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Computer Graphics Project Report

Introduction

My research into machine learning applications in waterways spurred my thought process for deciding my approach. Two of the most common objects that I see in my Anacostia river dataset are plastic water bottles and bottle caps. My theory is that the lightweight, buoyant, and common plastic product is easily swept up by rain or blown by wind. The plastic eventually finds itself within the river where it stands out against heavier, darker or just generally less buoyant trash. In my mind, building an as accurate as possible three dimensional model of these two objects (and even possibly the bottle label) could benefit my research by allowing me to model the behavior of these objects in various conditions. The behavioral analysis could lead to a better understanding of how these two common products end up in my Anacostia river dataset. That is why I chose to create a 3D water bottle for my computer graphics project.

Method & Approach

I considered using multiple types of plastic water bottles. A Fiji water bottle is very different in shape, weight and other characteristics from a Voss water bottle. My dataset is biased in that the most common type of water bottle is the Nestle brand’s Purelife bottle. This may be one of the more common water bottles purchased within the District of Columbia / Anacostia area. Oddly enough, I could not find single servings of the product at the stores I searched for. Instead I observed that it is regularly purchased in bulk, potentially further biasing the dataset.

I considered multiple methods of data collection for import into Meshroom. According to the Meshroom manual some important considerations are lighting, resolution, angles, position, shadows and overall quality (blurry images being poor quality for our purposes). It is also possible to use a rotating rig in order to compensate for some of these variables. Moving around an object can cause blur, differences in lighting and shadows, or generally unsteady photos. Rotating the object in front of a stabilised camera can result in better photos altogether.

Implementation

My initial methods involved searching several stores for a Nestle Purelife water bottle, and settling for a Poland Spring water bottle. The dimensions are similar but the bottle is less round and made of slightly thicker plastic, resulting in a heavier bottle. I initially photographed the bottle from a single angle, on my carpeted floor. The background contained my computer carry case. The lighting was a little brighter than would be ideal (the Meshroom manual suggests overcast lighting) but there were few shadows. There were some "gleams"/bright spots caused by indirect sunlight. I rotated the water bottle on a lazy susan and took one hundred and forty-three 3024x3024 resolution images from varying heights and angles.

Fig. 1 Poland Spring bottle on a lazy susan with a carpeted background

Unfortunately the meshroom algorithm did not make it past feature extraction. I was met with the following error for each FeatureExtraction node:

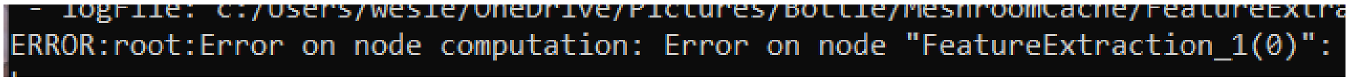

Fig. 2 Error message for FeatureExtraction_1. This error occurred for _1,_2 and _3.

After some quick research I found a reddit comment for someone with a similar error.

> "It could likely be failing as a lot of features present in each image are in the background, and between each image those features don't overlap.
>
> Your object has some specularity, remember that any software will find it exceedingly difficult to solve anything shiny, as the software will struggle to find features on the target object.
> I would try to retake the photos, but this time frame your object to fill the whole image and limit the specularity with a polarising filter.
>
> Run some tests on a small, rough and feature-full object like a rock or tree stump to develop a further understanding of what the software is picking up in the feature extraction phase."
> -u/gillivis

I persistently attempted to address some of these issues. I repositioned my bottle onto my kitchen floor. My hope was that the tiles of the floor would provide ample features for the extractor to reference. I also spray painted the bottle white with the intentions of decreasing specularity and adding a level of roughness to the surface. Finally, I removed the lazy susan and walked around my bottle taking fifty 3024x3024 resolution images.

Fig. 3 Poland Spring bottle, painted to reduce specularity and highlight features, on tile background.

The feature extractor failed for this model as well. It’s my summation that the plastic water bottle, being relatively smooth, is too featureless of an object to easily build a three dimensional model of. This seems to be the case for many plastic and metal objects, especially objects with relatively flat faces.

