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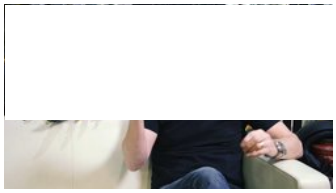
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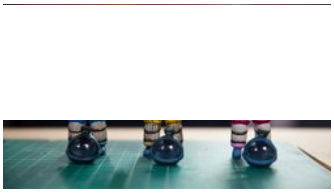
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ART > MAKERS FEATURED

The Art of Photogrammetry: Introduction to Software and Hardware

BY BRANDON BLIZARD ON FEB. 11, 2014 AT 1:19 P.M.

How do computer modelers turn a series of photographs into a 3D sculpture? Photogrammetry is a proven and affordable alternative to laser scanning, and we introduce you to the software and hardware you'll need to get started yourself. It's actually pretty accessible!

Our brains perceive depth by comparing the images that our eyes see. If you alternatively close each of your eyes, you will notice that the object you see will seem to shift left and right. An object that is closer, will seem to shift more than an object that is farther away. That's stereoscopic vision, and the core concept behind creating the illusion of three-dimensional objects and space from two 2D images. Your brain can use this information to subconsciously calculate and tell you how far away an object is supposed to be. In a similar way, photogrammetry is a photography technique using software to map and reconstruct the shape of an object, by comparing two or more photographs. The science of photogrammetry has been around for over 100 years. It was used in World War II by the Allies to construct invasion maps, discover the V2 rocket program, and later by NASA to make topographical maps of the moon for the Apollo missions. This was an expensive, laborious procedure employing a ton of people, and massive specialized cameras and plotting equipment.

Photogrammetry has come a long way since then, and it has even come along way since I first encountered it in my professional life years ago. Now you can create a 3D model from photos with just a smartphone and a few minutes of processing--what used to take a room of specially trained people many weeks to accomplish. Photogrammetry scanning pioneers like Lee Perry-Smith from **Infinite Realities**, and **TEN24** have turned it into an art form.

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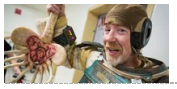
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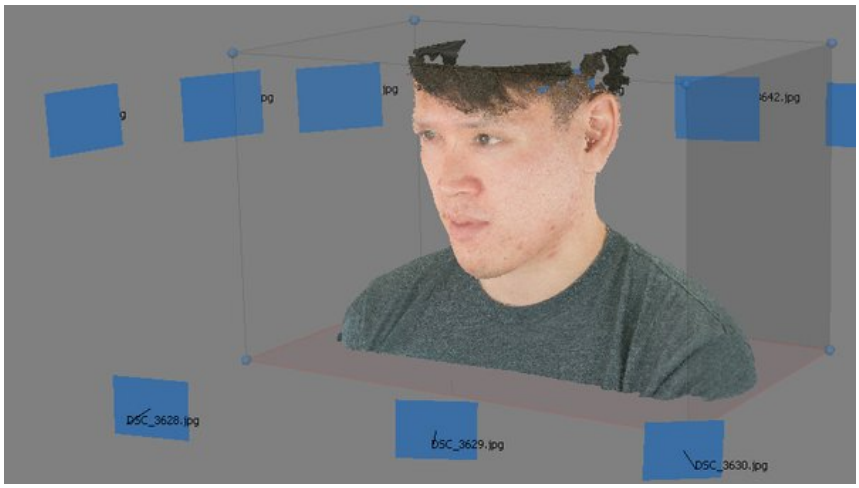
The very best 3D scanning I've seen has been done with a laser scanner, but photogrammetry is not too far behind. Laser scanning also takes special equipment, whether you have to make it or buy it. Using Microsoft's Kinect for 3D scanning is neat because it gives you real time feedback, so you know when you've missed a spot. It's pretty cheap, and millions of people already own one for their Xbox 360. However, because the camera in the Kinect is relatively low-res, it is not great for fine detail. I'm excited to see what people will be able to do with the Kinect 2 in the Xbox One, once Microsoft releases developer software for it.



