

Going Nuts with Photogrammetry: the Turntable Photogrammetry Tutorials series

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This PDF contains word-for-word transcripts of 10 of my video tutorials (plus an overview/introduction tutorial) on using Blender, Meshroom, and Substance Painter to complete a small Turntable-style photogrammetry project.

The video tutorials are scheduled to be published throughout April 2025 on my YouTube channels.

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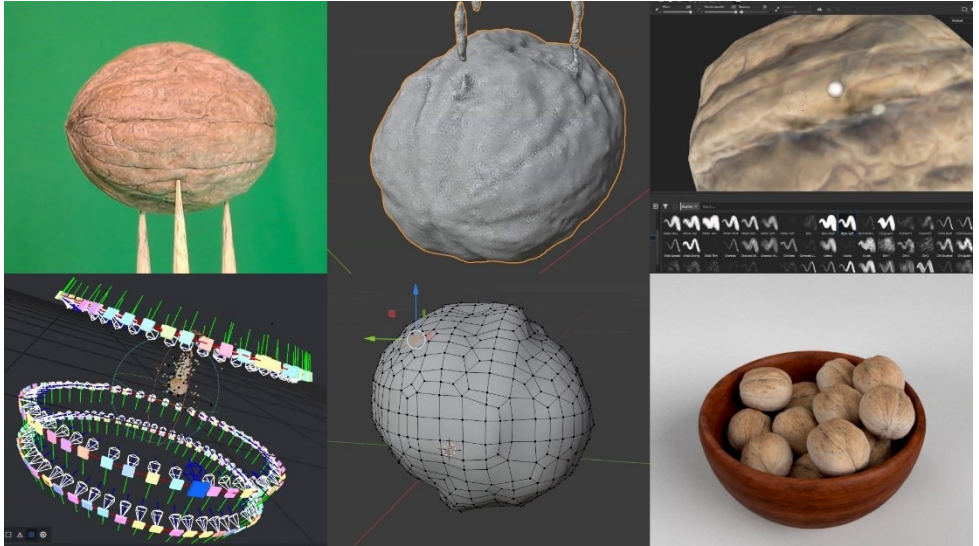
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00: Overview

scheduled for April 4, 2025: <https://youtu.be/cA8evTbRIs4>



Hello everyone! This is the episode 0 of a series on a photogrammetry project that involves the use of Blender, Meshroom, and possibly Substance Painter. This is a basic series aimed at those with little to no experience in photogrammetry.

Specifically, the project will be of the Turntable type, where an object is placed on a rotating platform, and photos are taken from the front against a uniform background.

The tutorials were created using versions 4.3 and 2023 of Blender and Meshroom, respectively. The series is intended for those who have a basic understanding of Blender and Substance Painter's interface and main tools,

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but Substance Painter is optional, as I will explain shortly. No prior knowledge of Meshroom is required. You'll just need to download and install it!

As for Substance Painter, I will be using the 2019 version, back when it was still an Allegorithmic product and perpetual licenses were available. However, the tools I will be using are also present in the more recent versions of Adobe 3D Painter. In any case, the tasks I will be performing in Substance Painter, namely creating Normal Maps and generating a PBR material, can also be done in Blender, provided you are comfortable with its tools.

I created this series by taking photos without using professional or semi professional equipment. This was a deliberate choice to showcase a photogrammetry and reconstruction pipeline starting with just a smartphone, a kitchen turntable, a green cloth, a desk lamp, and a light ring.

This setup is therefore affordable, easy to replicate, and useful for getting familiar with the tools and techniques before making any investments in better equipment.

Of course, a budget friendly setup has its downsides, both in terms of photo quality and lighting, which will cause some minor issues along the way. However, I will address these issues throughout the series, giving you some insights on how to overcome them.

The object to be reconstructed, which is a walnut shell, is a common item, but it has a surface with a good amount of detail and unique features that justify the use of photogrammetry and the creation of a Low Poly version.

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A PDF transcript of all the episodes in this series is already available for free download at the link provided in the description. The package also includes the photos used in the tutorial, with the green background already removed. This is also a great time to subscribe to the channel and enable notifications!

Throughout the various episodes, I will first show you the lighting setup and the photo capture process in detail.

Then, I will show how to set up a photogrammetry project in Meshroom using the default workflow for a turntable project.

One episode will be dedicated to using the Color Keying and Spilling nodes in Blender to remove the green background from the photos, so that we can use cleaned up, transparent images in Meshroom.

We will then see how to start the geometry reconstruction in Meshroom, adjusting elements such as the bounding box to reduce the reconstruction area and speed up the process.

The high poly version of the geometry will then be imported into Blender for an initial review and general cleanup before creating the low poly version.

Next, we will create the low poly version of the geometry in Blender. This geometry will have its own UV unwrapping and a temporary material.

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The low poly geometry will then be used in Meshroom to generate a base color texture mapped onto this new geometry.

The low poly geometry will then be imported into Substance Painter to bake the Normal Map, which means creating images that transfer details from the original high poly geometry to the new low poly model. We will see how to apply the base material with the Color and Normal textures to the low poly geometry, and then how to assign plausible materials for the Roughness channel.

In Substance Painter, we will also adjust tones and lighting using various layers. Then, we will fix errors and refine the edges between UV islands using the Smudge and Clone brushes in Passthrough mode.

Once the work in Substance Painter is complete, we will export the PBR textures. These textures will then be imported into the low poly project in Blender, allowing us to apply transformations such as position, rotation, and scale to the object, bringing the project to completion.

That's it for this series overview! See you in the next episode!

01: Environment Setup and Photography

scheduled for April 7, 2025: <https://youtu.be/oeyH2w7G8RE>

Hello everyone! In this episode of the basic turntable photogrammetry series, I will give an overview of the setup used to photograph the walnut shell that will be reconstructed through photogrammetry.

As mentioned in the series overview, the objects used are deliberately non professional. The goal is to demonstrate the basic elements of photogrammetry, some of the common issues you might encounter, and how to solve them, without needing expensive equipment, at least in the beginning.

Before we start, let me remind you that the PDF transcript of all episodes in this series is available for free download at the link in the description. The package also includes the photographs used, with the green background already removed. This is also a great time to subscribe to the channel and enable notifications!



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I placed the walnut shell on a support made of three long wooden sticks, which rest on a rotating base, with the idea of suspending it in the air, so to speak. This setup has two advantages. First, it allows for photographing the object from the bottom as well. Second, the area occluded by the supports is very small and will be easy to remove, both in terms of geometry and textures.

To take the photographs, I used a non high end smartphone, keeping it steady with a desktop Light Ring and a flexible tripod, using the latter for low angle shots. The Light Ring provides good general lighting for the object, although it is insufficient for the bottom part. So, I aimed a lamp at the base of the support to create bounce lighting for that area.

However, this introduced some greenish reflections, and the central lower part still remained slightly in shadow. I will show possible solutions for both of these issues throughout the series.



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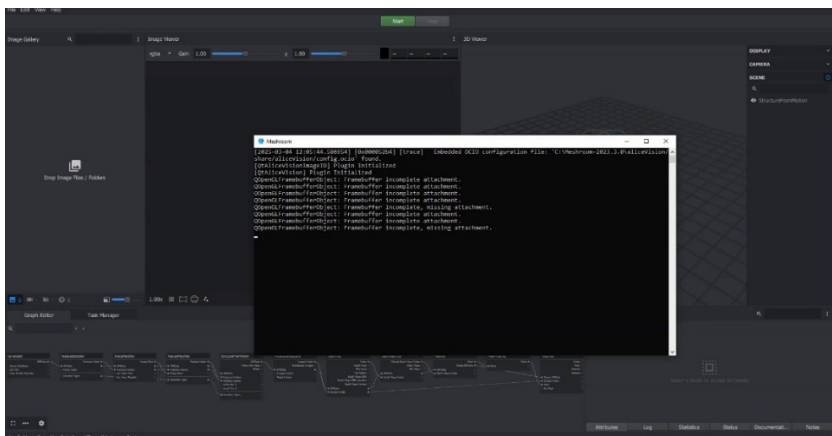
In a way, the small problems caused by this kind of setup turned out to be useful, as they allowed me to discuss various tools and techniques throughout the episodes. Let's try to see the glass as half full!

I took the photos by manually rotating the turntable each time. Of course, there are motorized supports, but for this basic experiment, I didn't want to rely on them.

I took photos from three different heights to capture the object from below, frontally, and from above. Before recording the episodes, I removed any blurry or poorly exposed photos, ending up with 146 usable images.



Alright, that's it for this episode! In the next one, we'll start getting familiar with Meshroom and photogrammetry! See you soon!



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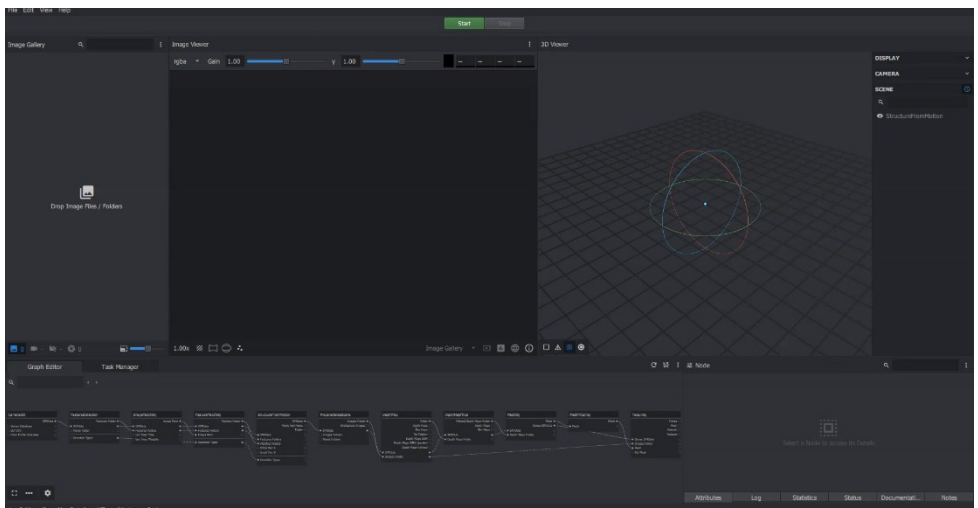
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Meshroom actually allows for different types of projects, as you can see by clicking New Pipeline in the File menu. Of course, we are interested in a Photogrammetry project.

The first thing to do is save the project. I recommend creating a dedicated folder where you can save the project file, as running the photogrammetry process will generate an entire folder structure, which we will examine shortly.

The project file will have the MG extension, which stands for Meshroom Graphs. The terms Pipeline and Graphs emphasize that processes in Meshroom follow a sequential, step by step order. This can be visually understood in the Graph Editor panel at the bottom, where nodes and their connections are displayed.

Before examining this pipeline, let's take a quick look at the program's interface.



The Image Gallery panel will contain the images we want to use for reconstruction. Initially, it is empty and indicates that we can also drag and drop files from a folder into this space. If I remember correctly, this drag and drop feature does not work in Windows if you run Meshroom in admin mode. In any case, images can also be imported via Import Images in the File menu.

In the Image Viewer panel, we can view the loaded images one by one, allowing us to discard poor quality ones or extract relevant data. This window will also display some data generated by Meshroom, such as the Depth Map, as we will see later.

The 3D Viewer panel will display the point cloud, which represents the reconstructed scene. Here, we can also redefine the volume to be reconstructed, known as the bounding box, allowing us to focus only on specific elements.

The Graph Editor panel shows the sequence of nodes to be processed and their connections. Each node represents a specific task that is executed step by step, using incoming data from the input ports and producing one or more outputs from the output ports.

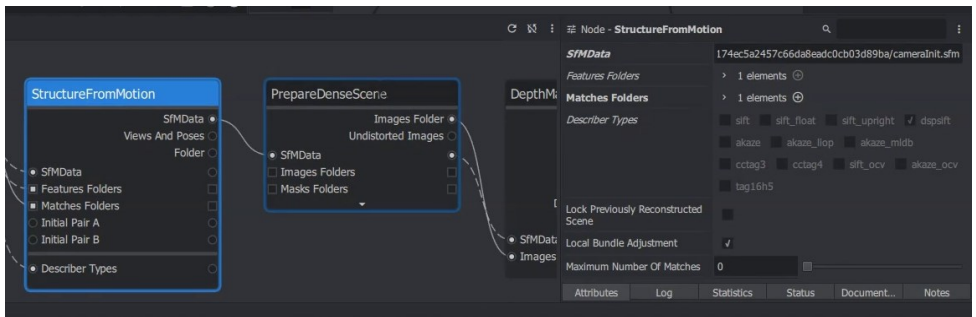
A new Photogrammetry project will have a basic pipeline with default parameters, which will work well for many projects. When we start the project, Meshroom will create a subfolder called Cache, inside which it will generate additional subfolders, one for each node present in the pipeline.

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The pipeline does not have to remain as the default one; it can be modified by adding new nodes or changing the connections between them, as we will see later in this episode.

In any case, by clicking on a node, we can view its parameters and settings in the Node panel on the right. Each node provides access to multiple types of information, displayed in the Attributes, Log, and other tabs at the bottom.



The last panel in the default interface is the Task Manager, which is initially empty. Here, we will later see execution details for the various nodes.

In the View menu, you may notice that the Live Reconstruction panel is missing. However, I won't be using it in this introductory series, so we can leave it disabled.

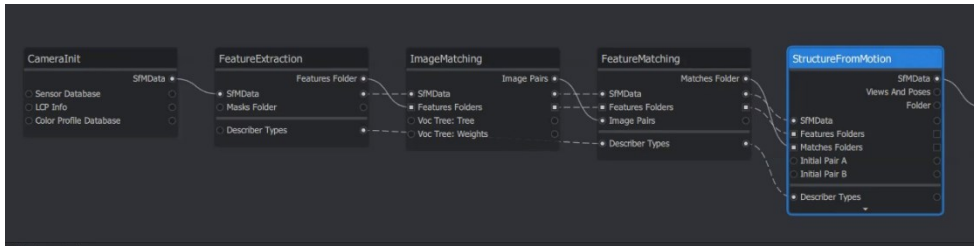
The Fullscreen option, as expected, allows the main program window to be displayed in full screen mode.

Before moving on to the practical steps, let me briefly introduce the pipeline, which represents the sequence of execution for the nodes.

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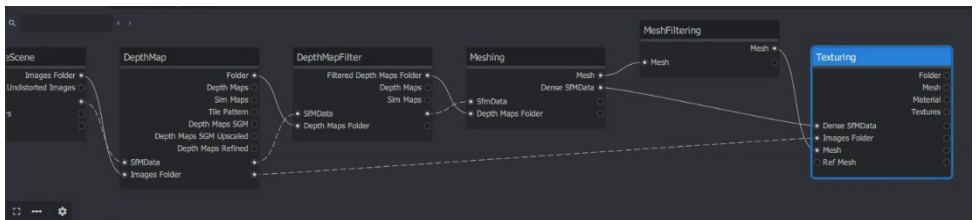
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The pipeline can be divided into two parts. In the first part, which runs up to the Structure From Motion node, Meshroom loads the images and extracts specific information, called Features, which allow it to identify reference points across multiple photographs.



