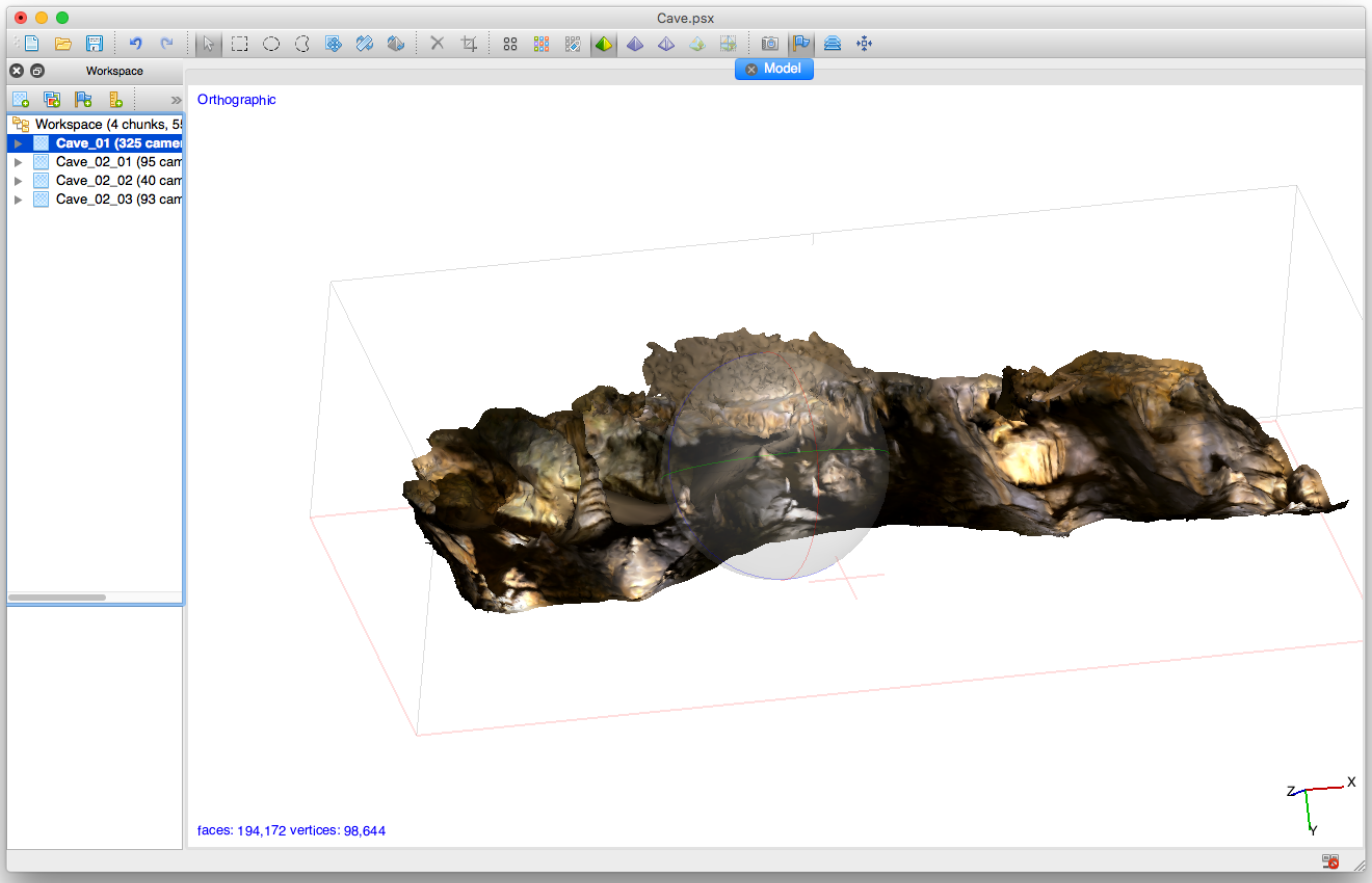
Face Count: Specifies the maximum number of polygons in the final mesh. High, medium, and low are calculated based on the size of the point cloud previously generated. I recommend using the highest number of polygons for mesh construction and decimating it after the fact.



