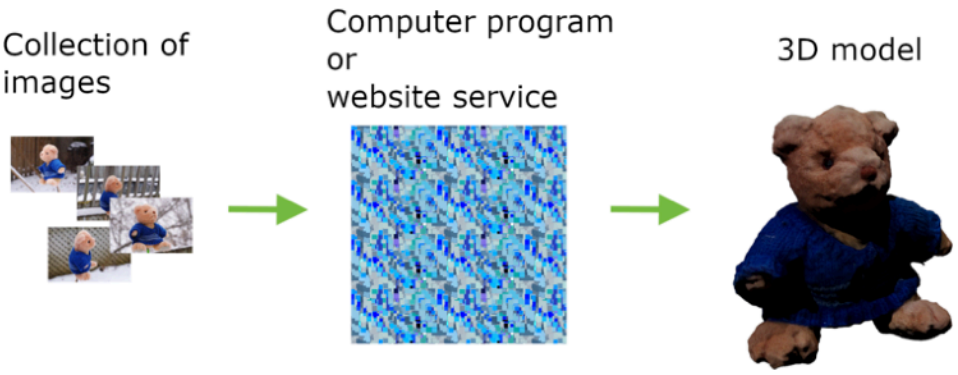
3D Models from Photogrammetry, and other tech

Intro

Photogrammetry is a scanning process to create a 3D object from a series of images. In this process, pictures are taken from all angles of the object being scanned. The images are then fed into a computer program that analyses the images, identifies matching points in the images, and creates a 3D model from the images. The resulting model can often be exported in a variety of formats suitable for social media, game environments, and simulations. The objects to be scanned can be as small as a bug, or as large as a building.

Variations on the process include: 1) using a video instead of a series of pictures as input, and 2) using a website to process the images instead of a local computer.



A more detailed explanation of photogrammetry is available on Wikipedia: https://en.wikipedia.org/wiki/Photogrammetry

When to use photogrammetry

3D models created with photogrammetry processes are often quite large in size, poly count, and texture image size. See the section below titled “3D model clean up, optimization, and conversion” for more details. An alternative to scanning would be to create the model by hand in a software program like Blender, Maya, or Substance Modeller.

Scanning is most efficient or useful for organic objects that would be hard to recreate out of basic shapes and blocks. Or when a near perfect replica of an artifact is the desired result.

Selecting an object to scan
Photogrammetry, in general, has troubles reproducing shinny , reflective, and/or transparent objects. There are techniques to make these objects more scanable but for now, avoid trying to scan shiny or clear things. Items you are photographing for photogrammetry should not change shape or size during the picture series. For example a rag doll with an arm that moves from one position to another would not work, nor would a plant blowing in the wind.

Selecting your camera
The idea of this session is to "bring what you have" and use it as a test. A cell phone camera will be a great a start, but if you want to use a different digital camera, please bring it. You will be taking approx. 60 images of an object and then need to transfer them to a website for processing. As such you may want to bring a data transfer cable to transfer pictures to a computer for uploading to the website.

Photographing your object
When taking the images move around the object in 3 consecutive rings taking approx 20 images per ring. The first ring around should be from above the object with the camera pointing down at the object. The second ring, or pass around, should be straight on the side of the object, and the third pass should be from slightly below looking up at the object. The idea is to capture each area of the object in as many images as possible.
Additionally:
- Any cell phone camera or digital camera should work fine for starting out
- Forty to sixty images are often enough to produce a decent model of an object at a useable level of detail.
- Quality does matter so choose highest resolution possible.
- Keep your camera orientated the same way for all images, portrait or landscape.
- Do not zoom in or out while taking pictures
- Consistent and even lighting is preferable
- Photograph in a well lit area but avoid direct, harsh light that casts shadows.
- Move in close, the object should fill at least 50% or more of the image.
- If possible use a higher F stop to increase depth of field, F8 or F11
- Review images and delete blurry images before processing
- If your camera moves around the object, the object should stay stationary
- If your object rotates (if its on a turntable), the background should be plain or blank and the camera should be stationary

Tip: on cell phones, the camera shutter can often be triggered via the volume down button as well as the on-screen button. This makes it easier to take a large

number of photographs in a row. On iPhones, you can also use the volume control on a wired ear buds.

Note that this setup is pretty basic. The object is stationary and we walk around it to photograph it. Using a backdrop and a turntable to rotate the object and leaving the camera stationary is an advanced configuration that allows for better lighting control.

Trying it Yourself

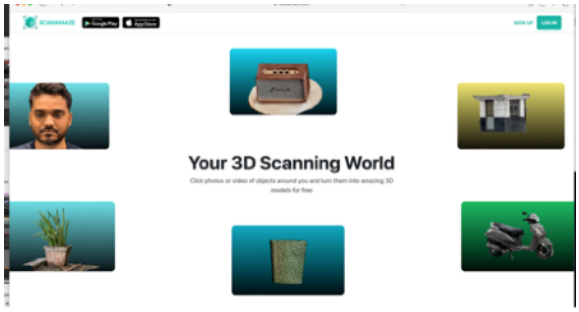
The next 4 Example sections demonstrate processes you can try yourself. Start with the ScanAMaze example, and then try one of the others based on your interest and computer resources available.