These Features will then be used to reconstruct the scene's geometry, but this process occurs after the Structure From Motion node. Specifically, in the second phase, Meshroom calculates depth data for the detected Features, generating a 3D point cloud. It then reconstructs the geometry, which is called a Mesh because it consists of vertices connected by edges, which in turn define triangular faces.

Finally, the original photographs will be combined into an image called a Texture, which represents the colors of the various parts of the original 3D object, but arranged in a 2D image.



From the Features detected in the photographs, we start with points in space that are initially unconnected. These points are then linked together to form

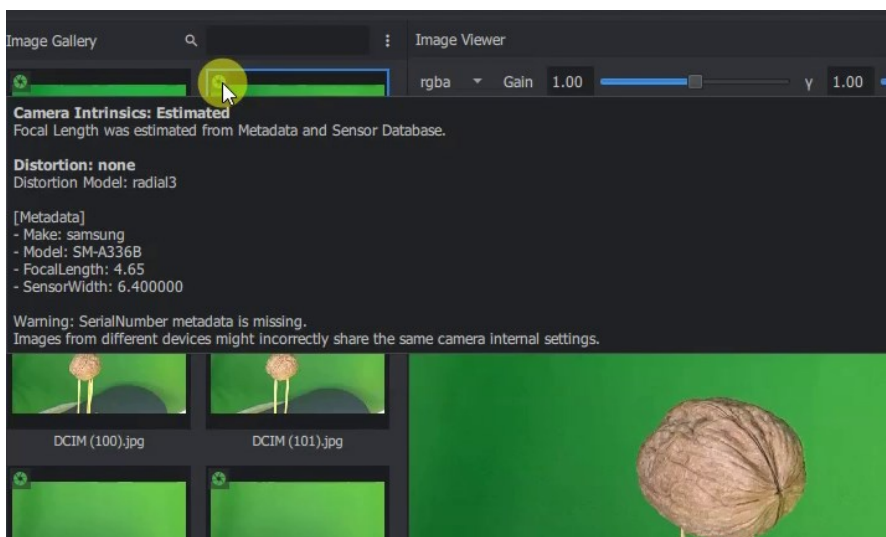
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geometry, made up of surfaces, onto which a Texture image is applied to give the reconstructed geometry the original object's colors.

There is much more to discuss about the pipeline, the nodes, and the overall execution process, but I will explain these details as we progress with the project. Now, let's move on to the practical steps. First, I drag the original photographs into the Image Gallery panel.

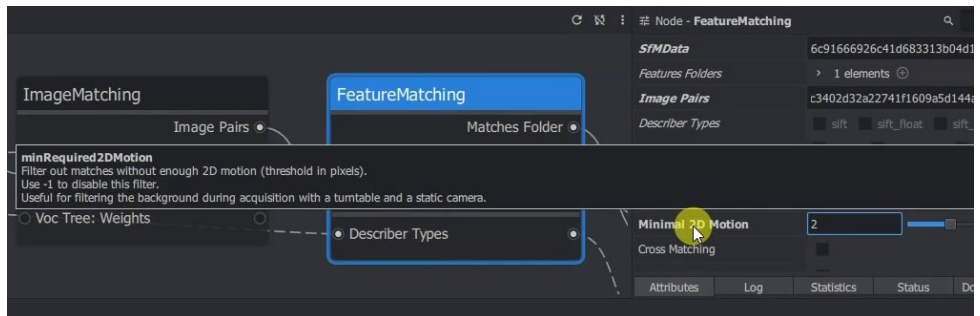
In the Image Gallery panel, we can see the total number of photos added and how many cameras were recognized by Meshroom, based on the intrinsic data extracted from the images. This number is displayed next to the shutter icon at the bottom of the panel. For each photograph, we can examine this metadata, if available, by hovering the mouse over the shutter icon in the image preview. In this case, the metadata is present, so the shutter icon appears green. If the metadata is missing, the icon will be red, and Meshroom will proceed with the reconstruction as best as it can without that information.



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In a turntable photogrammetry project, it is recommended to select the Feature Matching node and set the Minimal 2D Motion parameter to 2. Once this adjustment is made, I save the project.



In a project where a green screen background was used in the photos, as in this case, it is possible to try to have Meshroom exclude the green background before extracting the Features. This can be done by adding an Image Masking node in the Graph Editor, by right clicking on an empty area of the panel and inserting the node.

In the Structure From Motion Data input of the new node, we need to connect the Structure From Motion Data output from the Camera Init node, by clicking and dragging between the two ports.

The output of the new node should then be connected to the Mask Folder inputs of both the Feature Extraction and Prepare Dense Scene nodes.

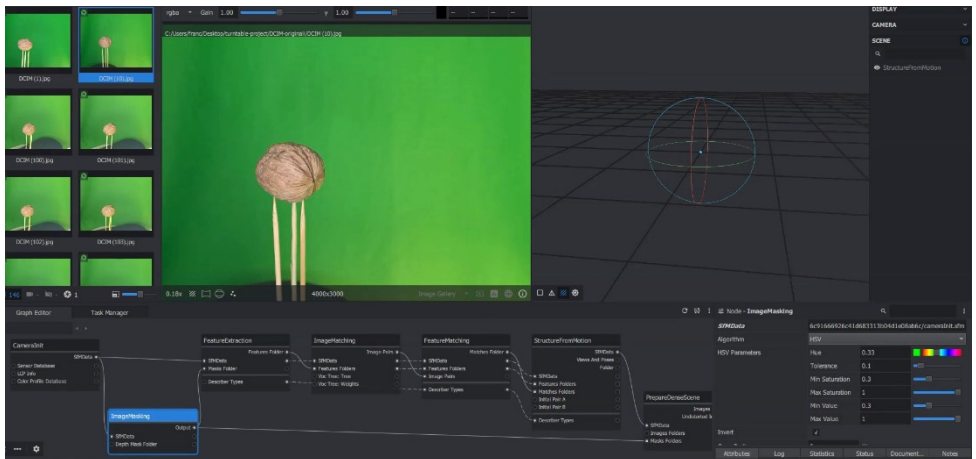
Now, by selecting the Image Masking node, we can define the color to exclude and adjust the tolerance values for hue, saturation, and intensity in the Node panel. However, this method for excluding the green background is not very

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practical, as it does not provide good feedback on the result and does not allow for customized parameters for each photo. This last point could be useful in our case since the lighting on the background cloth is not uniform.

For these reasons, I am removing the Image Masking node by right clicking and selecting Remove Node. For reference, a connection between nodes can be removed by right clicking on the link and selecting Remove.



I am also removing all the photographs, because in the next episode, I will show you a small setup in Blender that will allow us not only to remove the green background more easily, but also to eliminate the green spill, which is the green tint that affects objects photographed against a green screen.

The only custom setting I am keeping is the value 2 for the Minimal 2D Motion parameter in the Feature Matching node.

I am now saving the project with these settings, closing Meshroom, and I'll see you in the next episode!

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03: Color Key and Color Spill in Blender

scheduled for April 11, 2025: <https://youtu.be/EZM14qZv434>

Hello everyone! In this episode of the basic turntable photogrammetry series, we will see how to remove the green background and Color Spill from photographs in Blender.

The images obtained at the end of this process will be PNG files with transparency, which Meshroom will be able to use while focusing, so to speak, only on the object of interest during the feature extraction phase.

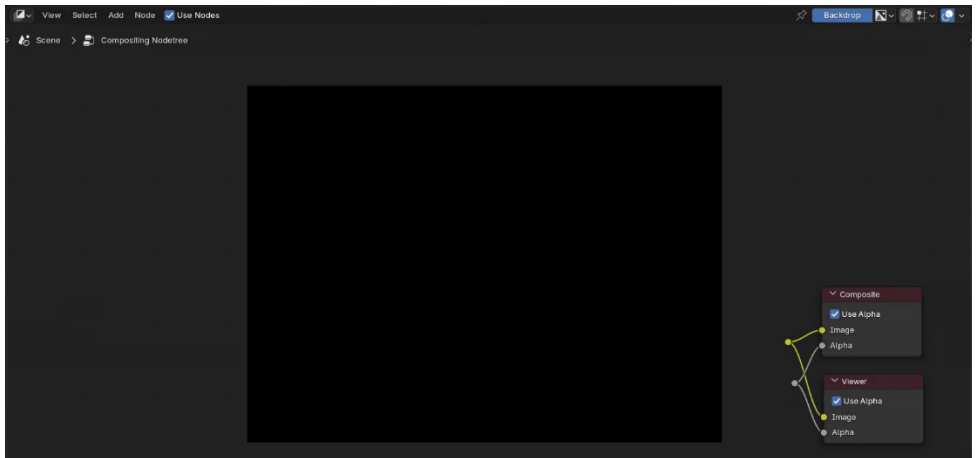
Before we begin, I'd like to remind you that the PDF transcript of all episodes of the series is available for free download at the link provided in the description. The package also includes the photographs used, with the green background already removed. This is also a great time to subscribe to the channel and turn on notifications!

This tutorial was recorded using Blender 4.3, but the Compositing nodes used have been available in several previous versions of the software and will likely continue to be available in future releases as well.

All the work takes place in a Compositor Editor, so a virtual camera inside the scene is not even required. In fact, I can also delete the Render Layers node, which is present by default in new Compositing setups.

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First, I need to set the output format of the project with the resolution values of the photographs, which in my case are 4000 and 3000 for the X and Y resolutions.

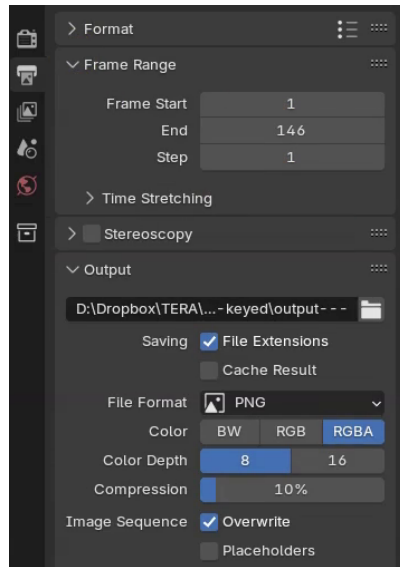
In the Output tab of the Properties Editor, I also need to set the output format to PNG with RGBA, meaning with transparency, and with a low compression value.

Within this tab, I also need to set the disk path where the processed files will be saved.

As the last preliminary step, before loading the images into the project, I need to set an End Frame value equal to the number of images to be processed, which in my case is 146.

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Regarding the images, Blender will recognize the image sequence in the folder as long as the images are numbered sequentially.

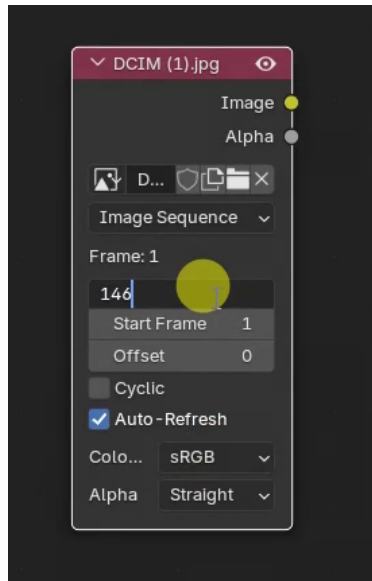
In a Windows environment, there is a very simple way to achieve this numbering. Select all the files in the folder containing the original photographs. Right click on the first file and choose the Rename option. Then, type a name and press Enter. As you can see, Windows will automatically add a progressive numerical suffix to all the file names in the folder.

Now, I can drag the first file into the Compositor Editor in Blender and change the node type to Image Sequence.

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Inside the node, I enter the number of files to be processed in the Frames field. This value should be the same as the one previously entered in the End field of the Timeline.



I connect the Image output of the image node to the Viewer node so that I can see the image in the Backdrop of the Compositor Editor.

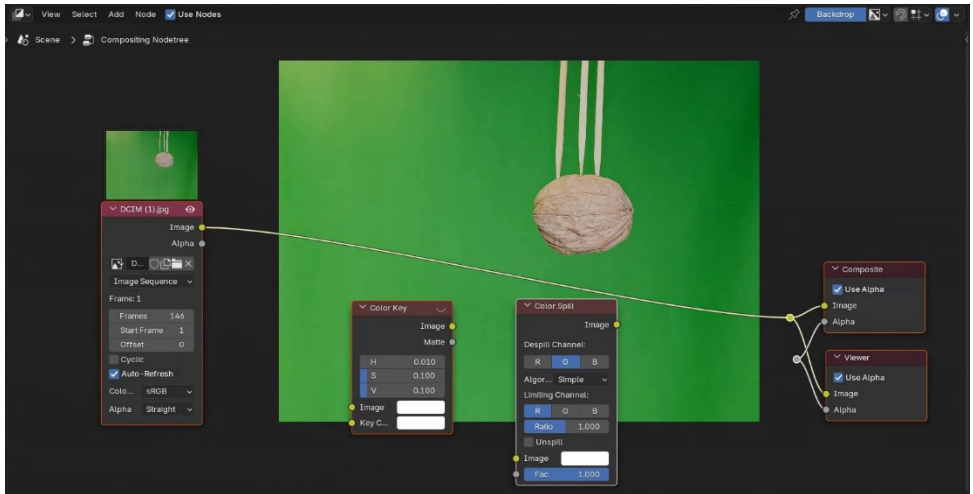
When I took the photographs, I sometimes rotated my smartphone, which means some images appear upside down. This issue can be easily fixed with a Rotate node, where the Degrees field can be animated so that the node is used only when needed. However, these rotations won't be a problem for Meshroom, so it's not strictly necessary to perform the rotations at this stage.

I insert a Color Key node and a Color Spill node into the setup.

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The Backdrop preview is useful for selecting a shade of green from the image for the Color Key node. I click on the default color in the Key Color field of the Color Key node, then click on the Eyedropper tool and select a green point in the photograph.



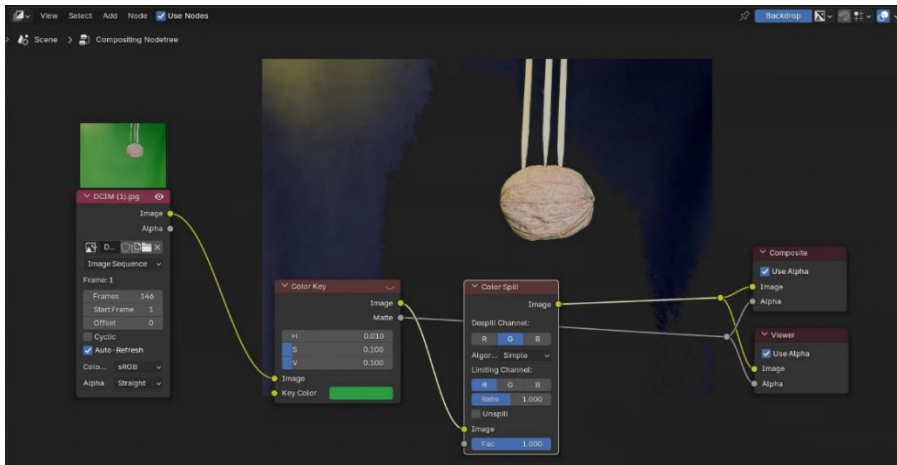
Now, I connect the Image output of the image node to the Image input of the Color Key node.