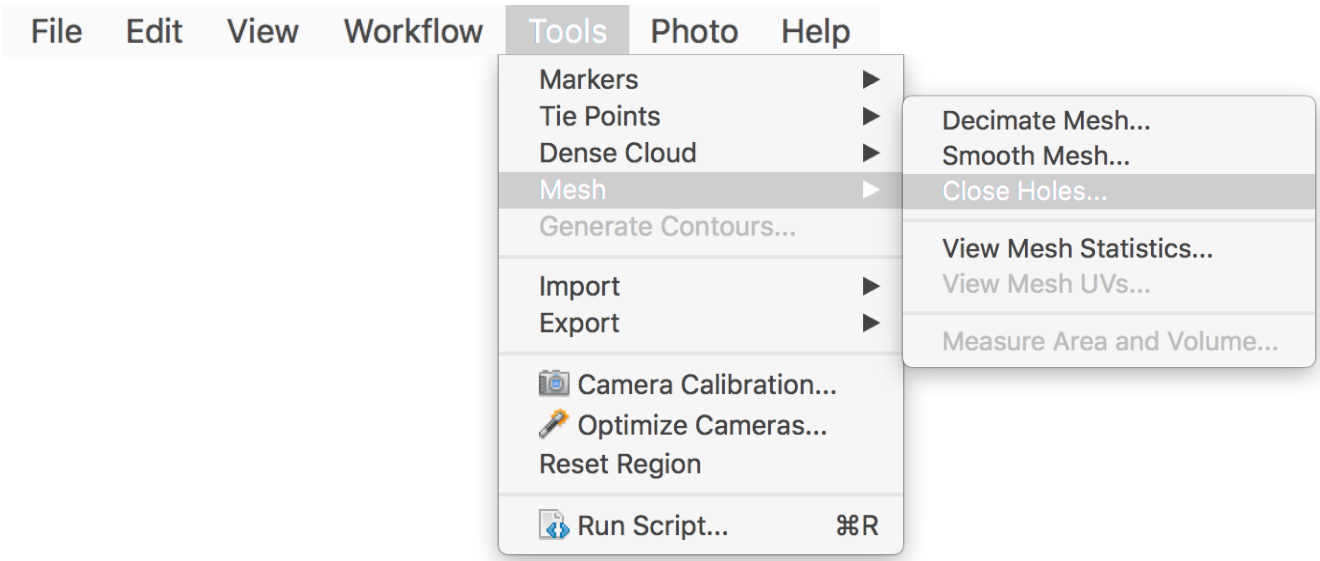
Interpolation: When disabled, no assumptions are made about the mesh, and it is precisely calculated from the point cloud. I recommend using enabled interpolation, as this produces a more filled in model. Extrapolation produces a mesh with no holes, that is usually very far from the original shape of the point cloud.

Point Classes: We are not working with point classes, so ignore this.

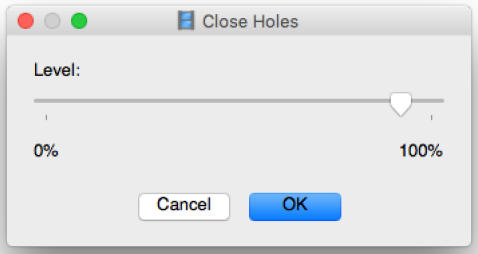
17. Once complete, a dense point cloud will appear in your main interface.



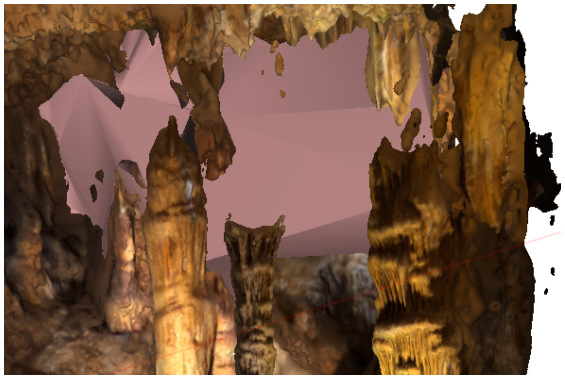
18. Fill holes in mesh. **Tools -> Mesh -> Close Holes…**



-Use the slider to determine the cut off size for holes to be filled. (you are setting the size of a hole in relation to the size of the whole model surface). Pink polygons indicate selected surfaces, and in this case, newly created holes. Unselecting these surfaces will return their color.