If you want to try the software on a set of existing images, you can get an image set at the ink below. This set of images has been tested under PhotoCatch, Scanamze, and Meshroom and produces a 3D model in all the programs.

https://github.com/sbenoit-gc/PhotoTestSet.git

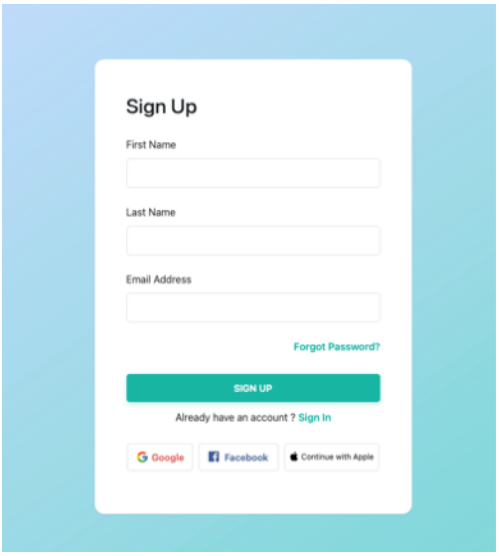
Example One - ScanAMze website processed images

NOTE: have recently experienced extended login delays on this site. In this example, we'll use a web site to process our pictures to create the model. We'll try a free account on the popular ScanAMaze site .

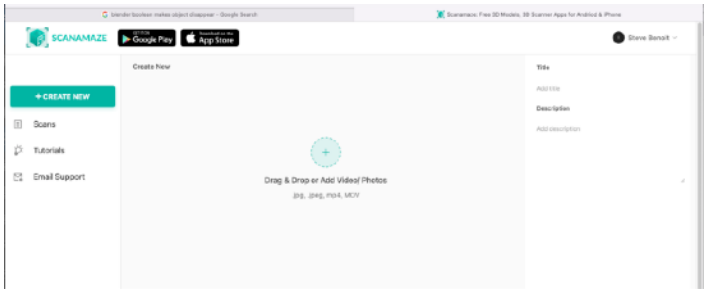


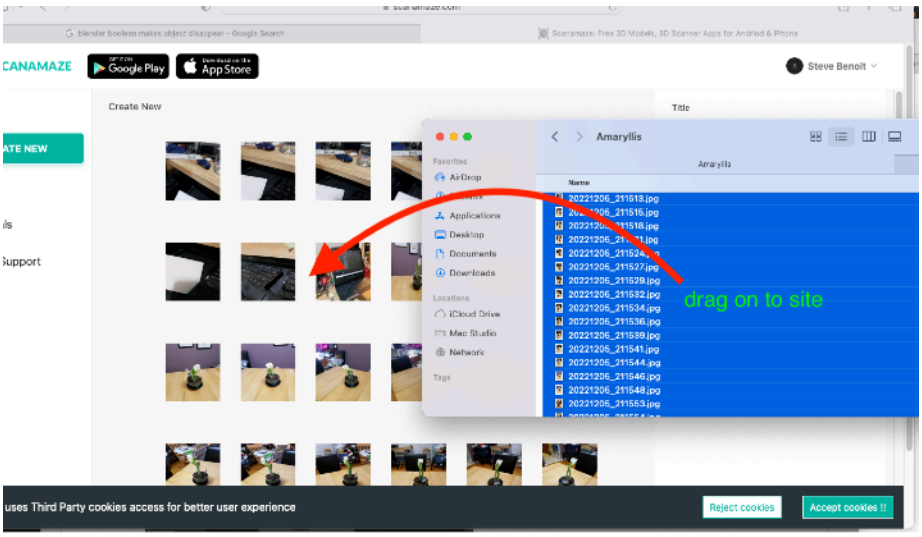
Steps

1. Take approx 60 pictures of the object from all angles and sides as described above
2. Browse to ScanAMaze website and create an account, https://www.scanamaze.com/ . We won't use the app at this time.