The Matte output of the Color Key node should be connected to the Alpha input of both the Viewer and Composite nodes, as it represents the transparency mask of the images.

The Image output of the Color Key node, on the other hand, should be connected to a Color Spill node, which allows for the removal of green reflections on objects that are photographed against a green background. The output of the Color Spill node should then be connected to the Image inputs of both the Composite and Viewer nodes.

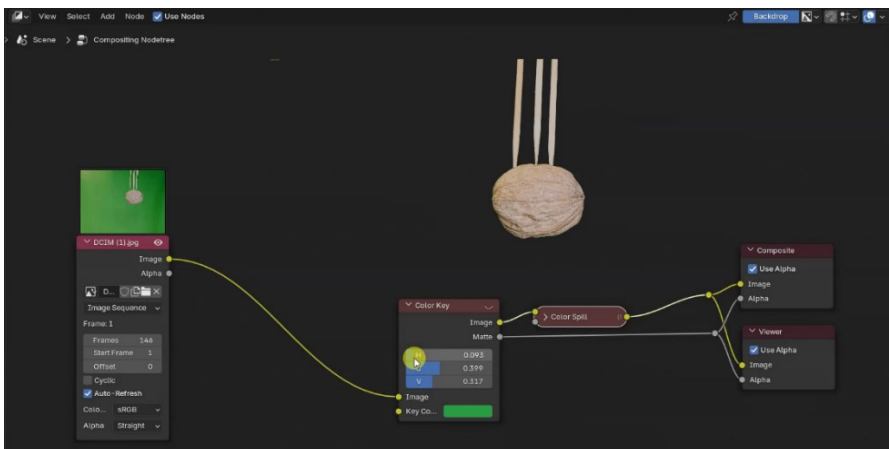
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In our case, the Despill Channel of the node will obviously be green, while the algorithm should be chosen between Simple and Average, depending on the quality of the result, which can be previewed in the Backdrop.

At this point, I can start adjusting the tolerance values for the Hue, Saturation, and Value channels in the Color Key node. These tolerances define how much the pixel color can deviate, in those three information channels, from the color specified in the Key Color field of the node.



The interesting thing about performing this operation in Blender is that the node values can be animated, meaning I can set values that work well for the first frame, keep them as long as they are effective, and then modify them if they no longer work for a specific image.

However, be careful: if you realize that the values set do not work well for another image, you need to go back to the previous frame and insert keyframes there to lock in the values that worked up to that point. Once this is done, you can move to the next frame, adjust the values to meet the new requirements, and record the new values with new keyframes. This step of inserting a keyframe in the previous frame before making changes is necessary because otherwise, Blender will create interpolations between frames, which might have negative effects on their masks.

In general, it is best to use low values for the Hue parameter, as there is a risk of excluding other colors that should actually be kept. It's better to maintain a base hue with low tolerance and adjust the other two parameters. Most of the time, the uneven lighting on the green screen will cause variations in brightness but will not significantly change the hue.

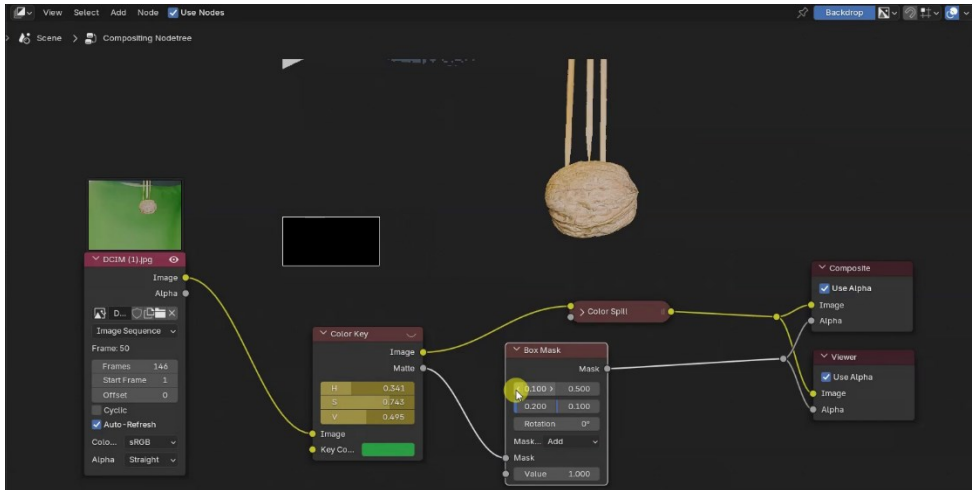
When adjusting values, you should always keep an eye on the object of interest, because while we want to remove all unwanted areas, sometimes this is not entirely possible, and you might accidentally remove parts of the object you need!

To eliminate more complex areas, you can use one or more Box Mask nodes, connecting them in sequence to the Matte output of the Color Key node. There

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are also other Masking tools in the Compositor, but a couple of Box Mask nodes will be more than sufficient for our purposes.

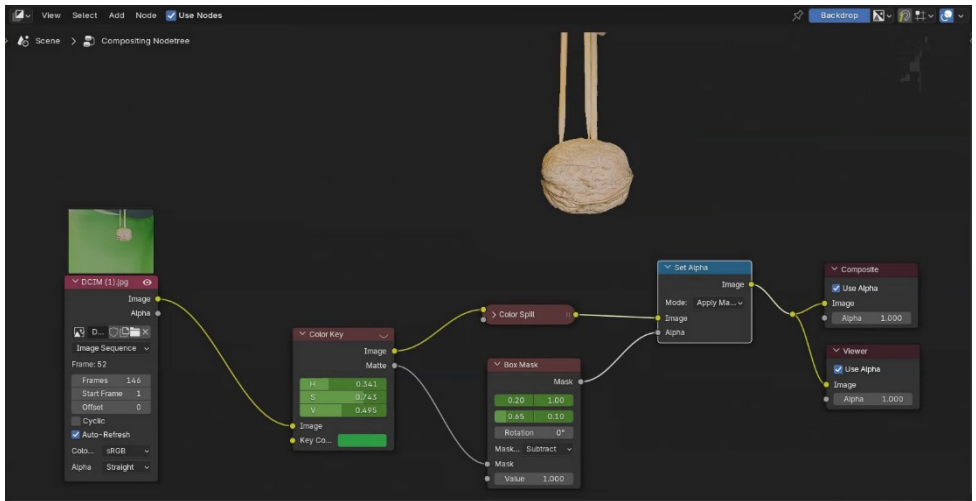


These nodes create rectangular masks that can be positioned and rotated on the input mask using parameters that allow you to adjust their position, size, and rotation. The masks have different application modes. For our purposes, I will use the Subtract mode, but keep in mind that this will make the affected areas black rather than transparent.

To solve this issue, simply insert a Set Alpha node before the Image inputs of both the Composite and Viewer nodes. First, I disconnect the Alpha connections from Composite and Viewer. Then, I connect the Image output of the Color Split node to the Key Image input of the new Set Alpha node. Finally, I connect the Alpha input of the Set Alpha node to the output of the last Box Mask node in the setup.

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Now, I am skipping ahead to the final result of the Compositing setup just to show you that it is essentially a combination of keyframes, both for the tolerance values in the Color Key node and for the position and size values of any masks used.

The position and size parameters of the masks can also be animated, which allows us to bring them into the workspace only when they are actually needed, avoiding the risk of covering the object of interest in other frames.

The same warning given for keyframing the Color Key node values applies here: it is crucial to insert keyframes before modifying a frame to prevent incorrect interpolations between mask positions throughout the animation.

This process of analyzing and adjusting the Color Key values and masks may take some time, but it will save a lot more time later when Meshroom processes these cleaned-up images instead of the original ones.

However, it is not a big issue if you cannot remove every single unwanted element, as Meshroom will still interpret some small artifacts as noise and automatically ignore them. The more we can refine at this stage, the better, but there's no need to overcomplicate things.

After verifying the quality of the Color Keying and masks across multiple frames, I can finally start the rendering of the sequence, producing the images that will be imported into Meshroom. This rendering process will not take long, as it is simply processing external images rather than rendering a full 3D scene. The images produced are the same ones included in the free package, so you can replicate the steps we will cover in the next tutorials.

That's all for this episode! See you next time!

04: Reconstructing Geometry in Meshroom

scheduled for April 14, 2025: <https://youtu.be/54yY9mKxzCI>

Hello everyone! In this episode of the basic turntable photogrammetry series, we will see how to reconstruct the high poly geometry from the images with transparency generated in Blender at the end of the previous episode.

Among other things, we will see how to interrupt the process halfway through to resize the reconstruction area and then resume from where we left off.

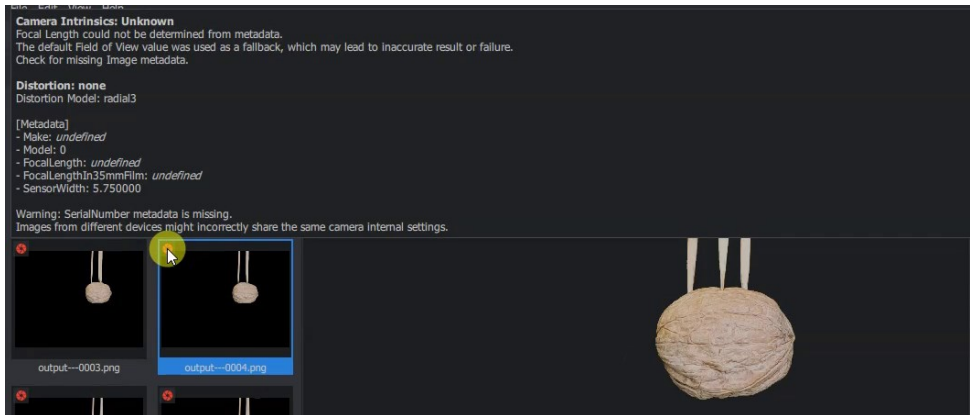
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First, I open the Meshroom project, which I created in the second episode and saved after setting the Min 2D Motion field of the Feature Matching node to 2.

I import the rendered images from Blender into the Image Gallery tab. As you can see from the red shutter icon, this time the images do not contain additional information because they are no longer the original photographs but renders created in Blender.

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By using the Image Masking node, which we examined in the second episode, the original data is preserved, but removing the green background will be a bit more difficult. On the other hand, it is easier to achieve better Color Keying in Blender, but at the cost of losing the original EXIF data. However, this is not a big deal since Meshroom will handle it excellently, as we will see.

I save the Meshroom project with the new data and click on an empty spot in the Graph Editor to deselect all nodes. Then, I start the reconstruction by clicking Start.

If I now take a look at the folder where I saved the project's MG file, I notice the presence of the Meshroom Cache folder and its subfolders, where Meshroom will store log files and intermediate working files for the various nodes.

This feature of Meshroom is very useful because it allows processing only specific pieces of information as they are handled by the nodes.

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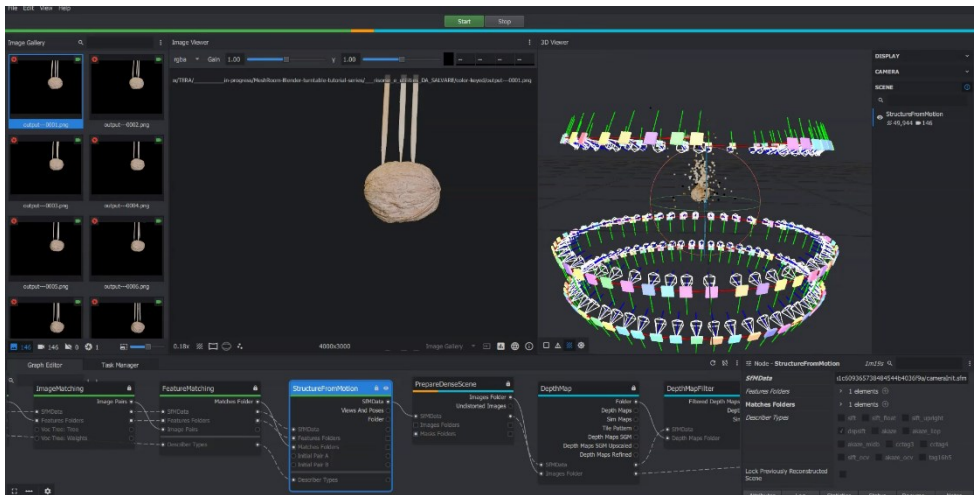
[illegible]

Another useful feature is that if I need to interrupt a process and restart it later, Meshroom will create new subfolders for the various nodes, so the previous work will not be lost, and I will still have access to the different processing steps.

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Speaking of interruptions, I click Stop as soon as the Structure From Motion processing is completed, which is the first part of the pipeline, so I can review some new data and adjust the reconstruction area, known as the Bounding Box.

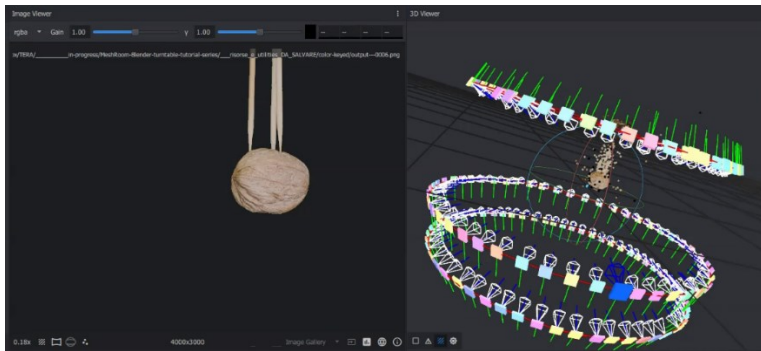


First of all, at the bottom of the Image Gallery tab, we can see that Meshroom has recognized and processed all 146 input images, which seems like a great result to me.