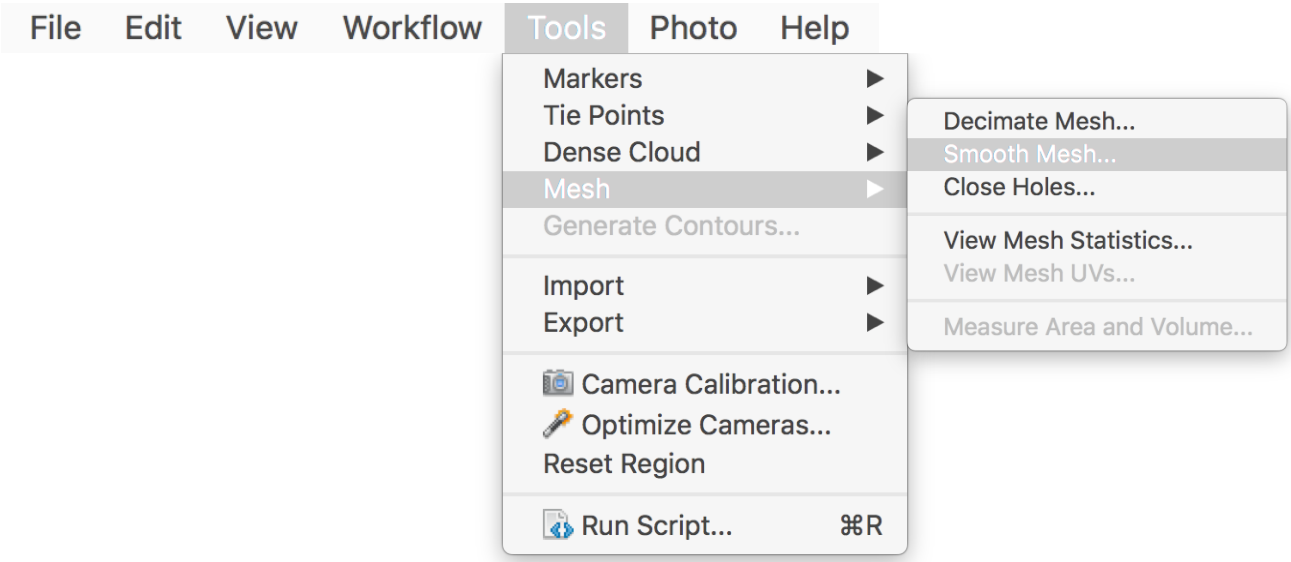


before Close Holes

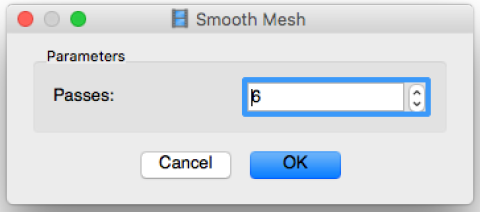


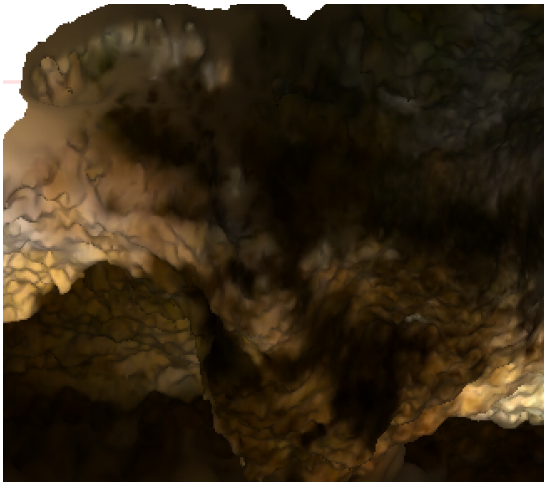
after Close Holes

19. Smooth Mesh. **Tools -> Mesh -> Smooth Mesh…** Models made with photogrammetry have a tendency to be constantly lumpy on the surface, and this can be undone with the smooth mesh tool. This tool is also helpful if “fill holes” was used, as it smooths the sharply low poly fillings in the mesh’s holes.

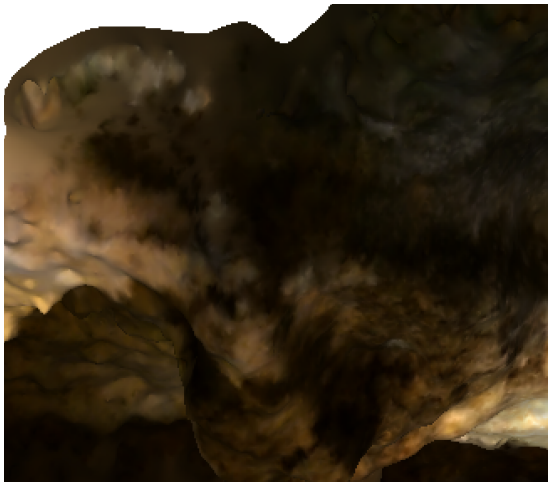


-The Smooth tool allows you to set the desired number of passes (higher number = more smoothing). I would recommend starting low and adding more passes if necessary.