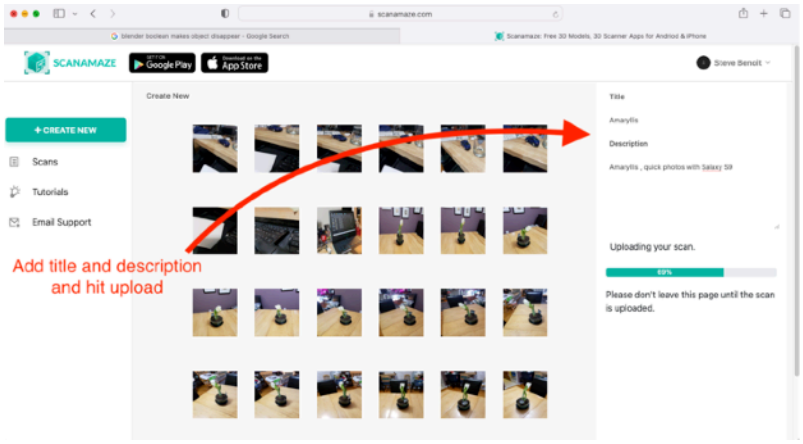


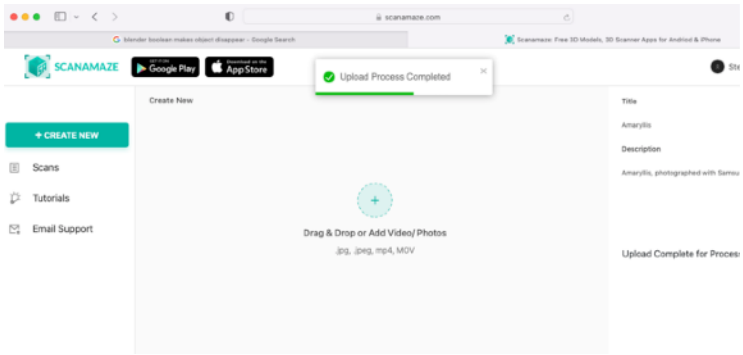
3. Login on ScanAMaze website and click the Create New button to upload your pictures



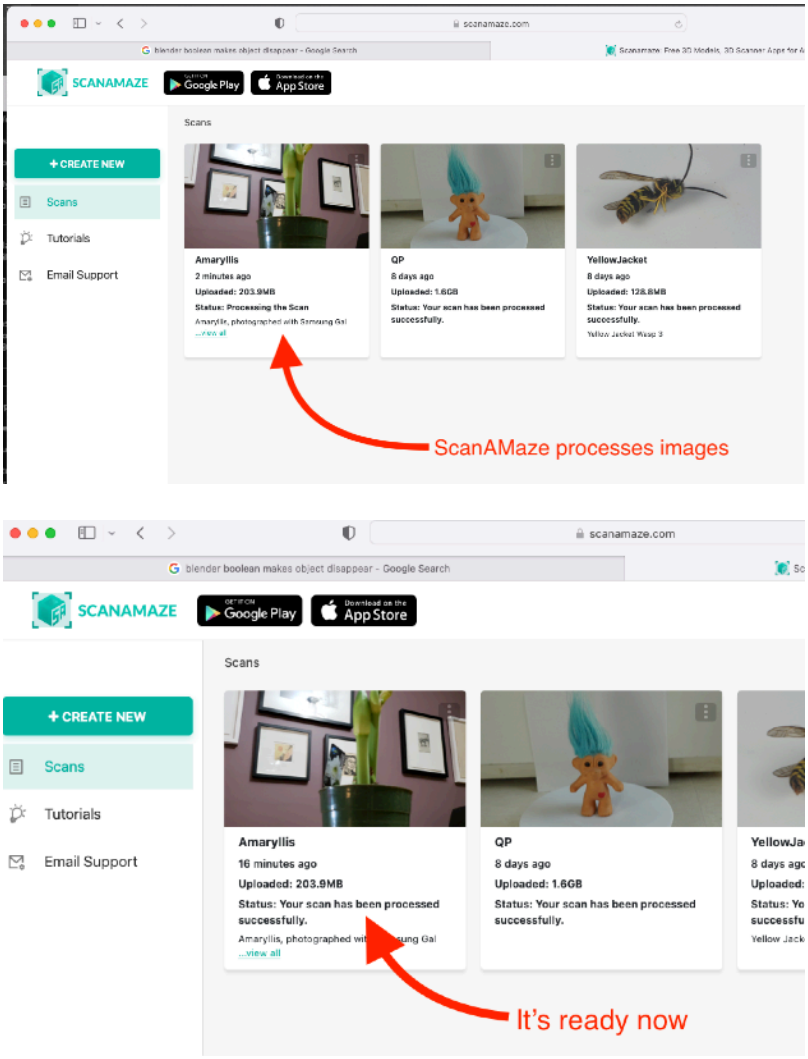


4. Add a title and description and hit Process button to start the upload.



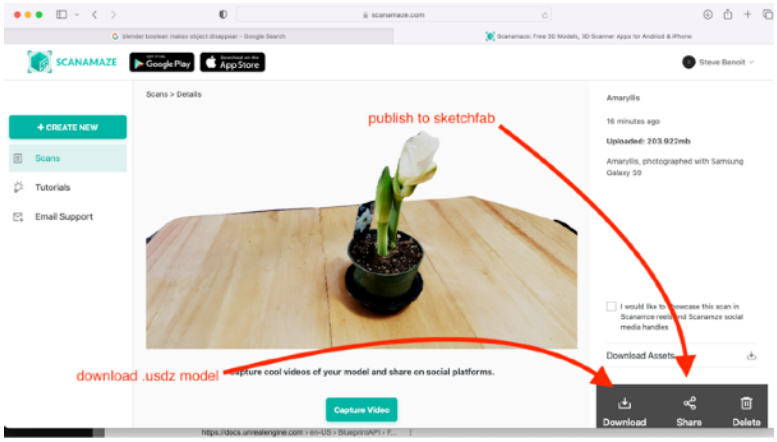


5. Wait while ScanAMaze processes your images to a model , watch for an email notification that its ready if you want to move on.