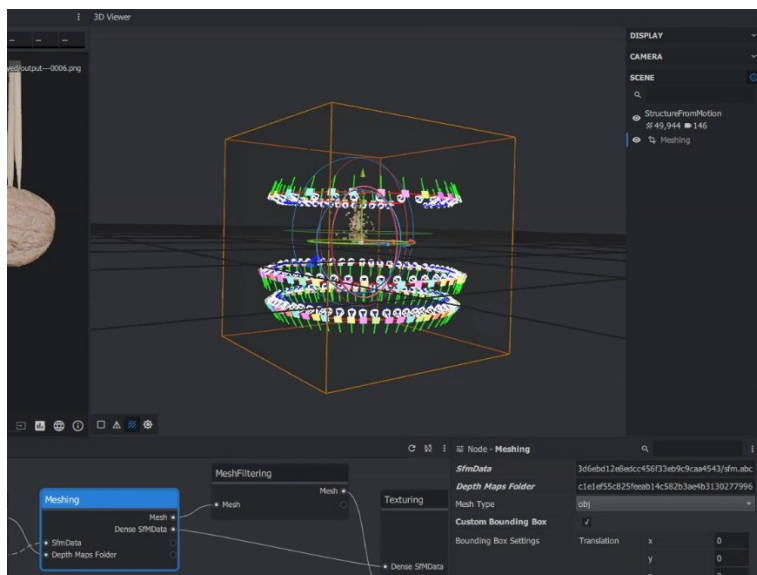
In the 3D Viewer tab, there are icons representing various cameras. These icons indicate the viewpoints from which the photos were taken. Clicking on a photo in the Image Gallery will select a corresponding camera in the 3D Viewer tab. You can change the viewpoint in the 3D Viewer tab by left-clicking and dragging to rotate around a pivot point. Zooming is done with the mouse scroll wheel. Clicking the scroll wheel or the middle mouse button allows you to pan the view. You can reposition the pivot point by double clicking on an element within the 3D view.

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Now I can select the Meshing node and enable the Custom Bounding Box option to define a custom reconstruction area. This scene is not particularly complex, so this step might seem unnecessary, but in other situations, this option can be very useful for limiting the reconstruction to only what is needed. However, simply enabling the Custom Bounding Box option will not display the reconstruction volume. In Meshroom, selecting a node is not enough to view its specific information or features. You need to double click on it.

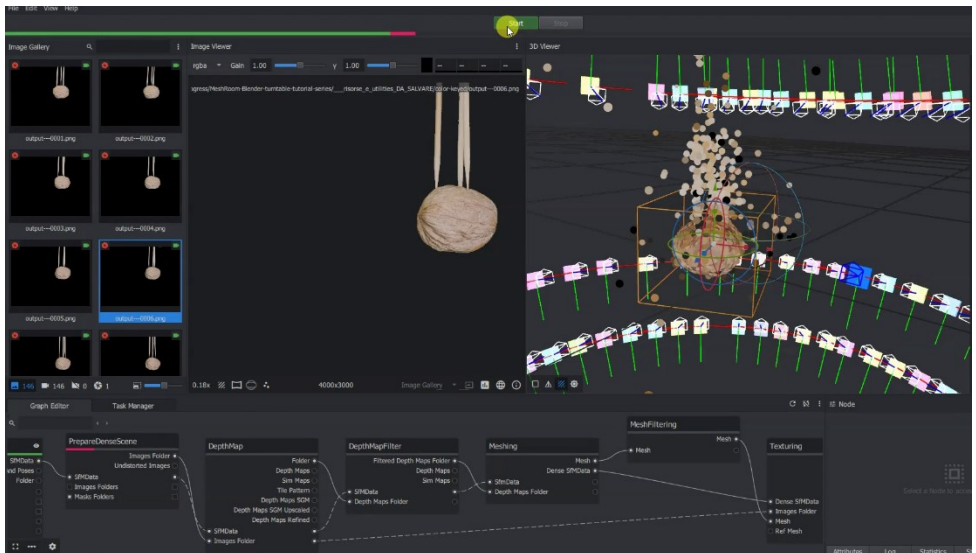


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Now, I can define the Bounding Box interactively using the transformation manipulators that appear at its center. The arrows allow me to move the center of the Bounding Box. The squares let me resize it along one of its axes. Finally, the circles allow me to rotate it around the axes.

After defining the Bounding Box, I can click Start to resume the geometry reconstruction pipeline from where I left off.



Now, by examining a subfolder inside the project's Cache, you can see that a new folder has been created. This happened because the previous pipeline was interrupted, so the new data is being stored in a new subfolder.

These subfolders have, by default, rather generic names, but you can rename them in the Folder fields of the various nodes. This is useful if you want to run multiple tests with different parameters, as you can name the folders based

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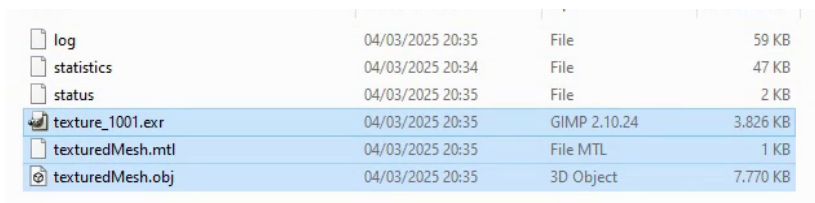
on the changes made. In any case, you can simply sort the folders by date to quickly find the latest processing result.

I resumed video recording at the end of the last processing step, which is Texturing. Before starting the process, I didn't modify this node's default parameters, so Meshroom should have created an OBJ file with a Base Color texture in EXR format, using the UDIM method for UV unwrapping.

However, in Meshroom's menu options, I don't see anything that suggests exporting this mesh to a specific location on disk.

No worries, though, because the mesh and its texture have already been saved on disk. The file paths can be found at the bottom of the Attributes tab in the Texturing node. More simply, the files will be located in the most recent subfolder inside Texturing.

I copy the EXR and OBJ files to the main project folder, renaming the copies as High Poly, so that I can keep the originals safe and work on the copies in Blender.



log	04/03/2025 20:35	File	59 KB
statistics	04/03/2025 20:34	File	47 KB
status	04/03/2025 20:35	File	2 KB
texture_1001.exr	04/03/2025 20:35	GIMP 2.10.24	3.826 KB
texturedMesh.mtl	04/03/2025 20:35	File MTL	1 KB
texturedMesh.obj	04/03/2025 20:35	3D Object	7.770 KB

I save the changes to the project in Meshroom and close the program. I will reopen it later when I need to Bake the textures from the High Poly version to the Low Poly version. In the next episode, I will show you how to import the High Poly version into Blender and clean it up before creating the Low Poly version. See you next time!

05: Importing and Cleaning the High Poly Version in Blender

scheduled for April 16, 2025: <https://youtu.be/1qU7ubieeEM>

Hello everyone! In this episode of the Turntable Photogrammetry basic series, I will import the High Poly mesh into Blender and clean it up a bit before creating the Low Poly version.

I will need to remove unnecessary parts and close any holes, as they can cause issues with the Remesh tool, which I will use to create the Low Poly version.

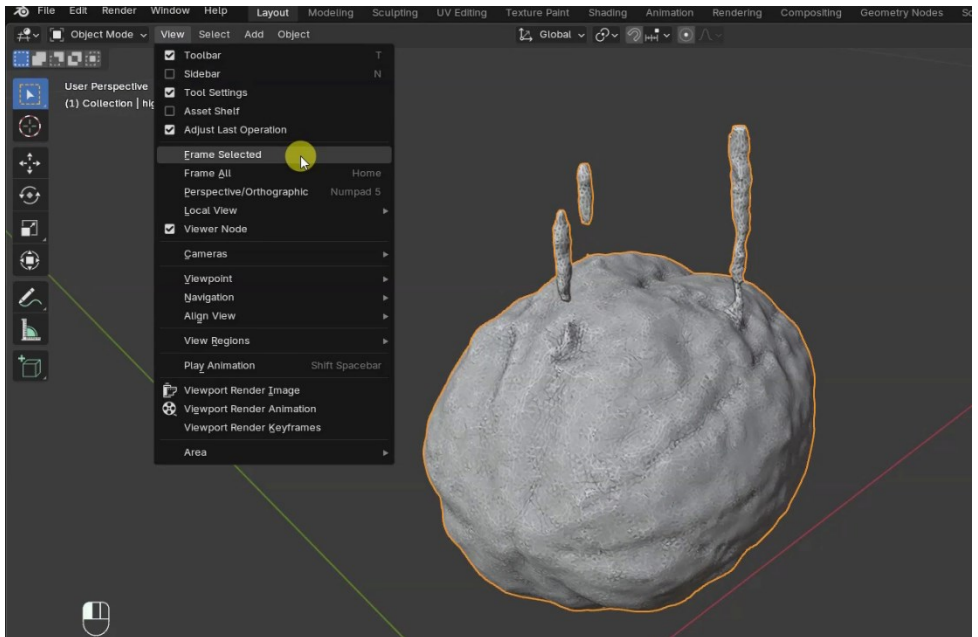
Before we begin, I'd like to remind you that the PDF transcription of all the episodes in this series is available for free download at the link in the description. The package also includes the photographs used, with the green background already removed. This is also a great time to subscribe to the channel and enable notifications!

To import the OBJ file, go to File Import OBJ and select the copy file, named High Poly, which was saved at the end of the previous episode.

To center the mesh in the viewport, I select it and press the period key on the numpad, or choose Frame Selected from the View menu in the 3D Viewport.

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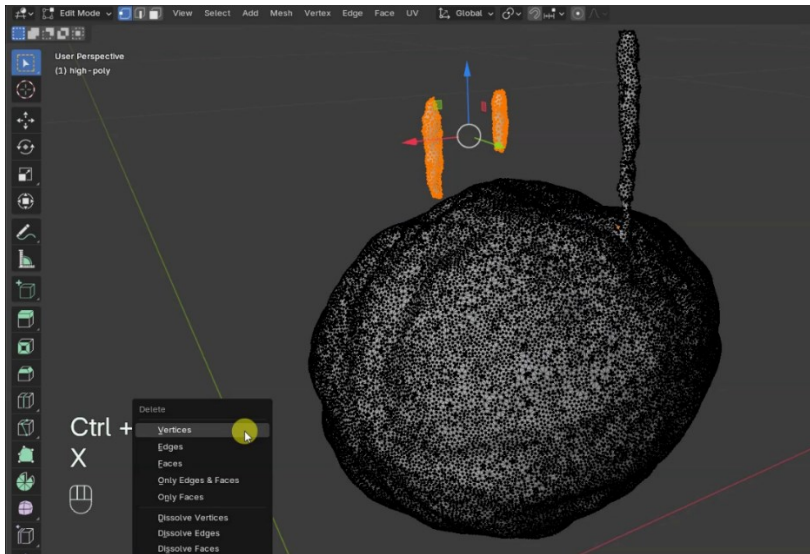
The object appears upside down and far from its Origin, which is placed at the center of the virtual world. However, I prefer to avoid moving or rotating it. I also don't apply Loc Rot Scale transformations. This is necessary because Meshroom requires both versions to be in the same 3D space to correctly Bake the color Texture.

At this stage, what I need to do is switch to Smooth Shading, remove unnecessary geometry, close any holes, and make sure the Normals are correctly set. Before starting, though, I save the project as High Poly 1, just to be safe.

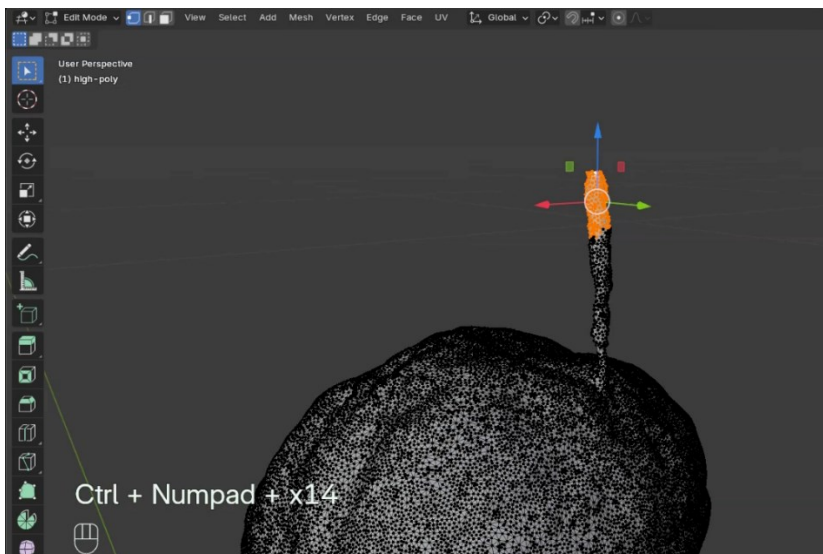
I set Smooth Shading for the object and then switch to Edit Mode. I select the entire main geometry by pressing L while hovering the mouse cursor over one of its vertices. Then, I invert the selection and delete the unwanted elements.

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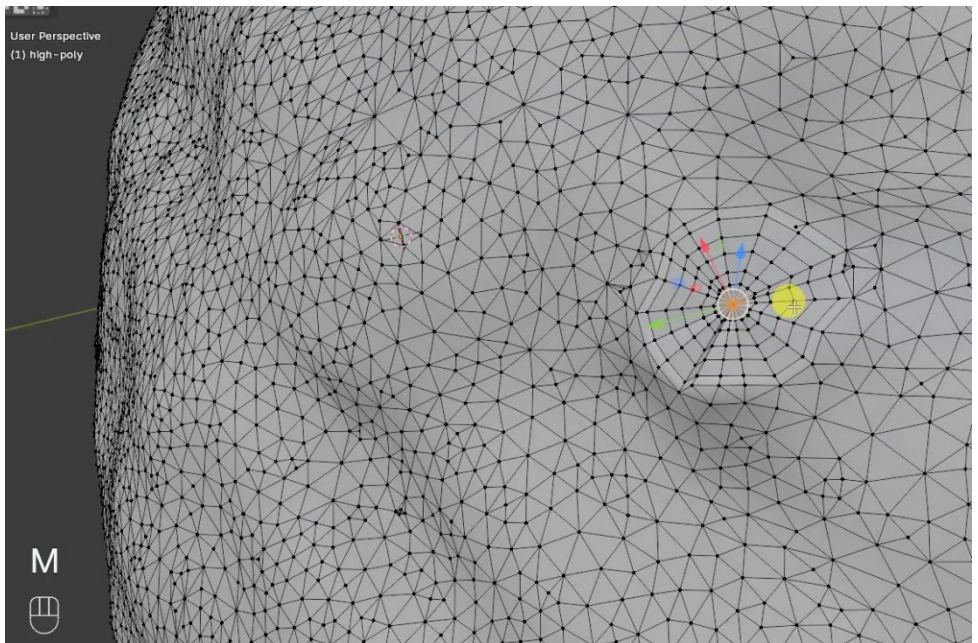
There are several ways to remove unnecessary elements. For example, I can select a part of an element to be removed and expand the selection using CTRL and numpad plus. This is the shortcut for the More operator in the Select menu.



Alternatively, I can use freehand selection by holding CTRL and right-click, which works best in Wireframe Mode, allowing me to select elements that are not in the foreground.

In general, I can use any selection tools and techniques that come to mind. For example, for more difficult areas, I can select a surrounding region and temporarily hide it with H, making it easier to select and delete the part I need. Hidden parts can be made visible again with ALT H.

All these holes need to be closed, preferably with a good amount of geometry, since they will later be adjusted with some sculpting. There are several techniques for this as well. For example, I can create concentric loops by selecting an edge ring and using extrusion, then closing the center with Merge At Center.