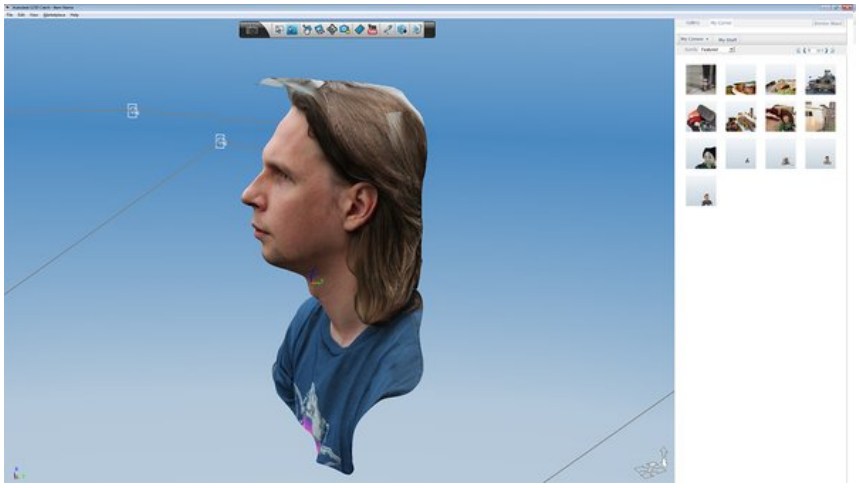
Compared to the other 3D mapping techniques, photogrammetry with a still camera and most of the work done in computation is relatively easy. Though not as streamlined as using a closed system like Kinect, photogrammetry gives much higher-fidelity results, and makes use of equipment that is available to virtually everyone. Because it employs just a regular digital camera, the quality of photogrammetry modeling scales well as camera technology gets better. Modern digital camera sensors are extremely advanced, and because there is so much demand, they are also very inexpensive for what they do.

Today, I'm going to give you an overview of how photogrammetry works, what consumer software and hardware is available for you to try it yourself, and how to stage a lighting environment to best conduct your photogrammetry work.

Photogrammetry Software

Two of the more popular pieces of photogrammetry software are **Autodesk's 123d Catch** and **Agisoft's Photoscan**.

123D Catch by Autodesk is free and relatively easy to use. Your photos are processed on Autodesk's servers so you don't need a powerful computer. By the same token Catch gives you very little in the way of configuration options, and the fine print says that Autodesk actually owns any scans you make with it.



123D CATCH BY AUTODESK

Photoscan is fast on lower detail settings, fairly easy to use, and can produce some amazing models. While $179 for the standard version isn't cheap, compared to buying or building a laser scanner, it is very affordable. The quality of its results is also determined by your home computer, specifically memory capacity (since you're processing many high-resolution images). If you want the finest detail you can get, you will need a machine with as much RAM as you can get your hands on. That can get pricey, but if Photoscan runs

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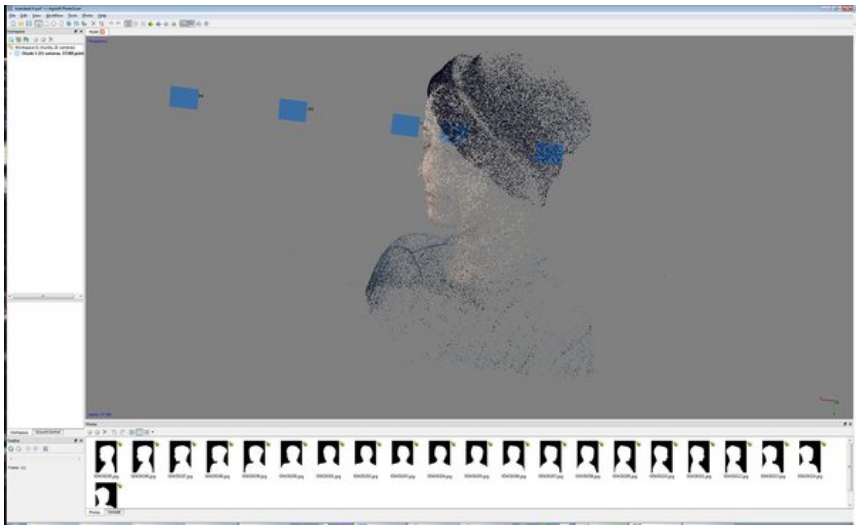
tex ed 3D model. Yes, it's textured and full color!



PHOTOSCAN BY AGISOFT

Since the programs have very similar requirements for input, we can actually do an apples-to-apples comparison of the output. This also means we can reprocess our photos as better software comes out, or even use old images that were never meant for photogrammetry. That's where some real creativity can come in, in creating 3D models from aerial photography or even video.

But all this depends on the source footage. If the photos aren't good, then it's going to put a ceiling on the quality of your 3D model, no matter how good the software is. That's why photogrammetry is really about taking good photos--which is going to be different than a "good" photo for normal photography work. If you are familiar with 3D tracking software, like **Syntheyes** or **Mocha Pro**, you will have a good idea of what will make for good footage.

