

Photogrammetry for Low Budget Game Development

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Abstract

3D modelling is an aspect of game development that is extremely time consuming, most notably when photo-realistic assets are required. Photogrammetry is a technique that can be used instead of traditional 3D modelling which involves using software to generate a 3D model from a collection of images. By utilizing photogrammetry techniques instead of painstakingly modelling an object from reference, developers can scan real world objects into 3D game engines. This results in extremely realistic assets for a comparatively low amount of effort. The purpose of this project was to find a workflow that enables developers to effectively utilize photogrammetry techniques in order to have access to photo-realistic assets on a small budget. Using a combination of consumer grade, open source and custom-built software & hardware, different techniques were tested & compared. These techniques include laser scanning, as well as traditional photogrammetry. Different methods are being compared by scanning identical objects and comparing the results. Preliminary results have shown that extremely detailed models can be attained through the use of open source software, and a relatively inexpensive camera.

Purpose

To develop a workflow to allow game developers on a budget to easily obtain high quality, photo-realistic 3D models without having to manually create them.

Methods

Photogrammetry

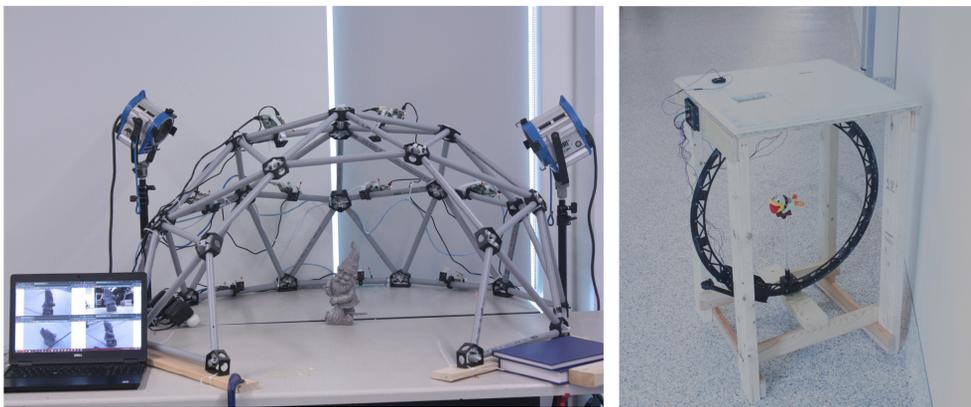
In a broad sense, photogrammetry is the process of measuring objects through photography. One application of these measurements is creating 3D models from a set of photographs.

Reconstructing 3D objects through photogrammetry begins by taking photos from every angle of the object. It's important that these photos have a lot of 'overlap', because photogrammetry relies on comparing features of the object that appear in multiple photos. These photos can be taken by anything from a smartphone camera to an expensive DSLR – the most important part is that the photos are composed well. Consistent lighting with little to no shadows is ideal. Photography for photogrammetry often results in "bad looking" photographs, the geometric detail of the subject is what is important, not beautiful photographs.

Next, these photos are loaded into a piece of 3D reconstruction software. By matching features that appear in multiple photos it's possible for software to locate the camera's position in 3D space around the object for each photo. From this information, software can extrapolate the position of every pixel in the photos, creating a "dense cloud" of points. From these points, an extremely high polygon-count model can be generated. [1]

For some applications this high polygon count model is ideal, but for game development a lower polygon count model is desired because of rendering requirements. 3D modeling software can be used to 'retopologize' the model, which is the process of creating a lower polygon count model that's easier to render, while maintaining as much detail as possible.

Custom Hardware



Above are two custom-built rigs that allow for automated photogrammetry. The structure on the left is built of PVC pipe with 3D printed joints, and 9 Raspberry Pi computers with attached cameras. Through custom software, photos are taken from 9 different angles simultaneously. The structure on the right is 3D printed, with an Arduino Nano running a custom script that allows for pictures to be captured of the subject from every angle using a smartphone's camera. 2

Photography

Tested photography techniques are listed below. All of the listed techniques involve capturing photos of the subject from all angles, in order to capture every detail of the subject.