Another option is to use the Grid Fill tool, for which I recommend switching to Edge selection mode. This tool works if the perimeter's vertex count is even, so in some cases, I may need to subdivide an edge to meet this condition.

In the case shown on video, Grid Fill didn't work because I selected not only the perimeter of the hole but also a triangle. I simply need to deselect the extra edge and try again. However, the geometry was too irregular to get a good result, so I first extruded it, then beveled it, and finally closed it.

To check for any remaining holes, the easiest approach is probably to select everything and use the Select Boundary Loops operator. In this case, the operator didn't return any elements, meaning the object is completely closed.

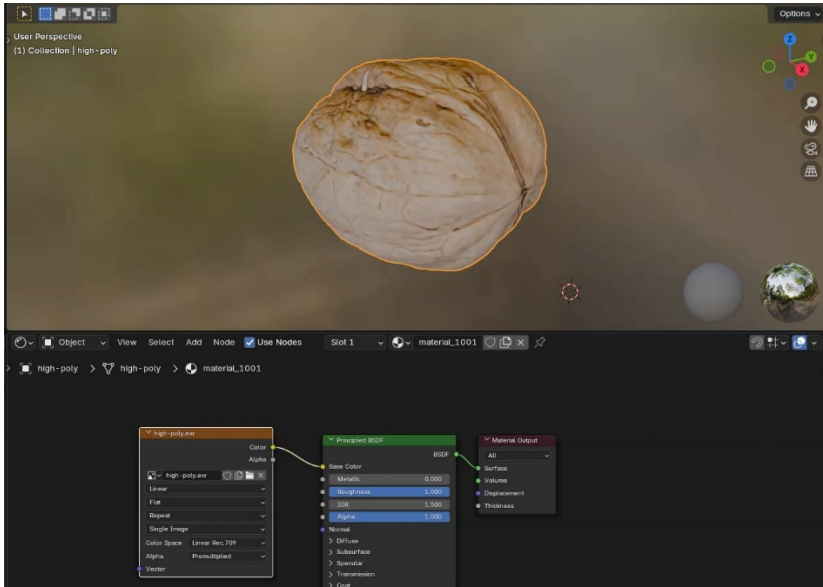
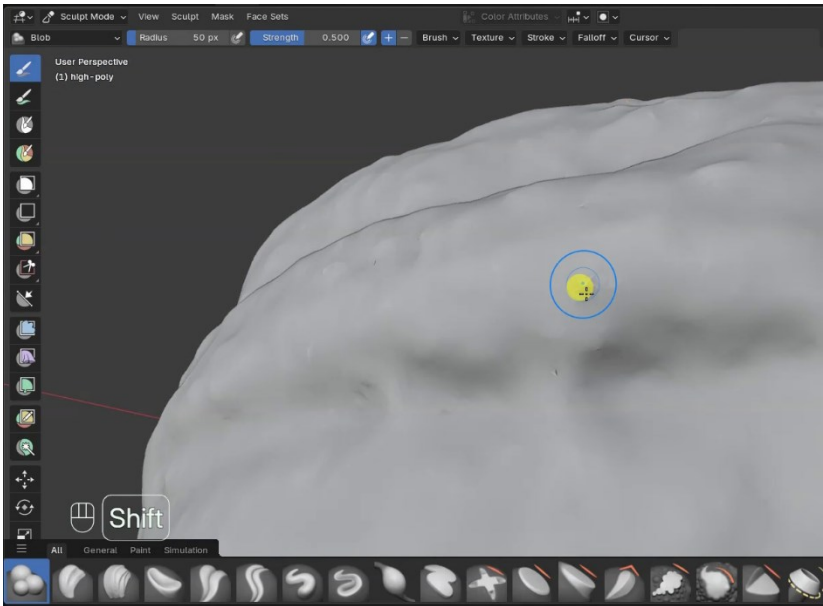
Now, I can switch to Sculpt Mode and refine the areas I manually closed to make them look more natural.

Holding SHIFT while left clicking in Sculpt Mode activates the Smooth tool, which is useful for eliminating small imperfections, usually caused by overlapping edges or faces.

To examine the Texture generated by Meshroom on this object, I drag the EXR file into a Shader Editor with the object's default material. Then, I connect the Texture to the Base Color input of the material. In a 3D View, I switch to Rendered Mode to inspect the result.

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Some errors are visible, mainly due to closing the holes, but they won't be difficult to fix in Substance Painter or other software, including Blender itself. There is also a noticeable difference in brightness between the upper and lower halves, caused by the lighting conditions during the photo capture. However, there are ways to correct this as well.

Before wrapping up this episode, I save the project with a progressive number using Save Incremental. In the next episode, I will create a Low Poly version of the object.

See you soon!

06: Creating the Low Poly Version in Blender

scheduled for April 18, 2025: <https://youtu.be/q7e2VeGzPkw>

Hello everyone! In this episode of the basic turntable photogrammetry series, I will create a Low Poly version of the geometry obtained at the end of the previous episode.

I will unwrap and export this mesh so that I can bake the base color texture from the High Poly version in Meshroom.

Before we begin, I'd like to remind you that the PDF transcription of all episodes in the series is available for free download at the link in the description. The package also includes the photographs used, with the green background already removed. This is also a great time to subscribe to the channel and enable notifications!

First, I save the project, naming it Low Poly, to keep a backup copy of the work done so far.

I duplicate the High Poly object in Object Mode, renaming it Low Poly, so that I have a copy that retains the same position, orientation, and scale properties as the original. This is necessary because Meshroom requires both versions to be in the same 3D space to perform the Bake correctly.

I hide the object named High Poly and select Low Poly.

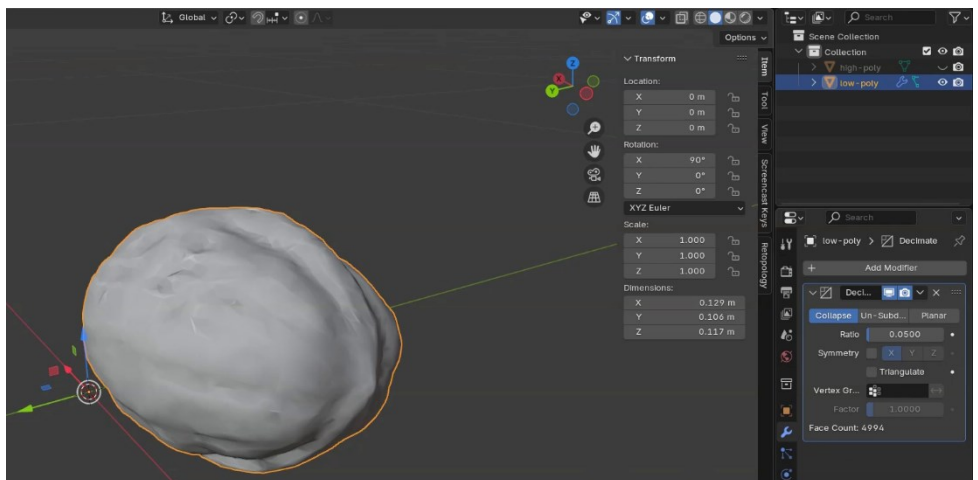
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There are various ways to simplify or decimate a geometry in Blender. For example, you can use the Decimate modifier. In my case, by setting the mode to Collapse and the Ratio value to 0.05, I can reduce the original 100,000 triangles to 4,994 while still maintaining a good approximation of the initial geometry.

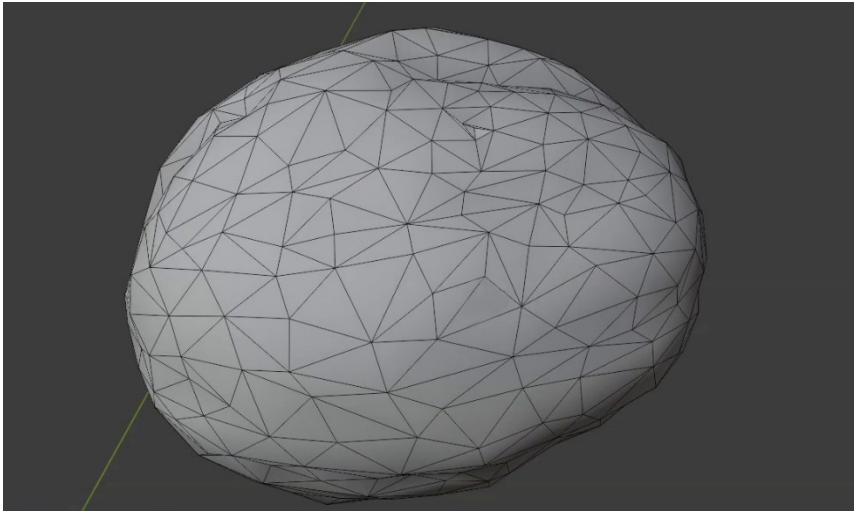
By lowering the Ratio parameter to 0.01, I reach just under 1,000 triangles while still preserving the main shapes of the geometry.

The issue is that Decimate will create a geometry with triangular faces and many poles, as you can verify by applying the modifier and switching to Edit Mode. If this is not a problem, for example if the object does not need to be deformable or animated, then you can follow this approach and proceed with unwrapping the UV maps. Here, I am undoing the application of Decimate and removing the modifier to show you an alternative method.

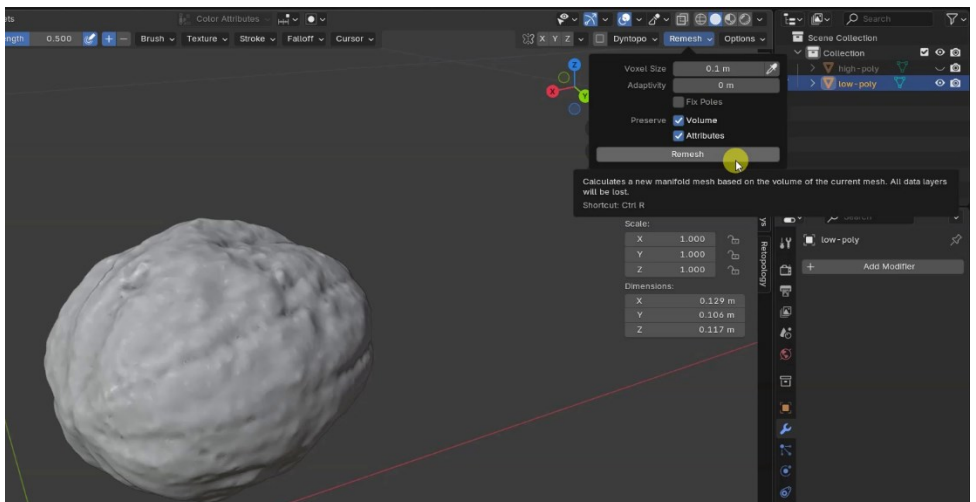


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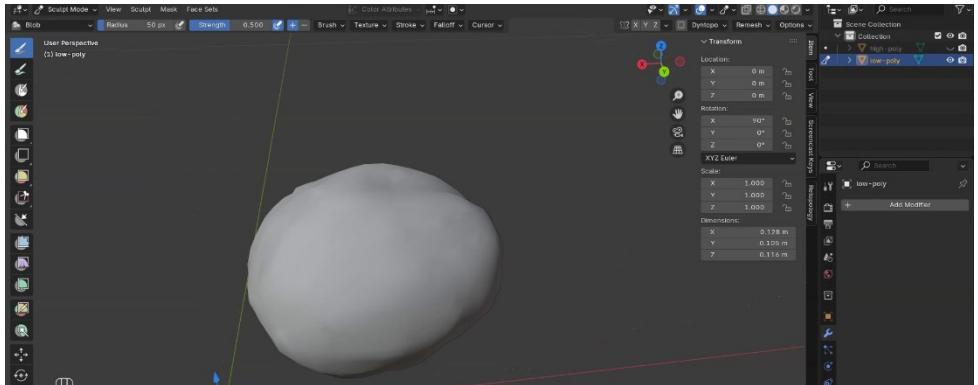
By switching to Sculpt Mode, you can use the Remesh tool to simplify the geometry, obtaining a closed object with quadrangular faces. To achieve a good result, it is necessary to set an appropriate value for the Voxel Size parameter. To determine a good starting value, you can use the sampler within this tool by clicking on a point on the object to understand its typical density.



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I clicked on a point where the Voxel Size is 0.001363. To obtain a less dense geometry, I need to perform the Remesh with a higher value for this parameter, so I make an initial attempt with 0.01. I'd say I got lucky because, on the first try, I obtained a geometry with just 708 quadrangular faces.



There are also various add-ons or extensions that allow you to perform automatic retopology, producing only quadrangular faces. However, make sure that the resulting geometry remains in the same 3D space as the original, as I mentioned earlier.

Keep this constraint in mind even if you decide to manually create the Low Poly version. In that case, to avoid mistakes, you could start from the Low Poly object that was just duplicated from the High Poly one, then merge all vertices into a single mesh, proceed with Snap, Shrinkwrap, and other tools to create the new geometry. This way, it will retain the same Location, Rotation, and Scale characteristics as the original model.

In any case, the geometry I obtained this way is quite good. I can try to improve the overlap with the original model using a Shrinkwrap modifier, testing different mapping modes to find the best one. Nothing prevents me from

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adding extra edge loops if necessary. Once I'm satisfied with the adjustments, I apply the Shrinkwrap modifier.

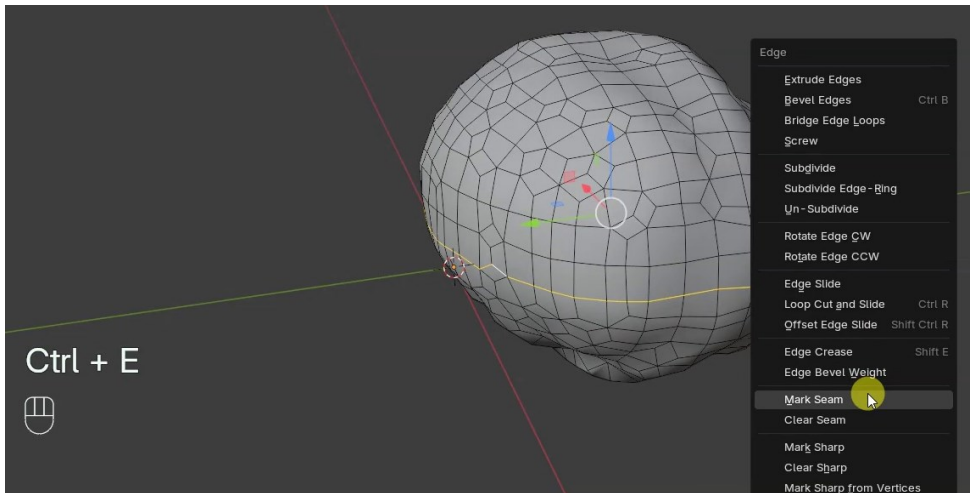


Now, I can also delete the High Poly object from this file. However, before exporting the Low Poly model, I need to give it a new UV unwrapping so that Meshroom can map colors and details onto two new Textures.