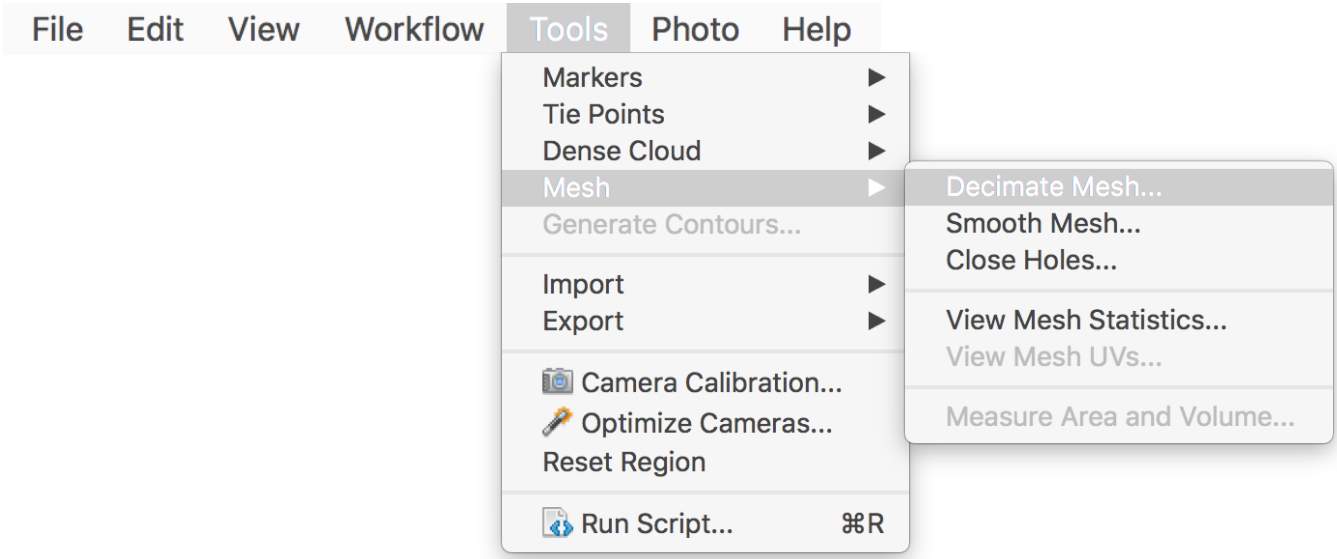


before smoothing

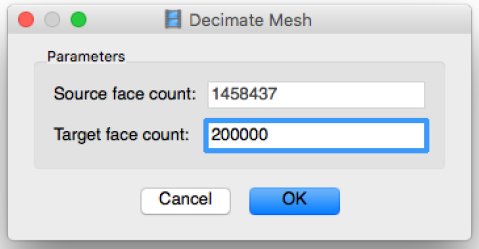


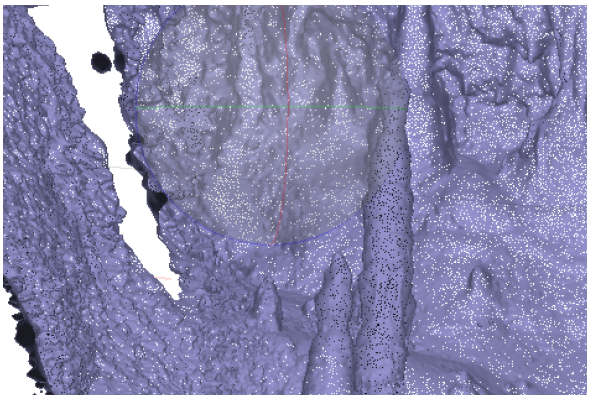
after smoothing

20. Decimate Mesh. **Tools -> Mesh -> Decimate Mesh…** Photogrammetry produces very high polygon models, which can be expensive for a computer to process, so it is almost always necessary to decimate (lower the polygon count of) your model. What this is essentially doing is decreasing the geometric resolution of the model by replacing high resolution mesh with a lower resolution one.