I'm going to talk about photography techniques for photogrammetry in the next piece, but the basic tenets are as follows:

Keep It Clear

Peep that pixel! You want to see those small features with as much detail as possible. If that freckle or tiny screw is blurry, find out why, and eliminate everything standing in the way of maximum sharpness. This is where more megapixels actually matters. And of course, shooting in RAW helps.

No Information is Better than Bad Information

Give the software only high-confidence information. If you don't need the background, mask it out. If you can't track a subject's hair, cover it up. If one image isn't aligning correctly, get rid of it. You're smarter than the software at filtering this out before it gets to work, and you want to make its job as smooth as possible.

Give the software only high-confidence information. If you don't need the background, mask it out.

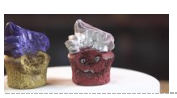
It's All in The Picture

If its not in the picture, then It's not in your mesh. Get underneath your subject to take photos, get above it as well. For heads, take a few extra pictures behind the ear. Make sure you have the coverage you need to get all the details you want, because it's difficult to go back and reshoot in the exact same conditions.

Photogrammetry Hardware

Digital Camera

Of course, you'll need a camera to take your source photos. A smartphone camera will do, but a nice DSLR will give you better results. I have used several DSLRs, Including the Nikon D800. With it's almost unparalleled resolution (36 megapixels), this camera is my favorite for larger and more complicated scenes that contain small details you want to capture. The Canon 5D Mk III is a great alternative with its excellent light sensitivity, allowing you to **raise the ISO** without introducing a lot of noise to your photos. This lets you keep your shutter speed high, and your aperture small (which is actually useful here).


Model Behavior: Painting Crazy Cupcakes!


LEGO Great Ball Contraption Mini-Golf...


LEGO Abrams Tank that Deploys a Bridge!

I have also used a number of other cameras for photogrammetry work. Most modern cameras will work with enough light and a good technique. But the better the camera, the more leeway you'll get with your photos and the higher source quality for your software.

Tripod

A tripod is extremely useful and almost necessary when shooting photos for photogrammetry. The same can be said for your subject--something to stabilize both it and your camera while you take your photos. For a person, that can be a tall stool. for a small object, a lazy susan really helps. Even if you're shooting photogrammetry source photos with a smartphone, a tripod can give you more consistent shots. A tripod with a ball head that lets you rotate your DSLR to its side is very useful for portrait orientation shooting, to full the frame with your subject and capture as much detail as possible.

Lighting

As with "normal photography", lighting is important for a number of reasons. Bright, even lighting will allow you to have a small aperture to reduce the image's depth of field. Think about that for a second. Shallow depth-of-field is actually a bad thing for photogrammetry, because blurred details confuse the software. Our goal is to have high-detail, sharp, and flat imagery. That requires closing up the aperture, which means you need more light. Good lighting will also allow you to lower the ISO which will reduce grain, and it will allow you to have a high shutter speed which reduces motion blur.

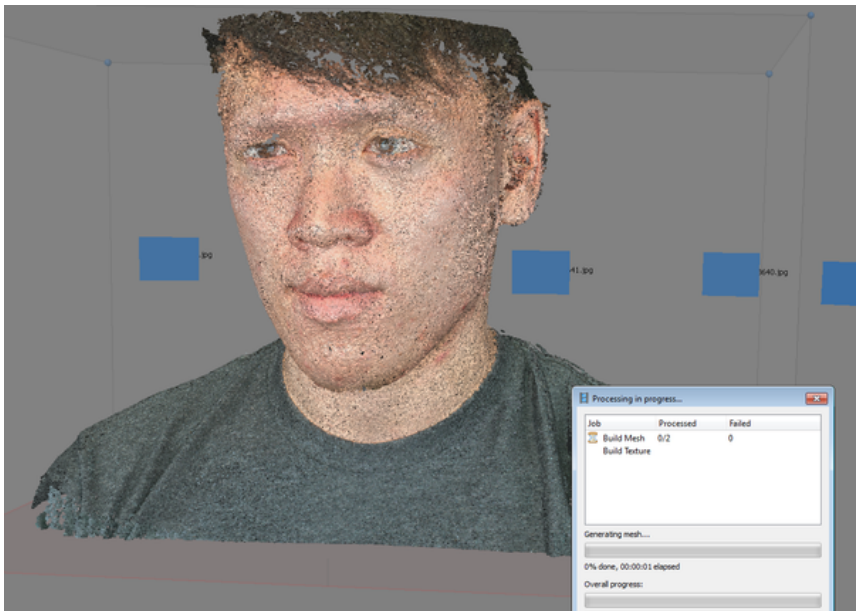
The “evenness” of the lighting itself will help in several ways, too. Even lighting will reduce the effect of highlights on shiny objects. It'll be much easier to use the texture map from the scanning program because the shadows will not be “baked in" to the photo. In uneven lighting, areas with shadows will have less detail, and will not resolve as well in processing.