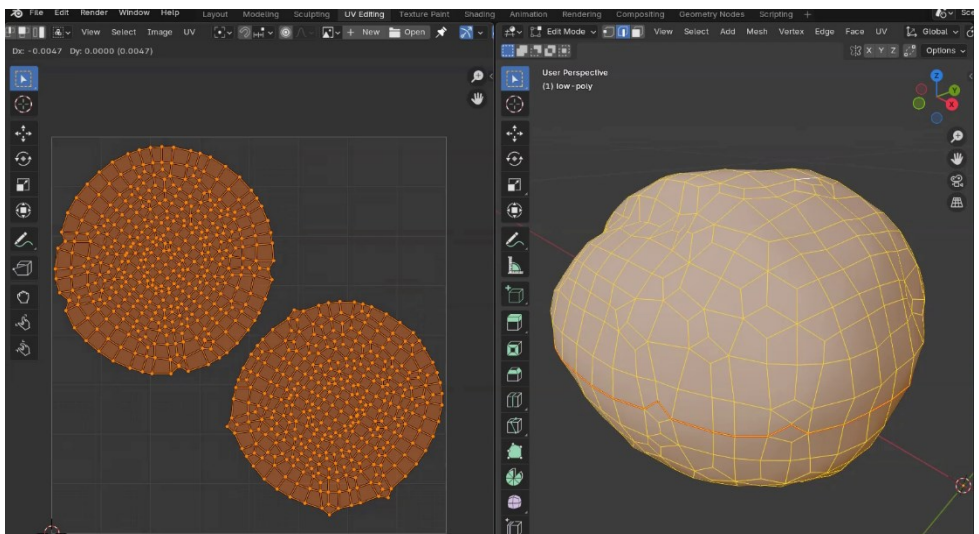
In Edit Mode, I notice that there is an edge loop that runs almost perfectly along the XY plane. I select all the vertices along that loop and mark them as Seams. In fact, the lower loop is slightly wider than the one I initially selected, so it might be even more suitable.

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I perform a simple UV unwrapping using the method that seems to produce the best result, meaning the one with the least distortion. This is a simple object with a shape comparable to a sphere, so dividing it into two halves works perfectly as a UV seam.

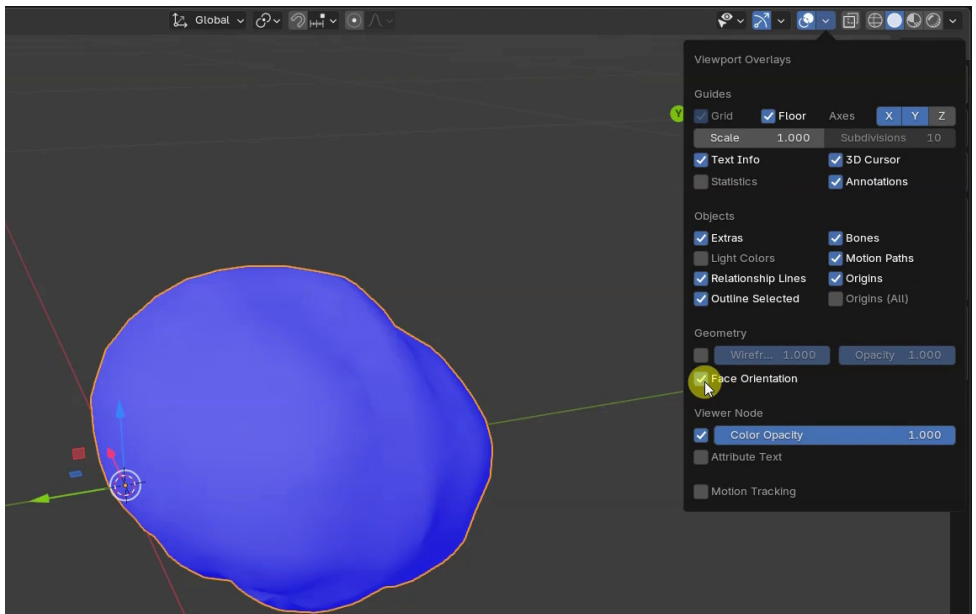


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The EXR image is no longer needed, especially since Remesh has destroyed the original mapping, so I remove it from the Shader Editor and clean up the file using Purge Unused Data from the Clean Up menu. While I'm at it, I rename the material Low Poly.

The Remesh tool produces a closed mesh by default, so normals shouldn't be an issue, but I check them anyway to be sure.



The only thing left is to save a copy of this file and export the model in OBJ format before closing Blender and returning to Meshroom for baking the Textures. That's all for this episode! See you next time!

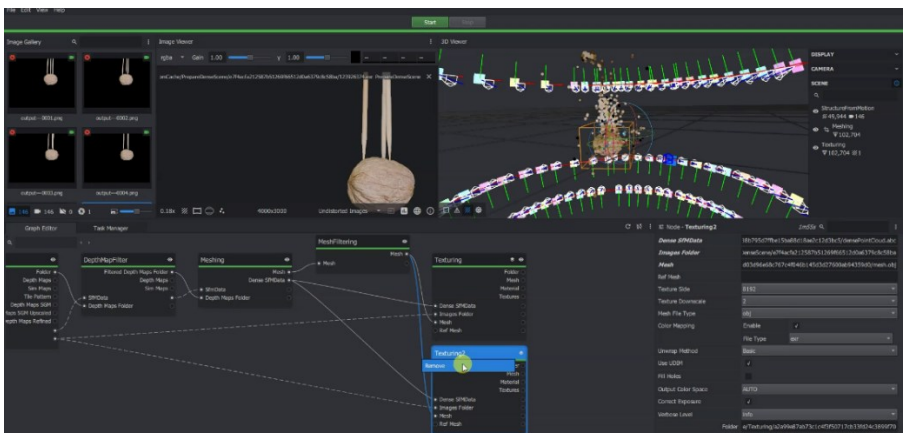
07: Baking Maps from High Poly to Low Poly in Painter

scheduled for April 21, 2025: <https://youtu.be/6Cza0vLbn0A>

Hello everyone! In this episode of the basic series on turntable photogrammetry, I will show you how to transfer the Color information from the original High Poly reconstruction to the Low Poly object obtained in Blender. This process is called Baking, and in this episode, we will use it to remap the Base Color Texture from the High Poly geometry so that we can apply this Texture to the Low Poly object, which has its own UV unwrapping, different from that of the High Poly geometry.

Before we begin, I remind you that the PDF transcription of all the episodes in the series is available for free download at the link in the description. In the package, you will also find the photos used, with the green background already removed. This is also a great time to subscribe to the channel and turn on notifications!

In Meshroom, to perform Baking on an external object, I first need to create a new Texturing node to insert into the processing pipeline. This can be done by duplicating the original node, selecting it, and pressing SHIFT D.



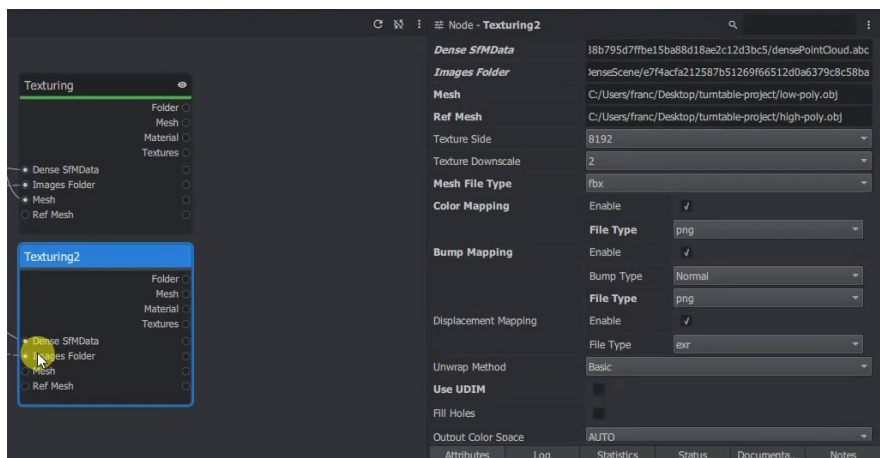
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In the new node, I will need to remove the connection to the Mesh input because I will be using the Low Poly object, exported at the end of the previous tutorial, as an external geometry onto which the Textures generated here in Meshroom for the original High Poly version will be mapped. The removal can be done by right clicking on the connection and then selecting Remove from the menu that appears on the screen.

Now I need to configure some parameters in the settings of the new Texturing node, starting with the Mesh field, where I have to copy the path of the Low Poly file I exported from Blender. I set the desired texture resolution freely. I recommend keeping the default value, 8192, to maintain good quality, as this Texture will still be processed further later.

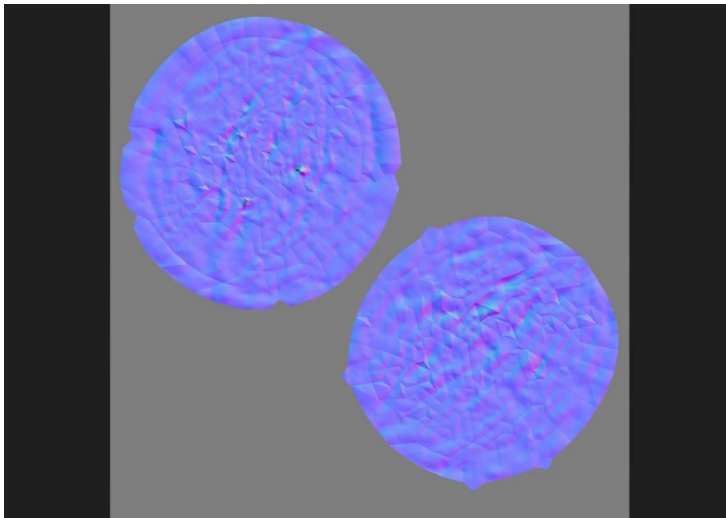
It is possible to choose a different format for both the geometry and the Textures to be generated. For example, I am selecting FBX as the mesh format and PNG for the images. Finally, I am disabling UDIM mode for Texture creation. To bake the details from the High Poly mesh, I need to specify the path of the High Poly object in the Ref Mesh field of the node.



After entering this path, options will appear for generating the Normal Map and Displacement Map, which will store the details of the High Poly geometry. I am setting PNG as the format for the Normal Map, in the Bump Mapping section. The only available format for the Displacement Map is EXR, because the data for this type of map is stored with a higher bit depth.

Now, I just need to save the project and click Start. Since I haven't modified any other nodes from the last execution, only the new Texturing node will be processed, so this computation won't take much time.

Once the process is complete, the generated Texture images will be located in a new subfolder inside the Texturing folder within the project's Cache directory on disk. As you can see, the Normal Map obtained this way appears faceted, even though the Low Poly geometry exported from Blender had Smooth Shading enabled.



I haven't found any valid solutions to fix this issue in Meshroom, not even by trying other processing nodes or exporting with Smoothing Groups from

Blender. No luck. However, I didn't lose sleep over this problem because baking the Normal Map from the High Poly version to the Low Poly one can easily be done in Blender or Substance Painter. What really matters to me at the end of this process is the new Base Color Texture, which has been reconstructed based on the UV unwrapping I created for the Low Poly object. This Texture will be easier to edit compared to the one initially generated by Meshroom, which you may have briefly seen in a previous episode.



Additionally, Meshroom sometimes doesn't generate a single EXR map for the Base Color, but rather multiple Textures, associating them with multiple sub materials. This can make it difficult to bake them into a single color Texture in external programs. In such cases, baking the Base Color onto the Low Poly version, which has only one Material here in Meshroom, can save a lot of trouble.

To wrap up, from this phase, we will keep only the new Base Color Texture in PNG format. In the next episode, I will show you how to bake Normal Maps in Substance Painter and how to set up the basic PBR material. See you next time!

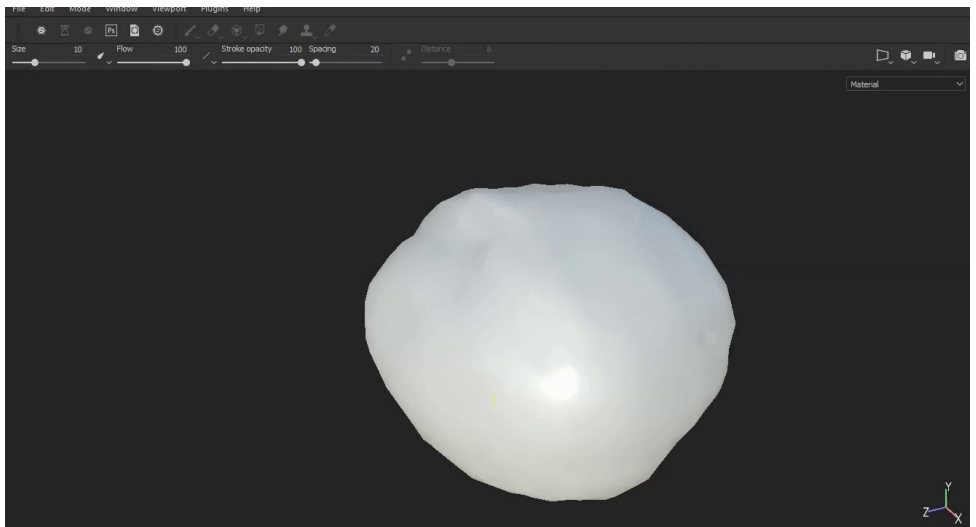
08: Creating the Base Material in Substance Painter

scheduled for April 23, 2025: https://youtu.be/TaI7hCpNc_o

Hello everyone! In this episode of the basic turntable photogrammetry series, I will show you how to bake the Normal Map from the High Poly geometry to the Low Poly one in Substance Painter. I will also set up an initial PBR base material, which includes information for the Base Color, Normal, Metallic, and Roughness channels.

Before we begin, I'd like to remind you that the PDF transcription of all episodes in the series is available for free download at the link provided in the description. The package also includes the photos used, with the green background already removed. This is also a great time to subscribe to the channel and enable notifications!

First, I create a new project using the Low Poly version of the model as the starting geometry.

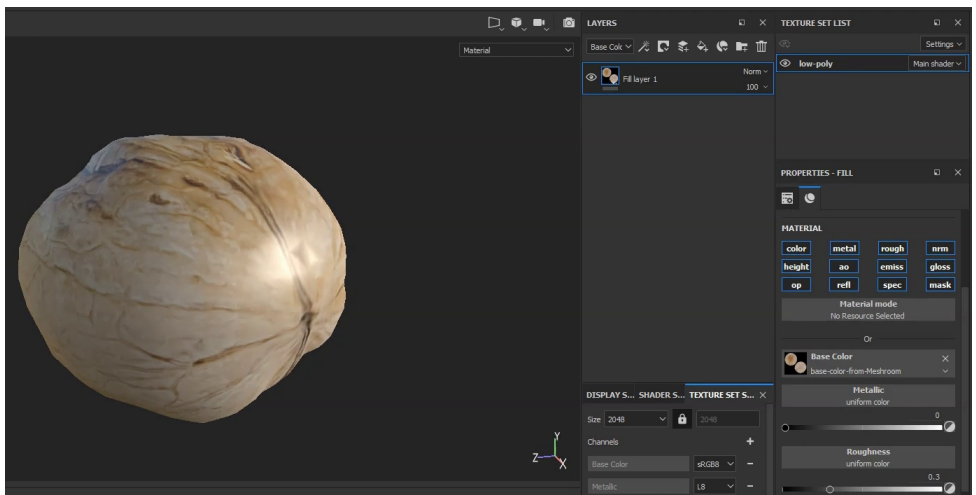


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I save this project to disk, then import into the project the Base Color texture obtained in the previous episode using Baking in Meshroom.