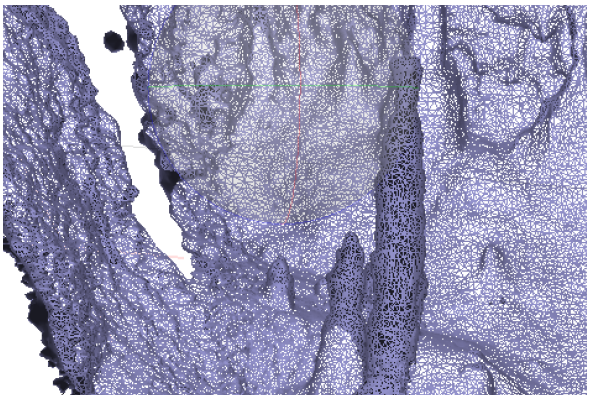


-Decimating Mesh tool shows you how many polygons (faces) your model has at the moment, and allows you to input your desired number of faces. While there is no “right” number, I would recommend keeping it between 50,000 - 100,000 for any model you plan on using in a browser based application, and between 100,000 - 200,000 for models headed for animation software // gaming engines.



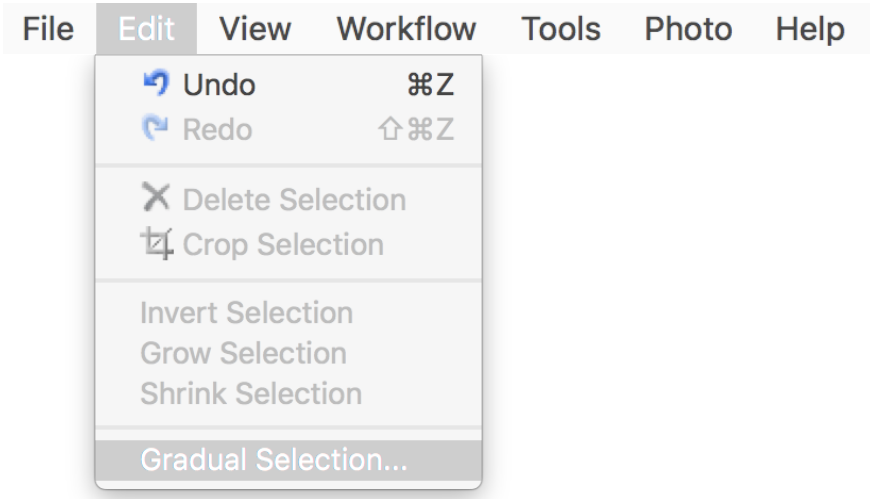


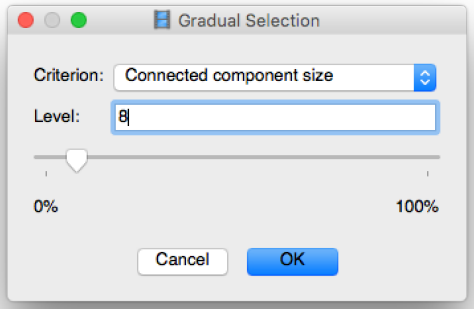
before Decimation

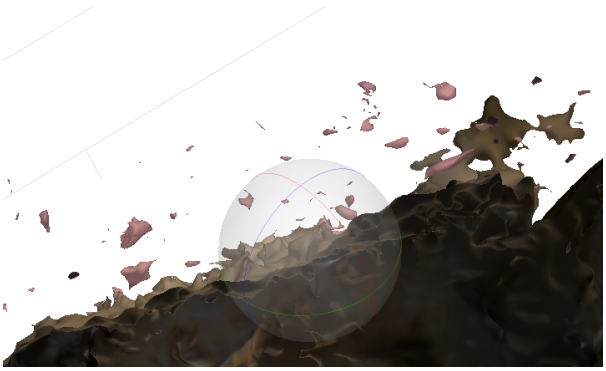


after Decimation

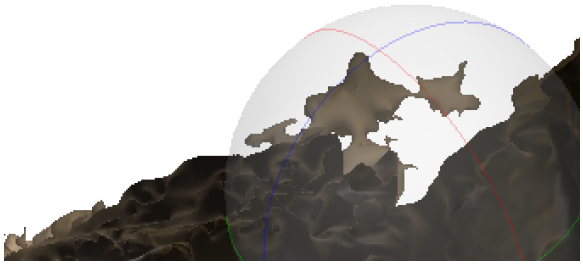
21. Have stray polygonal pieces disconnected from your model? Do not fear, gradual selection is here! The tool **Edit -> Gradual Selection** allows you to use a slider to select a desired threshold of outlying polygons. Once they are selected they can be deleted with the ‘x' in the tool bar.