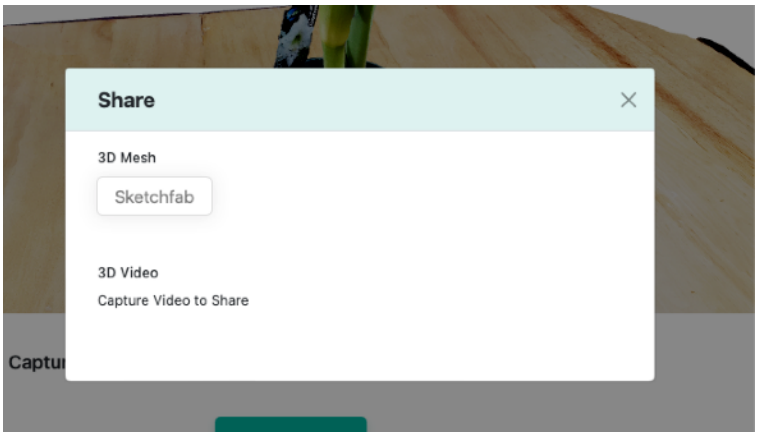


6. Select the Scans button, and then your new model, wait while it loads the model and the colour layer

7. Once loaded, you can pan and roll your mouse to view the model from all sides.



8. The Download button downloads a .USDZ model to your local device/ computer.
9. There are options to share the model on SketchFab and via video as well



Example Two - Meshroom - local Windows PC

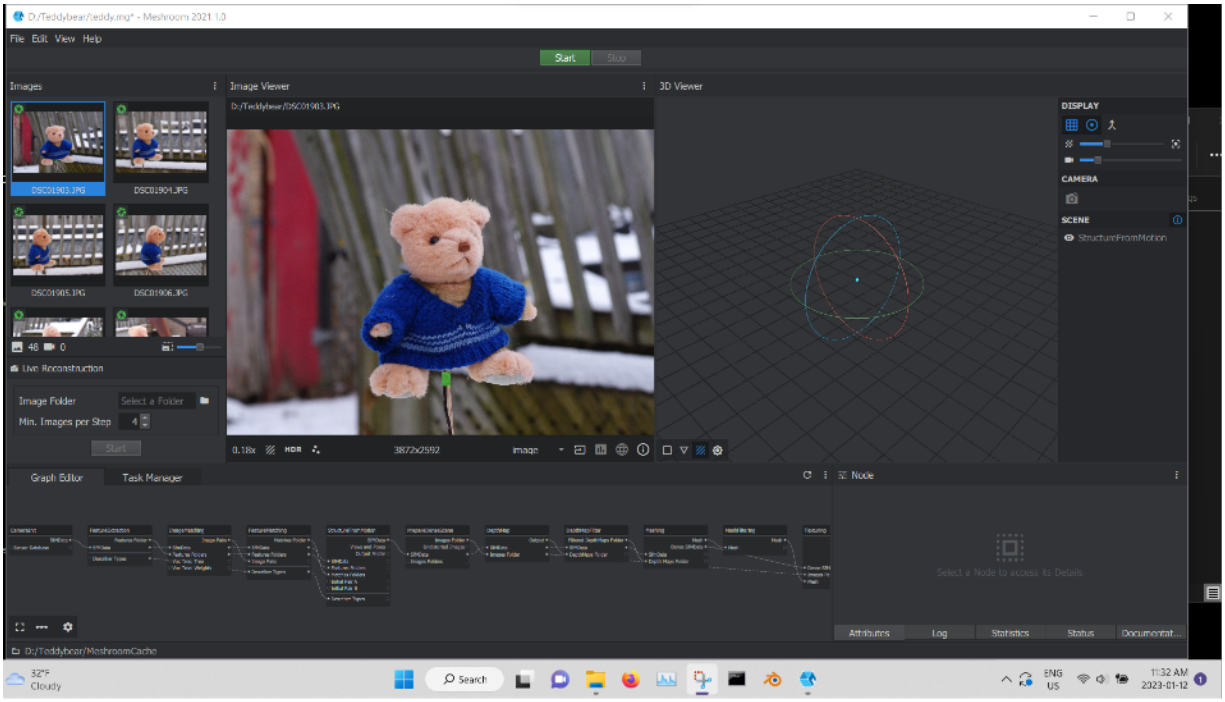
This example uses an open source photogrammetry software for Windows called MeshRoom available from AliceVision, https://alicevision.org
The images are processed on a local computer running the MeshRoom application. Running this on a faster computer with a good Nvidia graphics card (GPU) can produce models faster, AMD GPUs are not supported. With no Nvidia GPU only draft mode meshes can be created. Note: the application does not require an install, simply download, unpack, and run.