I add a Fill Layer to the Material, then drag the Base Color Texture into the corresponding channel of the Fill Layer to check the color texture mapping on the object.

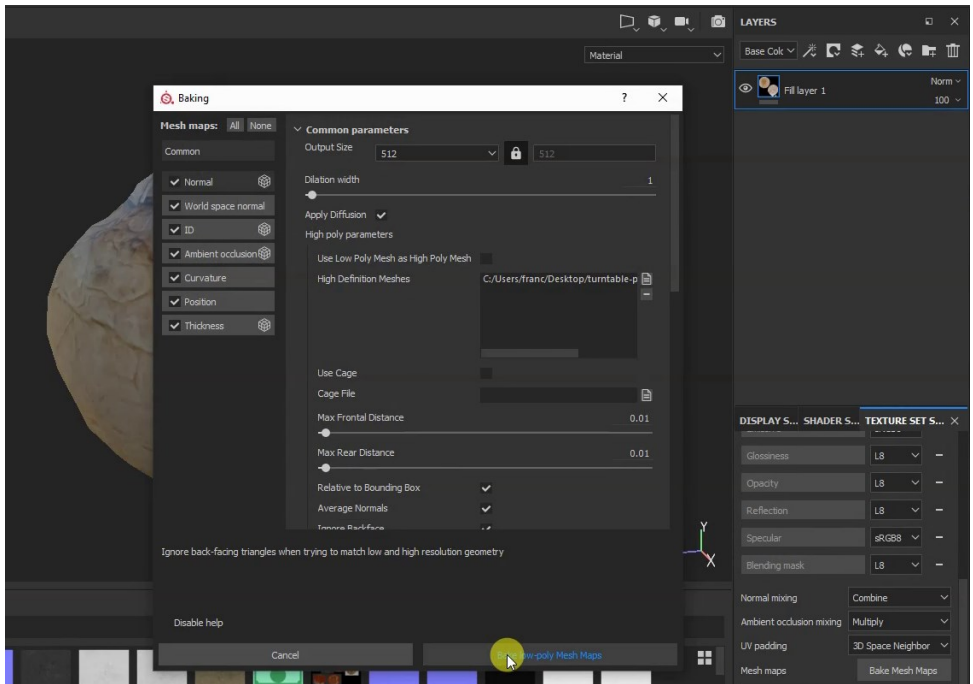


Now I can bake the Normal Map from the High Poly version onto this new version. To do this, I first click on the Bake Mesh Maps button in the Texture Set Settings panel.

In the Normal section, I set the High Poly geometry in the High Definition Meshes field, then click the Bake button. I will also let Substance Painter bake the other maps because, in general, they might be useful if I decide to use Generators or Filters.

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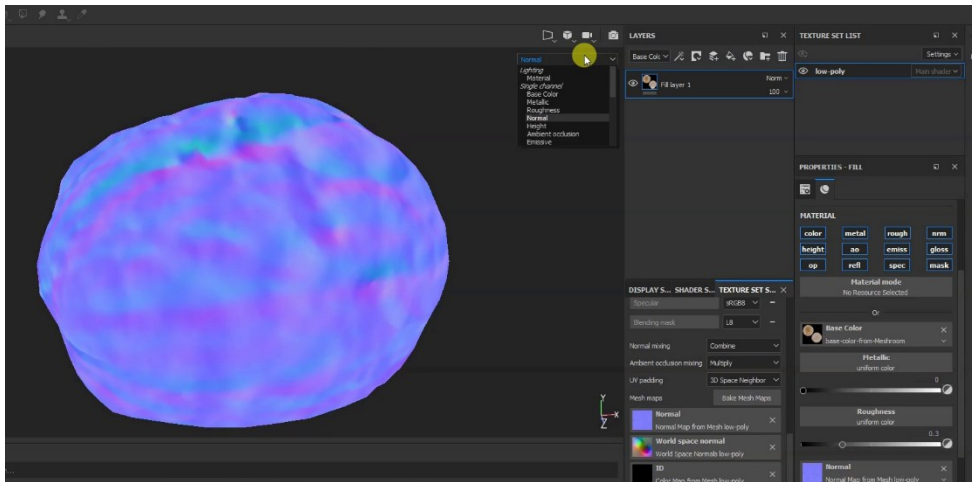
I assign the Normal Map obtained to the Normal field of the Fill Layer. I perform the same operation for the Ambient Occlusion map in its corresponding field.

The applied maps can be examined in the 3D View using the selector in the top right corner, or by repeatedly pressing the C key to cycle through the different maps. You can return to the Material View by pressing M.

The intensity of the Normal Map can be adjusted in Blender using the Strength parameter in the Normal Map node.

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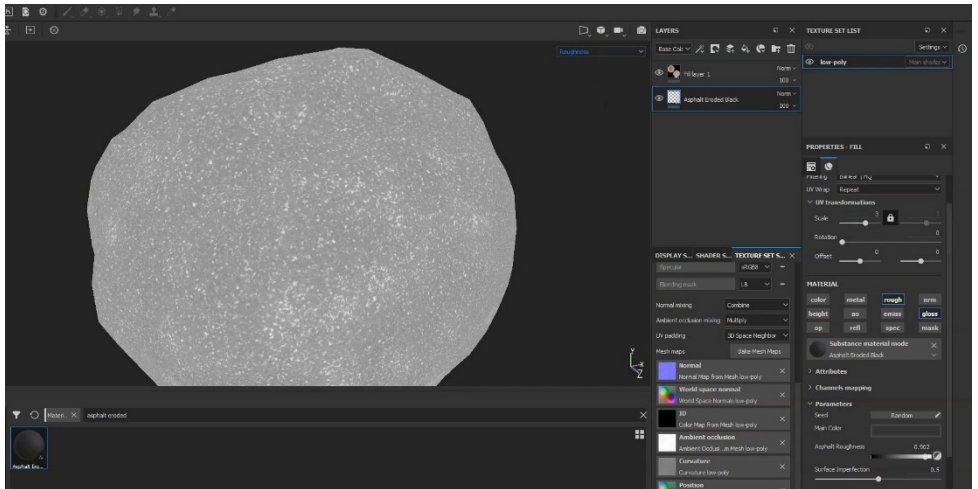
Since the object is a walnut shell, there is no need to define materials or Textures for the Metallic channel of the Material, which can simply be set to 0 as a uniform value for the entire object.

Regarding the Roughness channel, and consequently the Glossiness channel, it is possible to set a uniform value that reflects the overall roughness of the object. However, I suggest experimenting with materials that have a bit of variability.

I then disable the Roughness and Glossiness channels of the Fill Layer and add a naturally irregular and grainy material, such as Asphalt Eroded Black, increasing its Scale value while ensuring that only the Roughness and Glossiness channels of this material remain active. Of course, this is a purely personal choice.

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I chose this material because it allows me to adjust both the average Roughness value and the amount of imperfections, enabling me to achieve a grainy Texture with a selected average Roughness value while maintaining some variation in its appearance.

As you have probably noticed, the Base Color texture has an unpleasant pixelated effect in several areas.

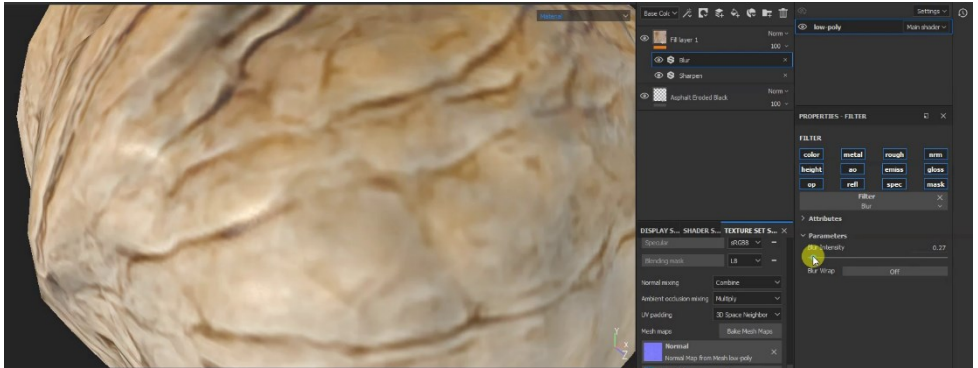
This is due to the entire image processing pipeline, starting with the fact that the images were initially captured in JPG format using a smartphone, then assembled and processed in Meshroom.

A quick and dirty solution is to apply a Blur filter to the Fill Layer created at the beginning of the tutorial, followed by a Sharpen filter.

The best approach would have been to use higher-quality images, but we have to work with what we've got.

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Some more noticeable errors remain, both in the original images and in the lighting, but for this episode, I'll stop here!

See you next time!

09: Corrections with Clone, Smudge, and Overlay in Substance Painter

scheduled for April 25, 2025: <https://youtu.be/-QY7EwpgY4c>

Hello everyone! In this episode of the basic turntable photogrammetry series, we will look at some useful tools for correcting errors in the Textures imported into the Substance project. I will also discuss the use of some layers that, with different intensities and application modes, can help adjust the lighting or tone of various parts of the Base Color Texture.

Before we begin, I remind you that the PDF transcription of all the episodes in this series is available for free download at the link in the description. The package also includes the photographs used, with the green background already removed. This is also a great time to subscribe to the channel and turn on notifications!

This phase of the workflow is the one that allows for the most customization or, so to speak, personal interpretation of the work to be done. So, don't focus on the final result I achieve, but rather on the tools and techniques that may be useful to you.

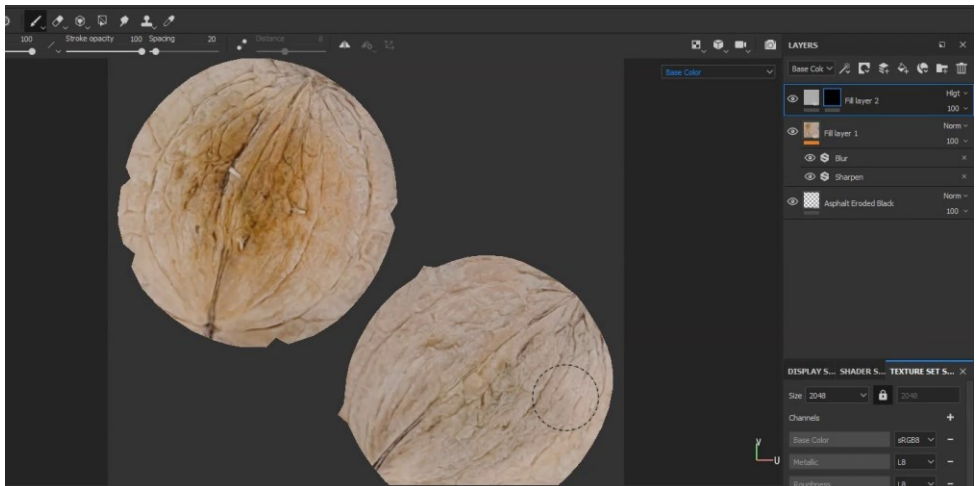
I'm starting by trying to correct the brightness differences between the upper and lower parts of the model. As mentioned in the first episode of this series, these differences are due to lighting errors in the real scene when the photos were taken. To view the Base Color without shading effects, I'm switching to Base Color view in a 2D workspace. You can also try correcting these errors directly in the Base Color Texture using other programs before importing it into Substance.

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One method to lighten or darken specific areas is to add a Fill Layer for the Base Color channel only, assigning it a uniform color and using a blending mode such as Hard Light, Overlay, Value, or others.

You will then need to apply a black layer mask to this Fill Layer and start painting on the mask to define the areas where the Fill Layer should be applied. After the first brushstrokes, you can adjust the color or the intensity of the Fill Layer application until you achieve the desired result.



In these cases, it is advisable to use a brush with very soft edges to avoid creating sharp differences between areas. Ideally, a graphics tablet should be used to control the intensity of the strokes, but alternatively, you can adjust the brush opacity in its settings panel.

Remember to occasionally switch to Material view mode, because the Base Color view mode only displays the pure color map, which does not take into account ambient lighting, Roughness, or the Normal Map.



When switching to Material view mode in the 3D View, I noticed that I had not disabled all channels except Color in the Fill Layer set to Hard Light. The new Fill Color was also affecting the Roughness and Glossiness channels. I quickly fix this mistake by leaving only the Color channel enabled.

You can also add additional layers for the Base Color only and adjust their color to use different blending modes.

For example, you can use Saturation or Tint modes to adjust the saturation and hue of the Base Color, or Multiply mode with a dark color to darken the Base Color. Of course, everything depends on your project and the final result you want to achieve.

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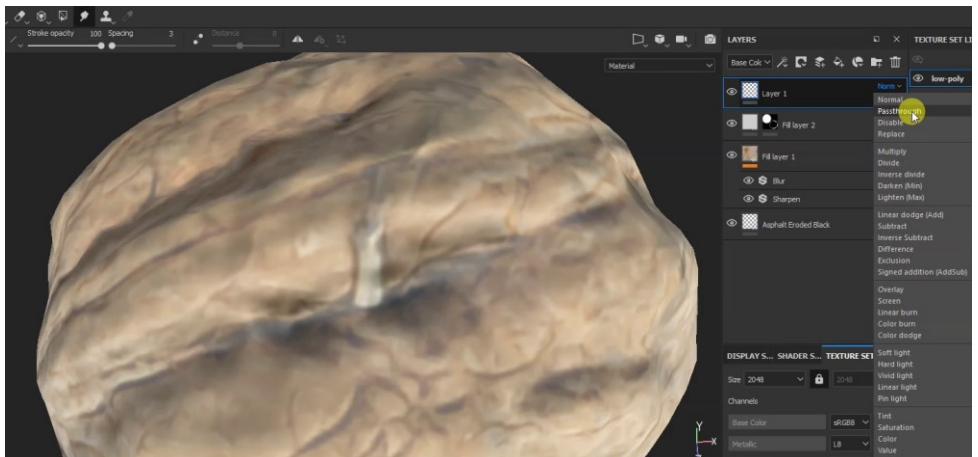
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Two other tools that can be used in this phase are Smudge and Clone, which allow you to blend or clone parts of the Materials, respectively.