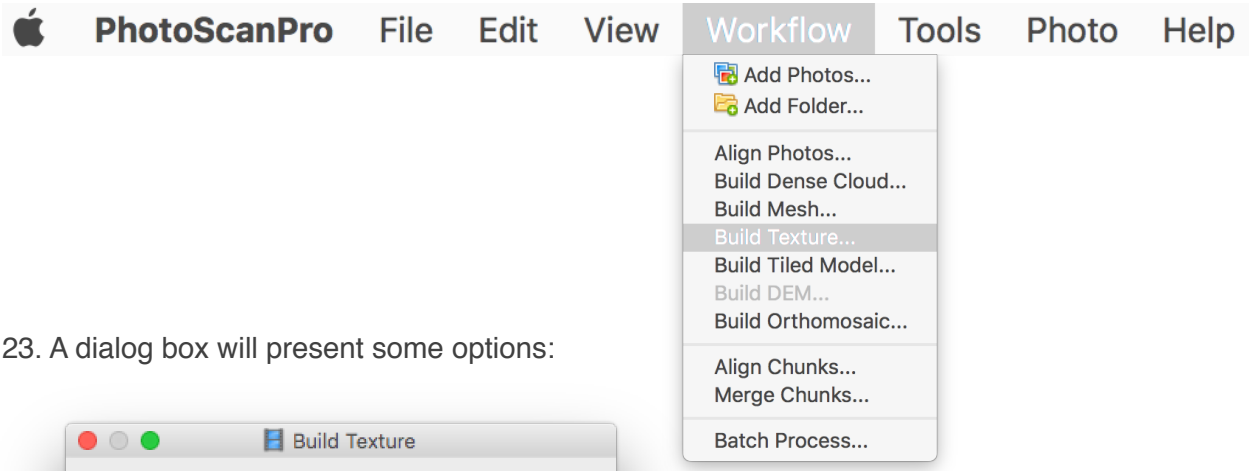


Gradual Selection

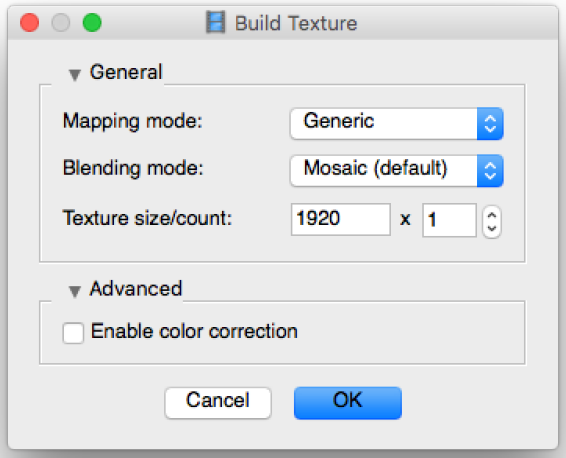


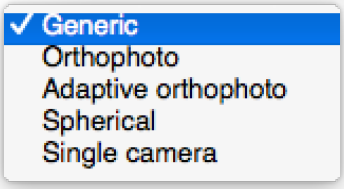
Deleted Selection

22. Last up! Building a Texture. **Workflow -> Build Texture**

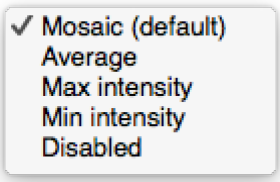


23. A dialog box will present some options:





Mapping mode This perimeter determines how the image texture will be stored in its final map or “atlas” form. Generic makes no assumptions about the context of the scene and strives for a uniform texture. (usually my go to) Adaptive orthophoto textures flat areas and vertical areas separately, so in the final image map they are split up. This is ideal for planar scenes ex. brick building on grass, as the image of bricks is stored separately from the grass. Orthophoto stores the entire surface as an orthographic projection. Compact > image quality. Spherical applies to mapping spherical forms Singe Photo generates texture from a single selected photo