Many tutorials for Meshroom exist, one such is AliceVisions page containing the tutorial and links to videos

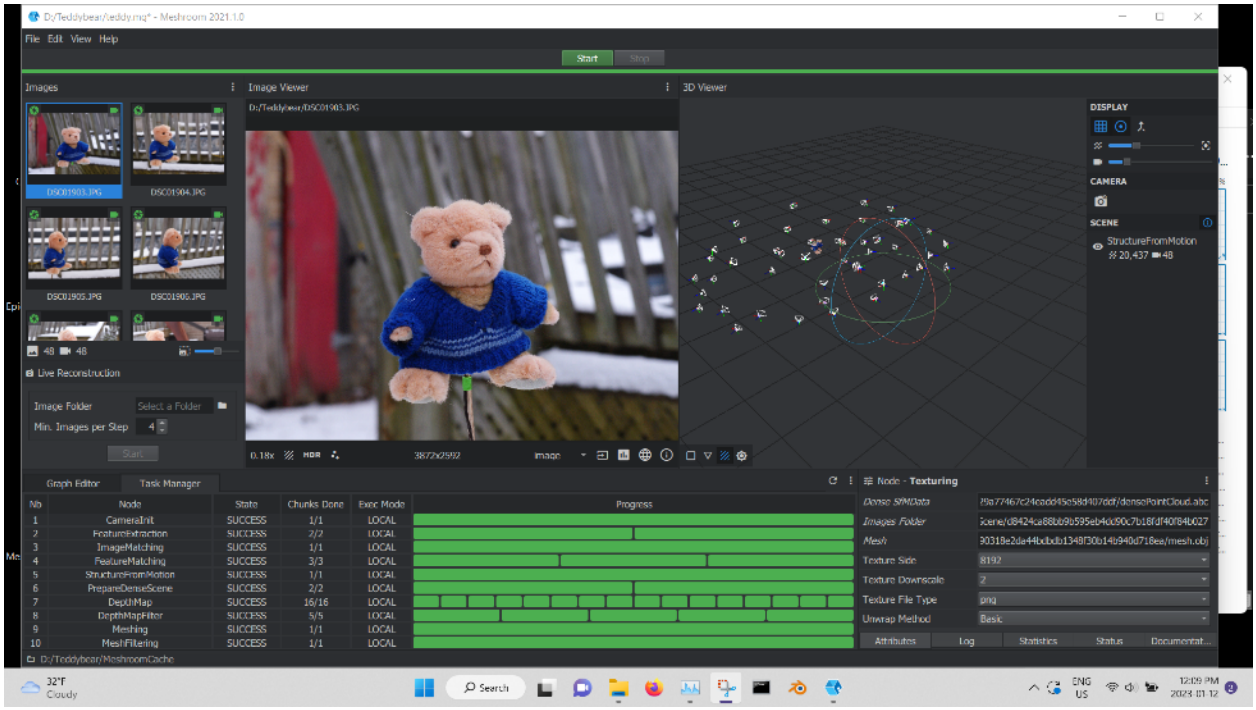
https://meshroom-manual.readthedocs.io/en/latest/tutorials/sketchfab/sketchfab.html

Steps

1. Take approx 60 pictures of the object to scan from all angles and sides as described above
2. Move the images to folder your computer
3. Open Meshroom, download if necessary, installation NOT required, just run
4. Choose File , New, and then File ,Save As and name project saving it to the same folder as the images.



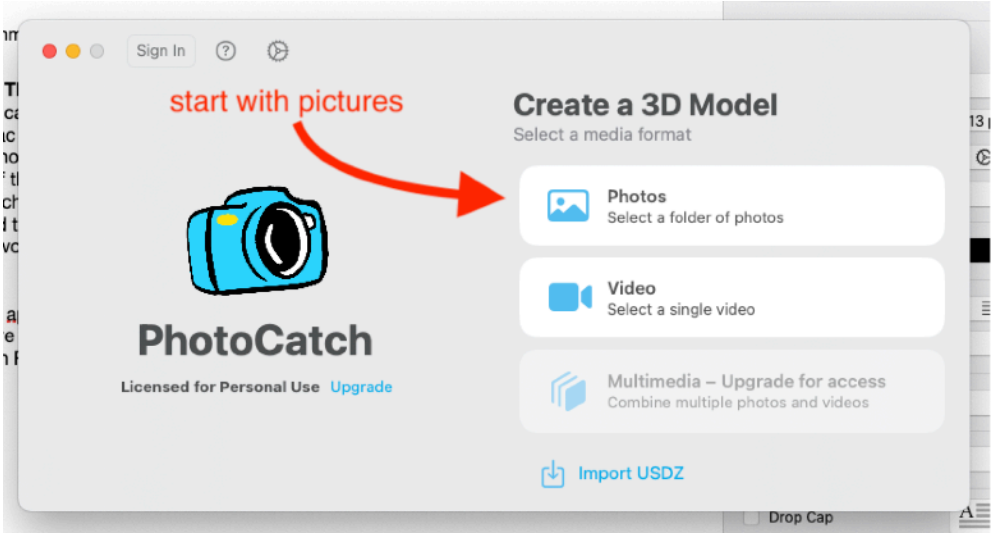
5. Open the folder and select all the images
6. Drop the images on the left hand side “Drop Image Files /Folder” pane
7. Press the green Start button and watch progress - this may take a long time based on computer performance and number of images
8. When finished, the model and camera locations appear in the view pane on the right