I said they can modify the Materials, not just the colors, because these brushes actually affect all the channels they are enabled for, not just the Color channel. This means they also allow us to modify the Roughness and Normals of the affected areas.

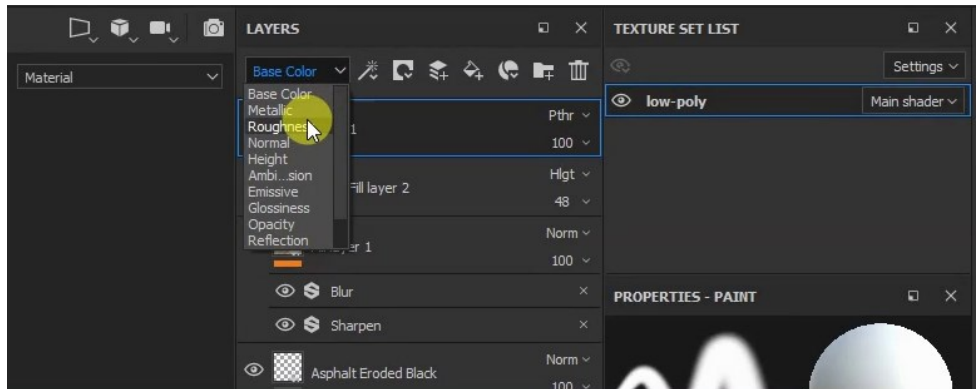
In both cases, to use them, you need to create a new empty Layer, changing its blending mode to Passthrough.

Be careful to create a paint Layer, not a Fill Layer! In the Layer panel, you can choose which channels to affect and which to exclude.



However, be extra careful at this stage because the selection of channels to influence does not take place inside the Properties panel of the paint Layer, as one might expect.

Instead, it is done in the dropdown menu located at the top left of the Layers panel. This menu is set to Base Color by default, and the Layer mode will be Passthrough only for the Base Color channel!



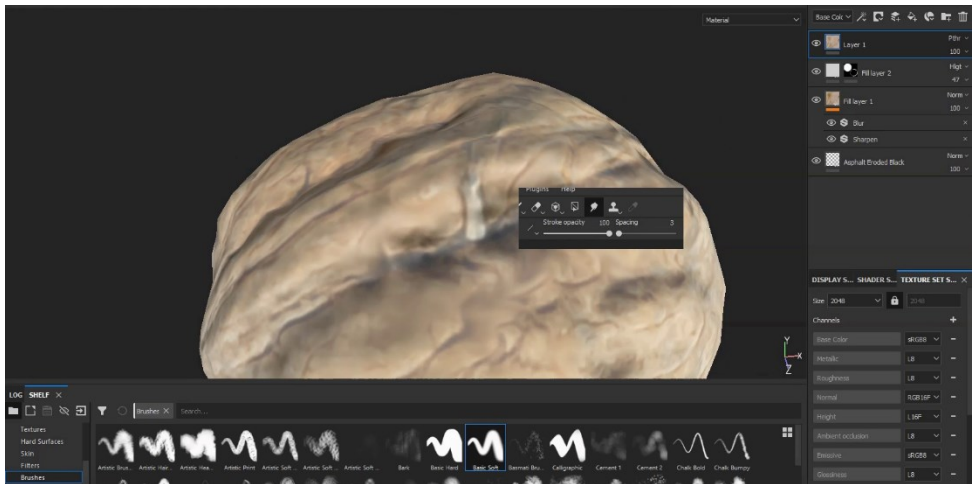
Therefore, you must select the other channels you want to influence and change the Layer mode to Passthrough each time.

In our case, we are particularly interested in the Base Color, Normal, Roughness, Glossiness, and Ambient Occlusion channels, but in other situations, you might also want to perform this operation for additional channels such as Metallic, Height, or Specular.

The Passthrough mode ensures that this Layer affects all the underlying Layers. So, I select the Smudge tool from the program's toolbar and start applying a few strokes here and there on the paint Layer to show you the effects.

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A walnut shell is not the best choice for using Smudge, because I want to preserve the details on this object, not blur them! However, I wanted to show you how to use this tool, as it might come in handy in other situations. Now, I will delete this paint Layer to demonstrate how to use Clone.

To use the Clone brush, you also need to create a new paint Layer in Passthrough mode, and once again, you must set this mode for the channels you want to affect, just as we did earlier with the Smudge tool.

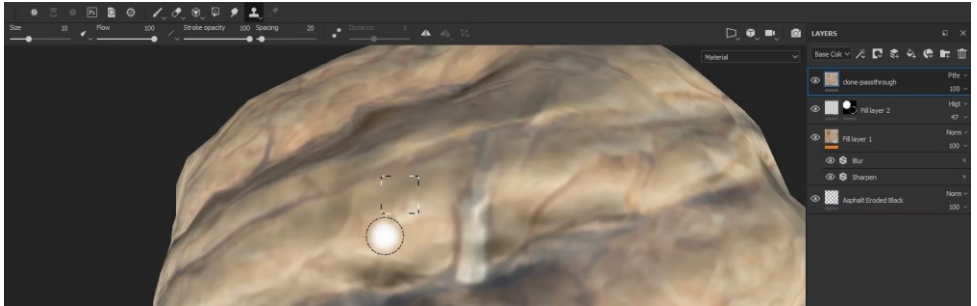
The Clone tool must also be selected from the Substance toolbar, but in this case, we have two available modes. I will show their differences shortly.

To use the Clone tool, the first step is to define the starting point of the portion to be cloned.

This is done by clicking the left mouse button while holding down the V key.

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Once done, you can release the V key and the left mouse button.

Move the mouse cursor to the area you want to fix, then click and drag to clone the source to the new destination.

This way, I can easily correct the material in areas where, for example, the support toothpicks were incorrectly mapped onto the Texture of the High Poly object.

More generally, you can remove or add details or features on the object.

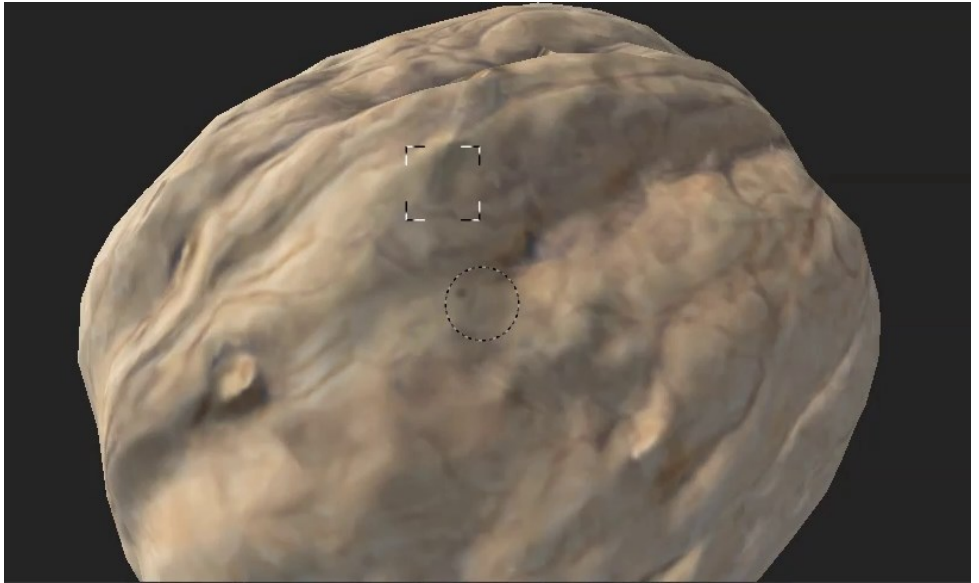
The difference between Relative and Absolute mode is simply that, in Relative mode, the source point of the cloning follows the mouse cursor after performing the operation.

In Absolute mode, on the other hand, the source point remains in its original position relative to the 3D view, even if we move the mouse cursor or change the viewpoint in the scene.

Anyway, I will stop making changes here. The goal was not to achieve a perfect object but rather to go through useful tools and techniques for correcting lighting issues or other errors in the original Base Color, and beyond.

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To wrap up this episode, I check that all channels have a Texture or at least a base color, then I export the Textures to disk to apply them to the model in Blender, as we will see in the next episode.

See you soon!

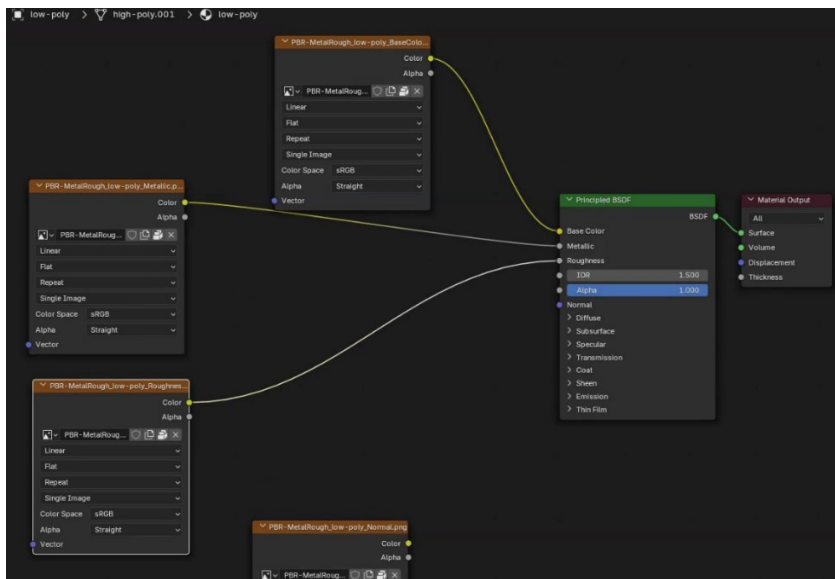
10: Applying the Material in Blender and Conclusion

scheduled for April 28, 2025: <https://youtu.be/DjVr0TzELow>

Hello everyone! In this final episode of the basic turntable photogrammetry series, I will apply the PBR Textures exported at the end of the previous episode to the Low Poly model. To conclude, I will reposition the object at the origin of the virtual world and apply Rotation and Scale transformations, making it ready for use in other contexts.

Before we start, let me remind you that the PDF transcript of all episodes in the series is available for free download at the link in the description. The package also includes the photographs used, with the green background already removed. This is also a great time to subscribe to the channel and enable notifications!

The object already has a basic Principled material, created in a previous episode. In a Shader Editor, I import the Textures exported from Substance Painter and connect them to the corresponding input channels of the Material.

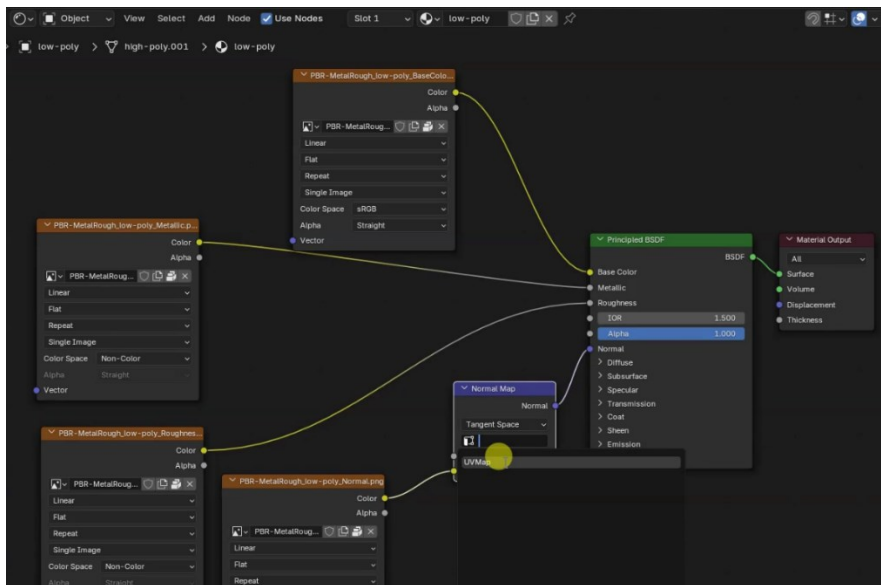


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When connecting these images, we need to keep two things in mind. The first is that only the Base Color Texture should have sRGB as its color space. For all the others, we need to set the mode to Non Color Data.

The second thing to remember is that between the Normal image and its corresponding input in the Principled node, we must insert a Normal Map conversion node, as indicated by the colors of the ports on the two nodes. In this node, we must then specify the UV Layout, which was created by Blender when we unwrapped the Low Poly geometry.



Using a 3D view in Rendered mode, we can adjust the intensity of the Normal Map as needed using the Strength parameter in the Material tab. This will be necessary because the Normal Map coming from Meshroom, and later exported from Substance Painter, will often be too strong, causing shading issues, as I showed in the video.

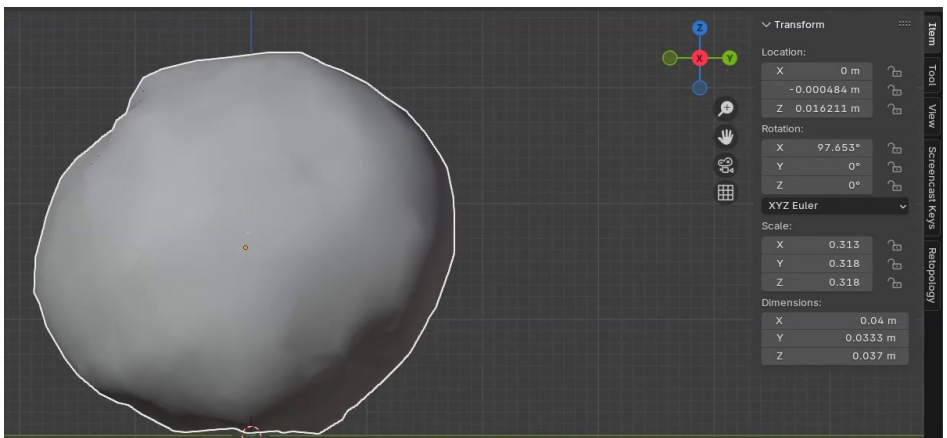
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The lighting I am using is not ideal for evaluating the final effect because it consists of a uniformly bright background without any light sources casting shadows or highlighting details. However, I will change the lighting later, as my current focus is on adjusting the model's position, orientation, and scale.

First, I set the object's Origin to its geometry, then move the object to the center of the virtual world. Next, I adjust the object's orientation and scale. The original object was slightly over 12 centimeters long. I resize it to approximately 4 centimeters along its longest dimension.



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After making these transformations, I apply the Location, Rotation, and Scale transformations to the object. Now this object is ready to be used in other contexts, so we can save it as a separate file.

The render you are seeing contains the same walnut shell duplicated and repositioned multiple times. I did not use Compositing, but keep in mind that you can use Blender's nodes both to modify object Materials and to adjust the final appearance of the render in Compositing.

However, this concludes this episode and this basic series on creating a Turntable photogrammetry project!

I hope these videos have been helpful to you! See you soon!