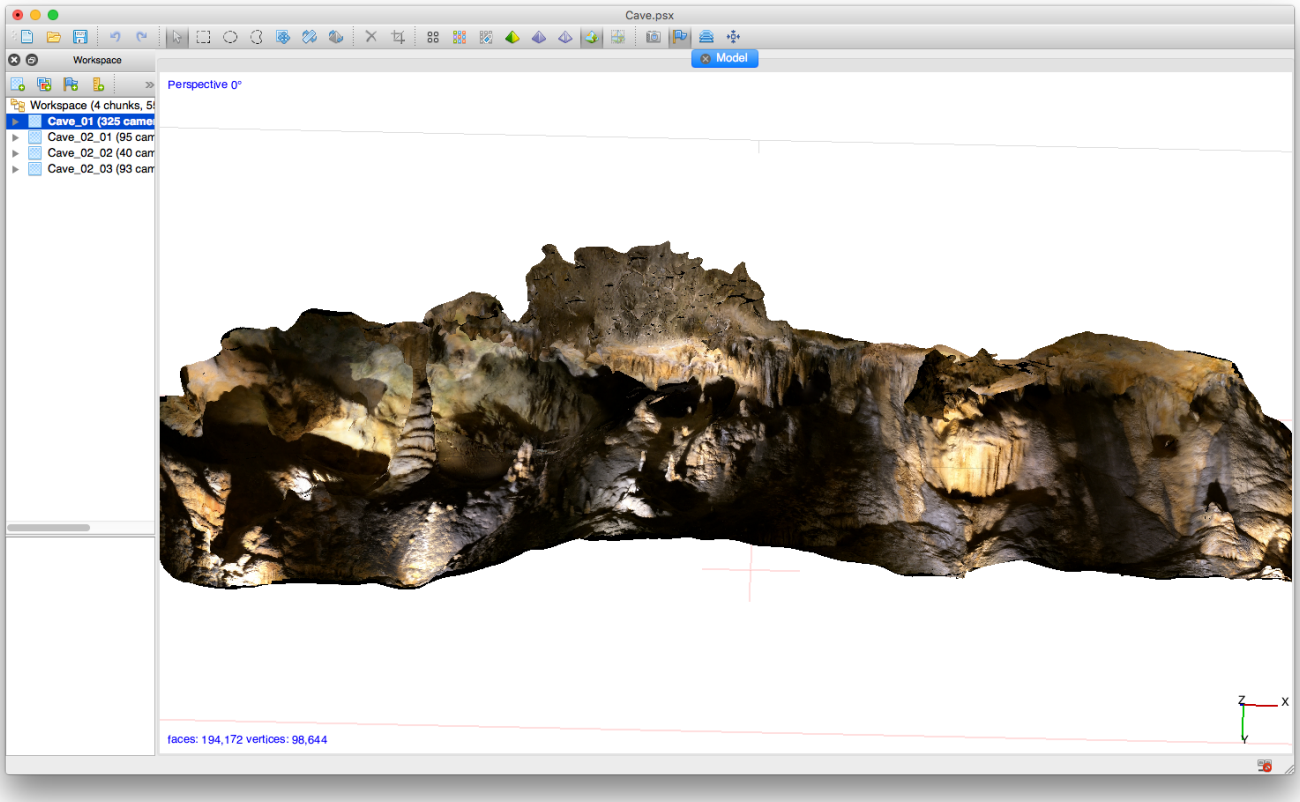


Blending mode This perimeter determines how the original set of images is blended together into one image texture.
Mosaic mode overlaps many images to avoid a seam, while also choosing one good resolution image for detail.
Average looks for the weighted average value of all pixels from individual photos. Max Intensity uses the photo which has maximum intensity of the corresponding pixel. Min Intensity uses the photo which has minimum intensity. Disabled is one I use frequently, as it produces images on a point by point basis, and thus avoids blur when working with video.

