

# Photogrammetry for a Virtual Reality Nature Scene

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## ABSTRACT

This groovy graphics assignment introduces students to the practice of capturing physical objects in nature using photogrammetry and professional software to prepare them as digital assets for building a virtual reality environment in a real-time game engine. Students are tasked with exploring outside, preferably in a natural setting such as a park, nature trail, or backyard, to find ephemeral objects or areas of interest to capture and use to build a virtual reality nature scene. This assignment inspires students to consider the natural environment as a resource for creating virtual environments while simultaneously challenging them to work with an emerging technique for asset creation. It also exposes students to different software packages while preparing the captured data as 3D models which leads to a deep understanding of the 3D pipeline. Once the assets are prepared and the scene is built, viewing the completed environment in VR may strengthen an appreciation for natural environments by viewing a digital representation with an increased sense of presence.

## CCS CONCEPTS

• **Computer methodologies** → Computer graphics; Shape modeling;; • **Applied Computing** → Media Arts.

## KEYWORDS

Photogrammetry, real-time rendering, virtual reality, 3d modeling

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## 1 INTRODUCTION

Photogrammetry is a process of creating 3D assets by taking photos of objects and environments. It has become a popular technique in games, film, simulations, and visualizations. This assignment introduces students to the practice and application of photogrammetry through an onsite capture of objects and areas of interest in a natural environment, processing the captured data, preparing 3D assets, and building a nature scene in a game engine viewable in VR.

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We chose to focus on natural environments because they are often easier to capture and yield results that are difficult to replicate with traditional 3D modeling techniques. Furthermore, we believe working outside is beneficial to mental health, and using the natural environment as a resource for creating digital assets can strengthen a connection to nature, which may be enhanced when building for and viewing in VR because of an increased sense of presence.

This assignment is appropriate for second year undergraduate students and above who have previously taken an introductory 3D modeling course and have worked with a real-time game engine. Since some of the steps can be automated, students without prior experience may be able to complete the assignment, however, students with experience are better able to troubleshoot and improve their work through adjustments and modifications.

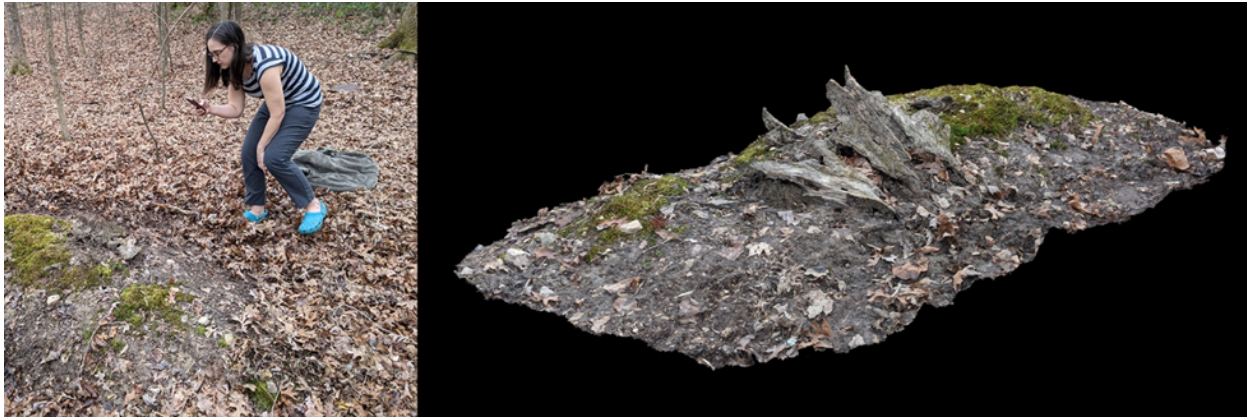
## 2 MATERIALS AND PROCESS

We recommend using a DSLR camera when taking photos for photogrammetry, however any camera would work including 360 cameras, video, cellphones, and drones. Photogrammetry software processes higher quality photos faster and the resulting 3D data usually has more detail in terms of geometry and surface textures. A DSLR camera allows students to set the f-stop, shutter speed, and film speed to allow for optimal photo quality. We understand because of the cost, students may not have access to DSLR cameras, especially when many are taking classes remotely. In those cases, we recommend experimenting with using a cellphone. Figure 1 demonstrates capturing a patch of forest using a Google Pixel phone and the resulting 3D asset.

Students need access to photogrammetry software to process the captured data. Students also need access to a 3D modeling package(s) for retopologizing, UV mapping, and baking texture maps.

We recognize access to software can vary from institution to institution and even more so with remote work. There are several software packages that can be used to complete this assignment. Many, such as those in the Autodesk and Substance suites, are free for educators and students. Others include Houdini and RealityCapture which offer different price structures. There are also completely free options such as Meshroom for processing photogrammetry data, and Blender for retopologizing, UV mapping, and texture baking. Since there is no standard software pipeline for working with photogrammetry data, we recommend students working with, first, what they have access to, and second, what they have experience with.

After the 3D models and texture maps are prepared, students import them into a game engine. Both Unreal Engine and Unity 3D are free and offer templates and toolkits for quickly and easily creating VR projects. A VR headset is also needed to complete this assignment.



**Figure 1: Photogrammetry with Google Pixel. Photograph by Authors.**

Summary	Build a VR nature scene with assets captured from the natural environment using photogrammetry
Learning Outcomes	Learn photogrammetry techniques, develop a deep understanding of the 3D asset creation workflow, design and build virtual environments for VR
Classification(s)	Modeling, rendering, virtual reality
Audience	Second year undergraduate and above
Dependencies	Introductory knowledge of 3D modeling and using a game engine
Prerequisites	Previous assignments include processing pre-captured photosets in photogrammetry software and retopologizing 3D captured data.
Strength	Capturing outside and working with emerging techniques for asset creation, realistic and highly detailed visual results, working with VR
Weaknesses	Sometimes results are unpredictable, shooting outside can be disrupted by weather
Variants	Students can capture different types of objects and are encouraged to explore using them in different ways to create their nature scenes.
Assessment	Assessed in VR on how well it runs (framerate) and level of detail

### 3 METADATA

### 4 CONCLUSION

In addition to practicing photogrammetry and learning advanced workflows for creating 3d assets, this assignment fosters a connection between natural and digital environments. Students use nature as a resource for creating assets, use them to build their own

environments, and experience them in VR. Working in a real-time engine allows students to bring their environments to life while forcing them to process the photogrammetry assets to balance efficiency and detail. This assignment can easily scale in scope from the variety, size, and modifications to the digital assets and resulting virtual environments.