Smartphone Ring

Subject is placed on rotating stand, subject is rotated in a circle as photos are taken with a smartphone mounted to the ring. The ring rotates to allow for multiple 'layers' of photos to be taken.

Raspberry Pi Dome

Subject is placed in the middle of the dome, and 9 pictures are taken simultaneously. The subject is rotated by hand to capture images from all sides of the subject.

Freehand Camera

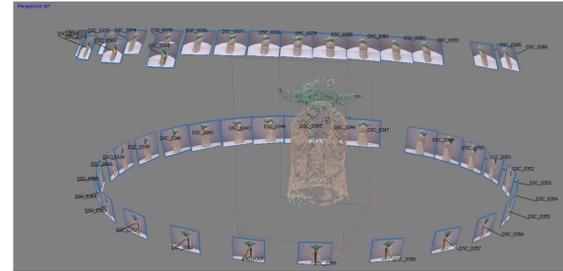
Camera is moved around the stationary subject, taking photos strategically to capture every angle.

Camera with Turntable

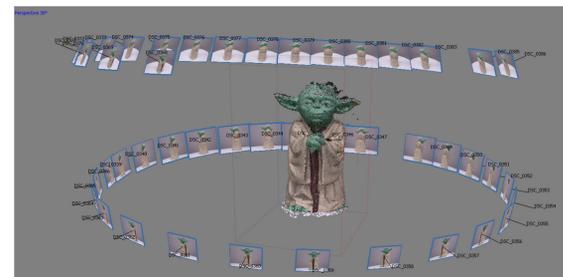
Stationary camera on tripod, subject on rotating turntable, photos are taken at regular intervals

3D Reconstruction

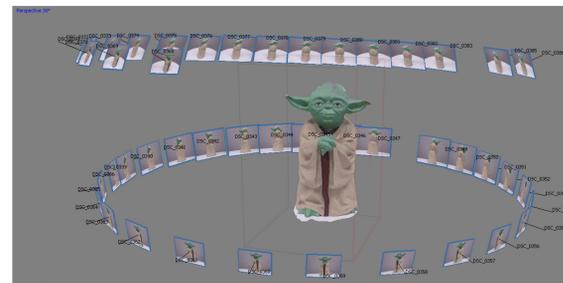
Many options are available to reconstruct photographs into 3D models, ranging from open source software like COLMAP to commercial software such as Agisoft Photoscan. Pictured below are results with Agisoft Photoscan.



The reconstruction process starts with the software looking for features that appear in multiple photographs, and using this information to map out where the photos were taken from in 3D space, in reference to the subject.



Next, the software uses these points that were matched across photos, as well as the positions that the photos were taken from to extrapolate more data from the photos to build a more detailed "cloud" of 3D points to recreate the form of the subject.



Finally, these points are used to generate a highly detailed mesh.

Processing

Instant Meshes

Used to retopologize the mesh to reduce polygon count, while maintaining as much detail as possible.

Blender

Used to sculpt rough areas away, as well as retopologize the mesh.

Results

The best results were attained when using a rotating turntable to rotate the subject and using software connected to a DSLR to take photos at regular intervals. These photos were put into Agisoft Photoscan to generate a mesh. This mesh was brought into Blender and cleaned up using the sculpting tools. Finally, the mesh was brought into Instant Meshes to retopologize the mesh into something with a more reasonable polygon count.



Above are the results of a completed scan. On the left is the raw mesh output from Agisoft Photoscan. This mesh is 1,377,222 polygons, which is too high for most use cases in game development. On the right is a model that has been initially cleaned up in Blender, and then re-meshed in Instant Meshes. The result is a cleaner looking model with much fewer polygons, 62,116. The entire process of this scan took around 2 hours, which is much quicker than the process to model a photo-realistic version of the statue by hand.

Future Work

- Automate workflow of bringing photos into Agisoft Photoscan/COLMAP
- Further testing with Smartphone Wheel/Raspberry Pi Dome, they were completed late into the research

References

1. Du, X., Jin, X., Zhang, X., Shen, J., & Hou, X. (2009). Geometry features measurement of traffic accident for reconstruction based on close-range photogrammetry. *Advances in Engineering Software*, 40(7), 497–505. <https://doi.org/10.1016/j.advengsoft.2008.09.002>