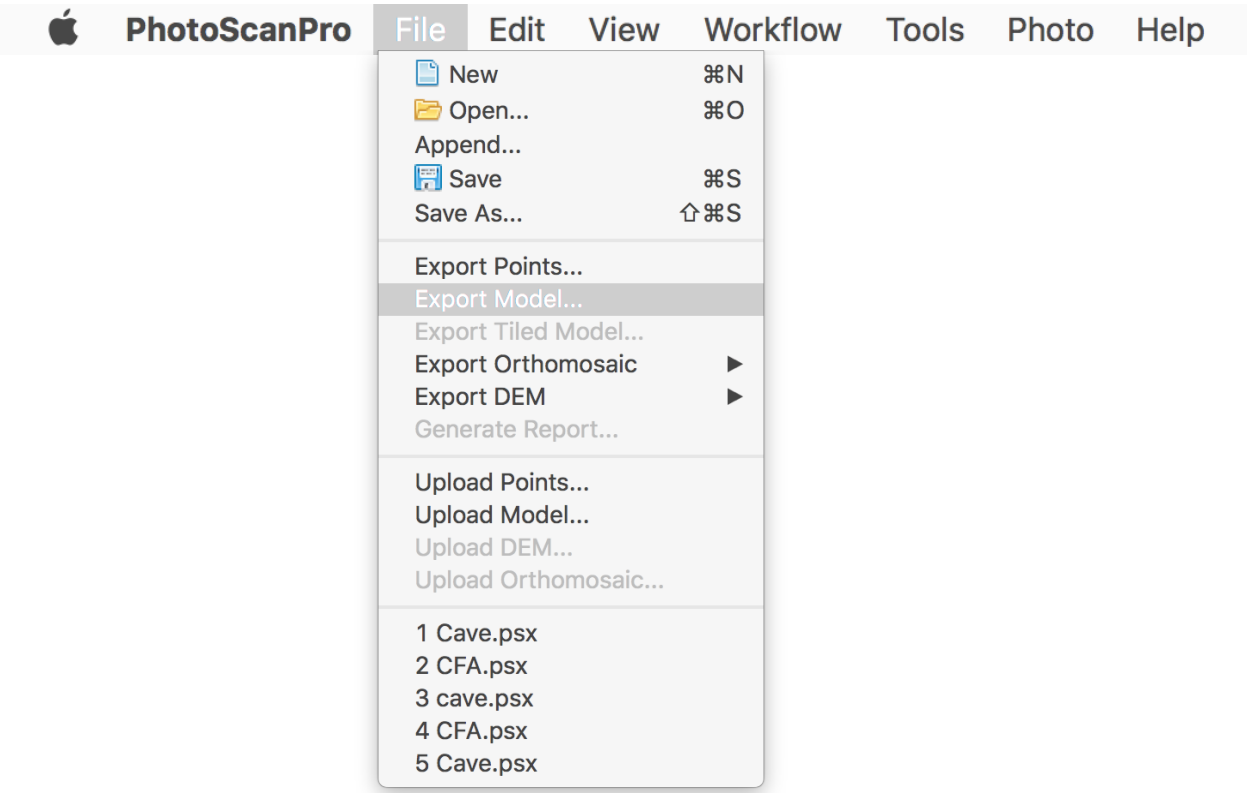
Texture size / count Allows you to enter the height and width of the final texture image. And the number of texture files to be exported. More files allows for higher image resolution. (3d models in this case store texture in an additional 2D image file which is wrapped around the model accordingly.

color correction Can be toggled on or off, and can help normalize extreme brightness differences in the original photos. I would recommend leaving this off at first. Creating an image texture is the fastest process in the pipeline, so after the initial texture is generated one can asses whether color correction might be necessary and if so, the texture can be built again with the change.

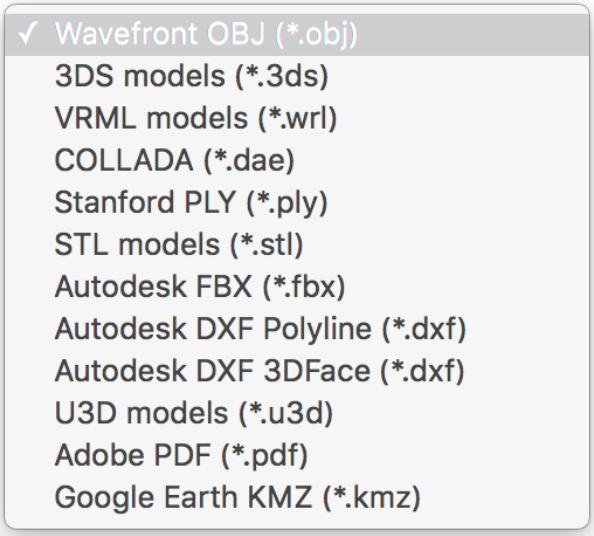
24. Once complete, a fully textured model will appear in your interface



25. Time to Export your model!



Models can be exported as the following:



about 3D file formats:

3DS models (*.3ds) - File formats used by the Autodesk 3ds Max software
works with 3ds max, .max

VRML models (*.wrl) - Virtual Reality Modeling Language" for 3D interactive vector graphics, designed particularly for the web.
superseded by X3D

COLLADA (*.dae) - COLLAborative Design Activity for establishing an interchange file format for interactive 3D applications.
works with most apps eg. blender

Standford PLY (*.ply) - Polygon File Format primarily designed to store three dimensional data from 3D scanners.

STL models (*.stl) - Native to the stereolithography CAD software created by 3D Systems and widely used for rapid prototyping and computer-aided manufacturing.
meshlab support

Autodesk FBX (*.fbx) - An exchange format, in particular between Autodesk products and other Digital content creation (DCC) software packages.

Autodesk DXF Polyline (*.dxf) - Drawing Interchange Format, or Drawing Exchange Format between AutoCAD and other programs.