If you don't have access to lights, soft flat light can be achieved easily outdoors on an overcast day. Pose your subject, and if you see almost no shadow under them (in the chin and neck areas), your lighting will be very flat and even. You can even use something white or reflective to get rid of any remaining shadows, like under the chin if you are scanning a head.

Green Screen

Since the software is essentially tracking patterns across multiple images, we do everything we can to help it see those patterns. Sometimes, when the patterns on your object are too complex, or not complex enough, we just need to fudge it a bit.

The same phenomena that helps our green screen work (i.e. being flat and featureless) will be bad for our subject. Subjects like blank white walls, or a one color plate. You can combat this by giving the software something to track. For a big white wall place pea-sized pieces of painters tape or post-it notes on the wall, which will give the software a hint of where the wall is, relative to the subject in each shot. For items like plates you can use a crayon or a grease pen. Put these marks in a place that will be easy to remove, both digitally and in real life.



As much fudging as you can do to help the software track the details of an object, some stuff is just too complicated for the software to make sense of. Unfortunately, people, (a popular scanning subject) have a big wad of this stuff on the tops of their heads--hair is really difficult to scan with photogrammetry. Until cameras have the resolution to resolve each individual hair, this is going to be a problem. Sometimes hair will scan, but usually you get a mess that is not worth fixing. It's usually better to avoid the problem by covering it up. A stocking, bald cap, or a thin beanie will give you the shape of the persons head and scan well.

So that's a brief introduction to the software, hardware, and basic principles of photogrammetry. Despite it looking like a dark art, it's actually really accessible. Next time, I'll dispense some tips for taking photogrammetry photos, and we'll walk through the process of photographing one object and processing it in PhotoScan. Post any questions you have in the comments below!

BrandonBlizard 5 years ago

@Firethorne said:

> Will this result in a Print the Mystery Norm?

Now, that's a mystery...

Alan_Smithee 5 years ago

a really powerful open source photogrammetry software i found is VisualSFM

this is a great article explaining the (rather complex) workflow

PassPose 5 years ago

@BrandonBlizard: Thanks for the reply. Your right it's hard to argue with the convenience of photogrammetry.

BrandonBlizard 5 years ago

@Alan_Smithee I saw that one. Have you used it before? I'd love to see some tests from it.

BrandonBlizard 5 years ago

@PassPose: I have a little Pico projector, I should see if it works well enough to scan. Do you use David 3D?

Alan_Smithee 5 years ago

@BrandonBlizard:

yes i did. the project itself wasn't a classic application though.. but the results where very good.

the advantage you have to other software out there is that you can control every aspect of the process, be it the mesh or the textures.

i know its a rather complex looking workflow but since its free i'd give it try if you're not satisfied withe the results of 123D for example...

BrandonBlizard 5 years ago

@Alan_Smithee: What did you use it for? If you have it still running, I'd like to send you some footage to try out.

PassPose 5 years ago

@BrandonBlizard: It's what I've used in the past (well borrowed if I'm being honest). What I've done in the past is digitize sculptures of mine to use in animation and 3d work. Since most of them aren't painted I've had bad luck with photogrammetry not tracking. Which is the main reason I like structured light.

heavyimage 5 years ago

@Alan_Smithee Thanks! I'm the author of the post. I think it turned out pretty well. Everyone else, you can check out a slightly lower-rez / lower-detail model via webgl here: **http://webgl.heavyimage.com/** I also have some other models built using this technique but I haven't posted them yet. Soon! Also, more information into bridging into a VFX workflow, which is my "real job".

BrandonBlizard 5 years ago

@heavyimage: Hey, I saw your write up when I was searching for alternatives to 123D Catch. What do you think of the articles so far, are there any other areas you think I can touch on? Have you tried Photoscan? How does it compare to VisualSFM?

jabusby 5 years ago

@jabusby: Thanks Jamie, If I'm ever in mass I'll have to check it out.

BrandonBlizard 5 years ago

@jabusby: Sheffield Rather..

rmcfadden89 2 years ago

This is great! Drop these models in Scanifly.com to get more from your data!

weijian247 2 years ago

I've recently taken some pictures of a person as my subject, in front of a green screen. I used the 'turntable method' and had him rotating while I took my pictures from the same position
When I align them inside of Photoscan, they all align properly but the cameras stay in the same location. I masked out everything that I didn't want scanned and I still got the same result.
I have done previous turntable methods without much trouble.

I'm not sure what else I could do, if there is anything to do. Have you guys any suggestions on how to approach it?