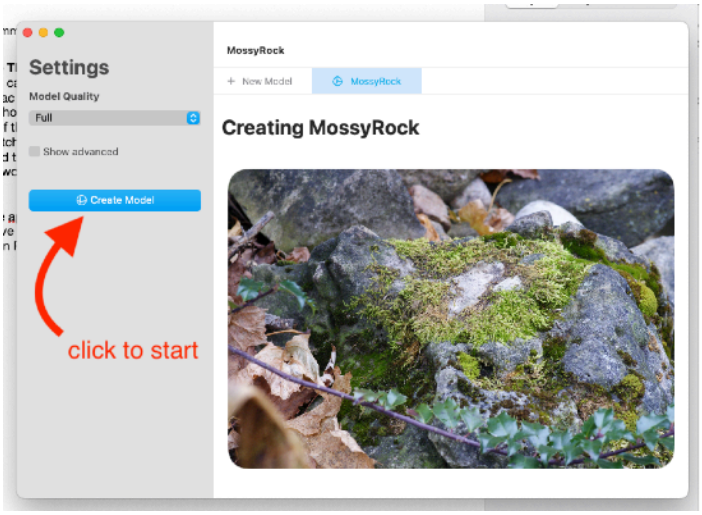
9. Next, open the MeshroomCache folder in the images folder and navigate to the Texturing folder
10. The 3D model is in the numbered folder and is named “texturedMesh”
11. Import model into your favourite 3D modeling program, or double click on it to view in 3D Viewer/3D paint.

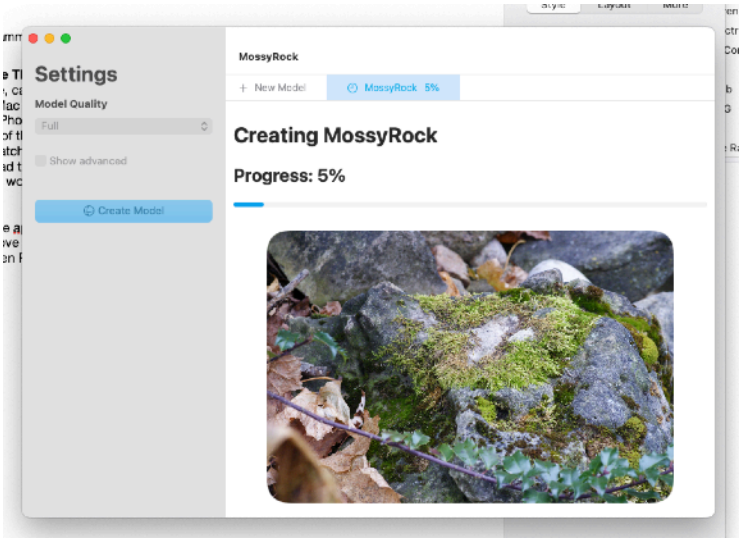
Example Three - PhotoCatch - local Mac
This one, called PhotoCatch, is my favourite as it runs on a local Apple Silicon based Mac computer. This is reasonably fast even on an M1 MacBook Air laptop. PhotoCatch is the software that processes your images to a model instead of the website in the first example, or the Meshroom application in the second example. PhotoCatch is MAC only and is available from https://www.photocatch.app . Download the “MacOs” version as it allows for processing images locally for free. We won’t be using the app at this time.

Steps
1. Take approx 60 pictures from all angles and sides as described above
2. Move the images to your computer
3. Open PhotoCatch, download and install if not already installed
4. Select the Photos option