Moving away from the plastic bottle I witnessed tutorials such as the “Test Meshroom”, “How to use Meshroom - Great Tool for Creating Realistic 3D Scanned Models”, or “3D Scanning For Free With Meshroom” on YouTube, all using natural objects for their models. I decided to explore my neighborhood for inspiration. The great thing about natural objects is that they are far from uniform. Natural objects have many faces with many different colors and textures. They often have other objects (such as moss) growing on or around them. The environment that they are in is also not uniform as roads, sidewalks and forests are littered with everything from bottle caps to leaves and sticks. This provides a wealth of easily viewable features for Meshroom’s feature extractor to leverage.

I found a particularly interesting dead tree to image. I circled the tree, taking one hundred and forty two 3024x3024 resolution images, capturing the many features of the tree and its surrounding. The feature extractor easily processed the images and the Meshroom algorithm created a model successfully on the first attempt.

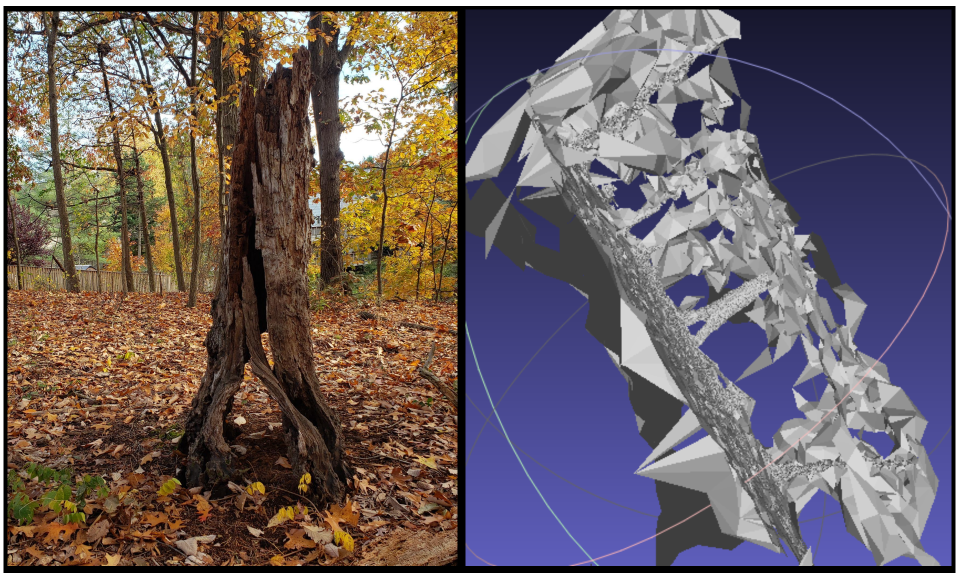

Fig. 4 Left: Dead Tree in ideal overcast lighting. Right: Tree & environment built by Meshroom

Figure 4 shows the object that was created. Meshroom captured the majority of the components within the images, including the fall floor and limbs of trees in the background. You can see the dead tree of interest in the center of the object.

I imported the object into Meshlab and cut away everything outside of the tree, with the exception of some of the floor below it. Additionally there was a floating remnant that was unattached to the model tree but hovering extremely close to it. This was also removed once discovered. The texture created by Meshlab was then applied in Meshroom. I did not feel the need to adjust the texture at the time. I exported the model and then uploaded that into P3D.

Once the model was built in P3D, I was disappointed to find that my texture was not also built. Meshroom/lab saves the model into three parts, a .obj file, a .obj.mtl file, and several texture_x.png files. All of these needed to be uploaded to P3D together. This is detailed in the "How do I upload my model?" section of P3D's faq.

Discussion

This exercise in computer graphics was not fun for me until I had a working model in Meshroom. At that point I realized just how exciting it is to take a real world object and make a nearly exact copy virtually. It was interesting to learn about how the feature extractor worked to base the camera position and other measurements off of different features that it picked up within the scene. The fact that it was able to discern the hollowness of the dead tree was surprising. It's clear that these algorithms are quite powerful.

Conclusion

Plastics, metals and other objects can be difficult to create 3D models of. It is important for the object that you choose to have many features that can be leveraged by the algorithm being used. Not addressing this in the planning stage of your project can lead to many setbacks. I found that natural objects are much easier to create models of. It is important to browse documentation for tips and tricks from the developers. These can help you immensely. By the end of my project, I had switched from using a man-made featureless object to a natural object with many features. This resulted in immediate success.

Fig. 5 Completed tree model, rendered in P3D

Works Cited

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