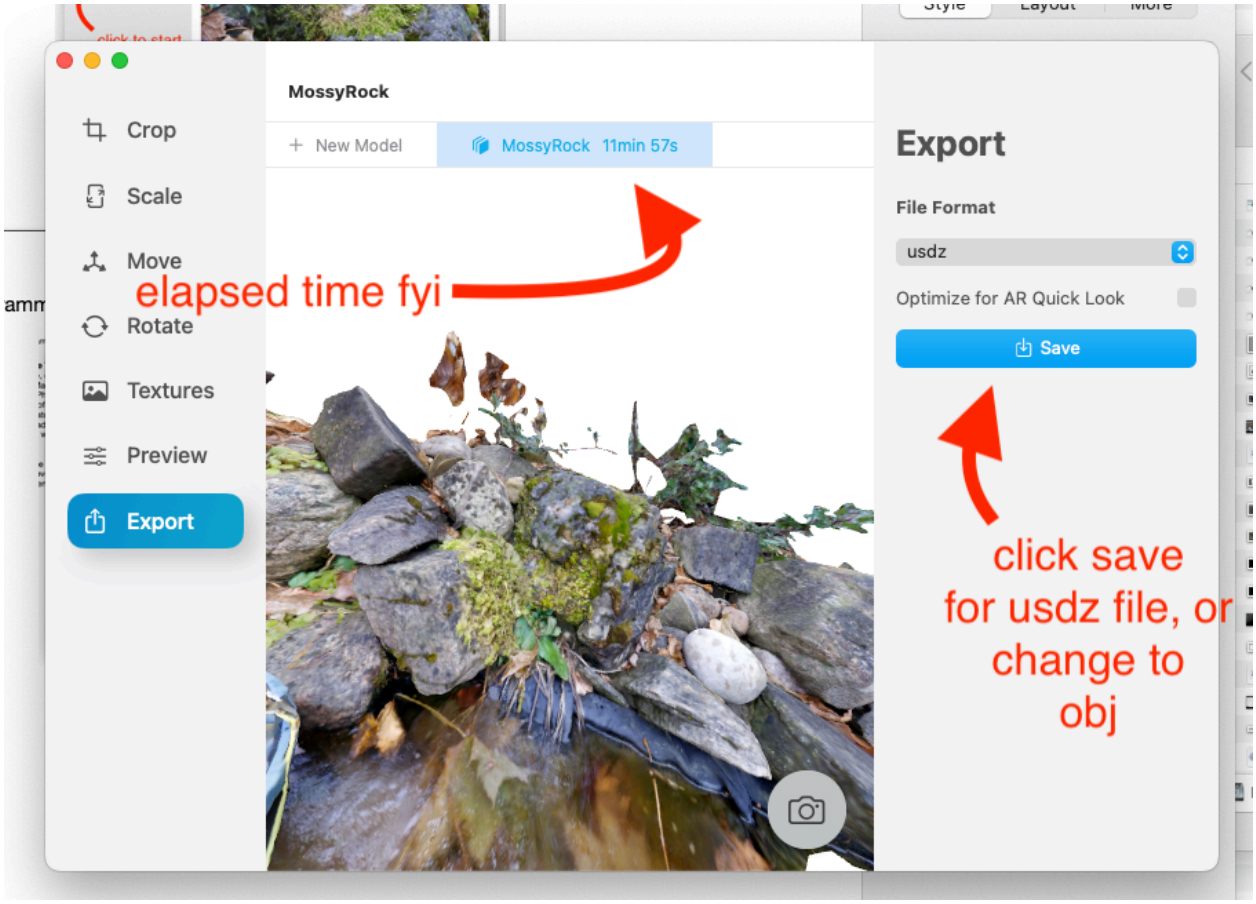


5. Select the folder containing your images
6. Then select Create model and watch the progress bar

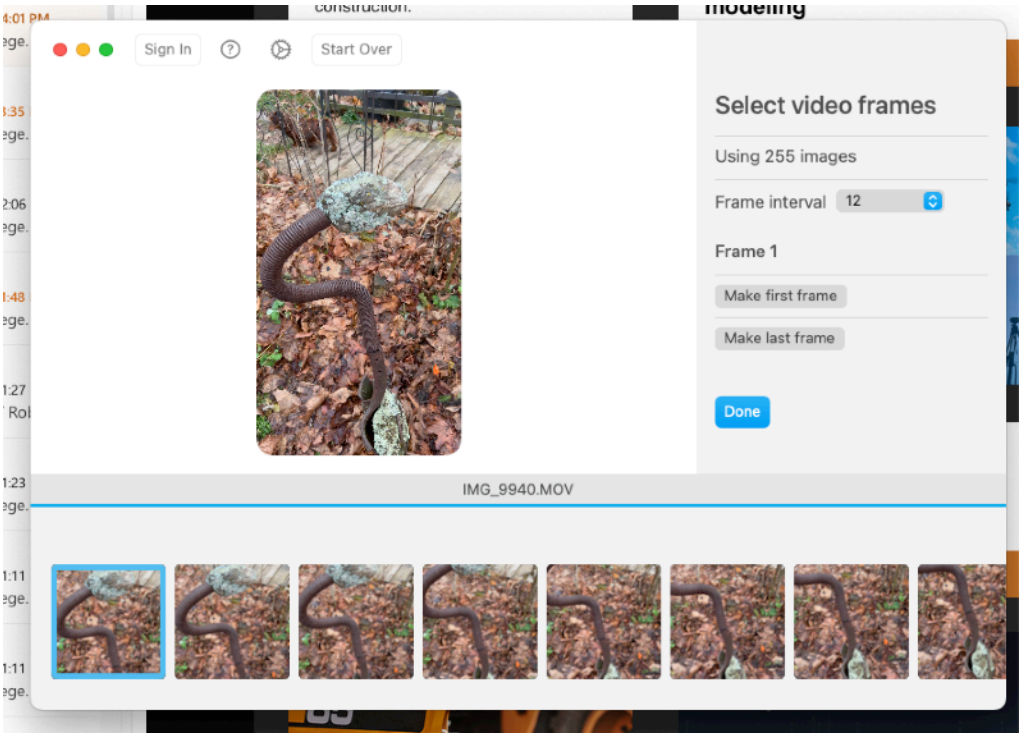




7. PhotoCatch may show 100% complete for a moment
8. Then the model is displayed along with an option to save it



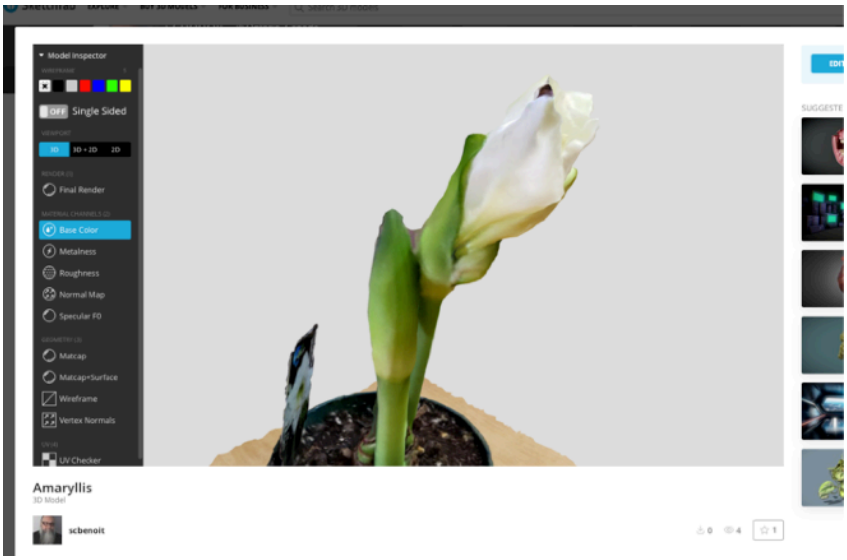
PhotoCatch will also process videos creating still images from the videos automatically and then processing them. With a video selected as input, the input screen changes to allow for the still image interval to be crated. A paid version of PhotoCatch allows the user to mix video and still images as input.

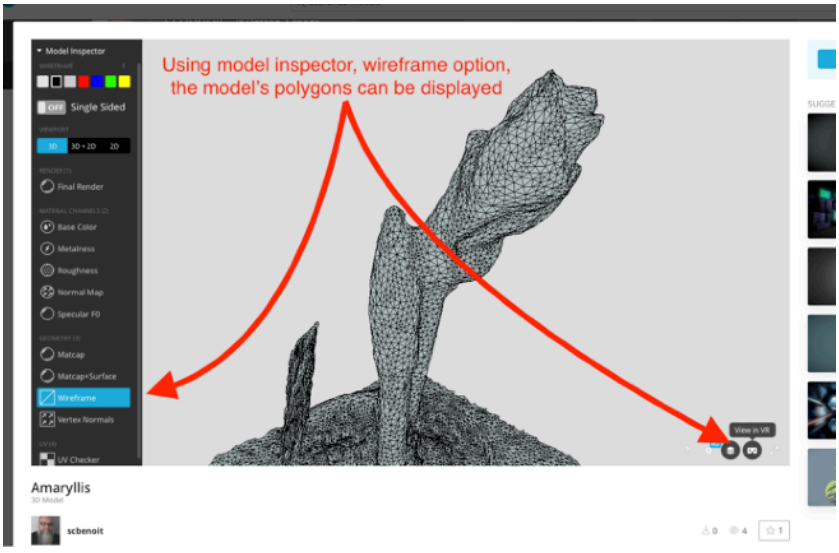


Viewing the created 3D models
On MACOS many models can be viewed in the Preview application, as well as imported into Blender for viewing. On Windows 10 and 11 many models can be viewed in 3D Viewer application, or imported into Blender.

Additionally, common .usdz model files can be viewed in AR on iOS devices.

Viewing and sharing models can be done by uploading to SkechFab.com , a sort of social platform for sharing 3D models of all kinds.





A models polygons or surfaces can be viewed on SketchFab as shown above.

I have sample scans created with photogrammetry, lidar scans, and structured light scanners posted on SketchFab at https://sketchfab.com/scbenoit/models

NIRA is another app for uploading, viewing and sharing 3D models , but is generally expensive and for commercial work https://nira.app/

3D Model clean up, optimization, and conversion
The resulting 3D models may need to be converted to a different format for your use, perhaps .fbx for use in Unreal Engine, or .usdz for use in ARKit applications. Blender is a good open source 3D modelling tool capable of converting these 3D models and providing functionality to clean up and modify them as well. Available at https://www.blender.org

Other tools to assist with mesh cleanup include Autodesk MeshMixer (https://meshmixer.com/),MeshLab (https://www.meshlab.net/), and Instant Meshes (https://github.com/wjakob/instant-meshes).

3D models created from scanning processes are often large in file size, and have a high number of surfaces or polygons. These highly detailed files may be too detailed for the intended use, and may slow down a device displaying one or more of these models. Two ideas for making such models more efficient and simple, all be it less detailed, are decimation, and “retopologizing”.

Decimation refers to the process were several smaller surfaces of polygons in a model are combined into one larger, averaged polygons reducing the number of surfaces and vertices in the file. Retopologization places a new skin on the object using a larger, regularly spaced grid, like shrink wrapping.

Depending upon the file format, these models can have embedded or separate texture files. Texture files are 2D image files that are applied like a skin to the model in order to colour it. Sometimes these texture files can be reduced from a 4k resolution to a 2k or 1k further reducing the size of the model, but again, making it a little less detailed.

Conclusion
This was a brief introduction to photogrammetry using free or open source software and tools you already have.