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Introduction to Computer Graphics CSC 322

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Building 3D models of real-world objects

INTRODUCTION

This paper discusses the importance of creating a 3D model of a real world object using images and the project that was created as an application . Computer Graphics is an emerging field with many applications and excellent opportunities for growth. Researchers like Ed Catmull and Pat Hanrahan who won the Turing award for their contribution to the field of computer graphics. Their impact on filmmaking led to a new genre of computer animation beginning with “Toy Story”[1]. Even though when we first think of computer graphics an animated movie might come to mind there is a wide range of applications in this field. In their paper about the benefits of 3D modeling and animation in medical teaching Tim Vernon and Daniel Peckham discuss the importance of computer-aided modeling in the field allowing medical illustrators to create virtual models which would aid in teaching.[2] In their attempt to work with software to analyze the 3D survey of ruins at archeological sites, M.Lo Brutto et.al analyzes the difference between using low-cost software to create a 3D model and that created with a laser scanning survey.[3] Turker Bayrak and Ammar Kaka explain in depth how digital photogrammetry is combined with 3D CAD modeling is applied in construction management, and the benefits of automating the

systems[4]. All the above applications show the importance of computer graphics in a wide range of fields ranging from construction to the medical field.

METHOD AND APPROACH

This project applies concepts of computer graphics to create a model of a real-world object. Meshroom and Meshlab are the open-source software used in this project to create the model. Photogrammetry is the science by which information is extracted from interpreting and measuring photographic images and patterns. It is the process by which a 3D model can be reconstructed by 2D images/photographs. Meshroom is used to reconstruct the images into files containing information for the 3D models. The software can be downloaded but has device specifications that need to be noted so it can be used efficiently. The basic requirements to run Meshroom are a minimum of 8GB RAM memory and an NVIDIA CUDA-enabled GPU without which the system might crash or the software might not be compatible with your device. “Meshroom is a Python application and it relies on the AliceVision framework. If you are using the pre-built binaries everything is shipped with the package, so you do not need to install anything else.[5]” The wavefront obj file is created by Meshroom after the images of the model, this is then uploaded to Meshlab. “Meshlab is an open-source software for processing and editing 3D triangular meshes. It provides a set of tools for editing, cleaning, healing, inspecting, rendering, texturing, and converting meshes. It offers features for processing raw data produced by 3D digitization tools/devices and for preparing models for 3D printing.[6]” Thus the unwanted background noise can be removed and the final model is obtained.

IMPLEMENTATION

Since the software that is used for the project is fairly new to me, I started by searching online for tutorials on how to download the software packages and install them on my computer. I found a few youtube tutorials[7] explaining the step-by-step process of how to work Meshroom. At first, I picked a statue on campus as my model but soon realized that it was too big of a structure to create a Meshlab model on. I spent some time trying to find the right angles as well as the right amount of pictures to take of it to create a good model. I rendered the images of the statue on Meshroom, after the obj file was uploaded to Meshlab I quickly realized that I did not take enough images in the correct lighting. I tried to take better pictures but the model was not good enough to be submitted as a final project. I decided to switch the object to a stuffed toy I had in my room, this turned out to be a better choice since I was able to take sufficient pictures with the help of the artificial light in my room. After reviewing the 47 images I took of the toy and making sure they were good, I used Meshroom to render the model. I first saved the .mg file and then the image began to render.

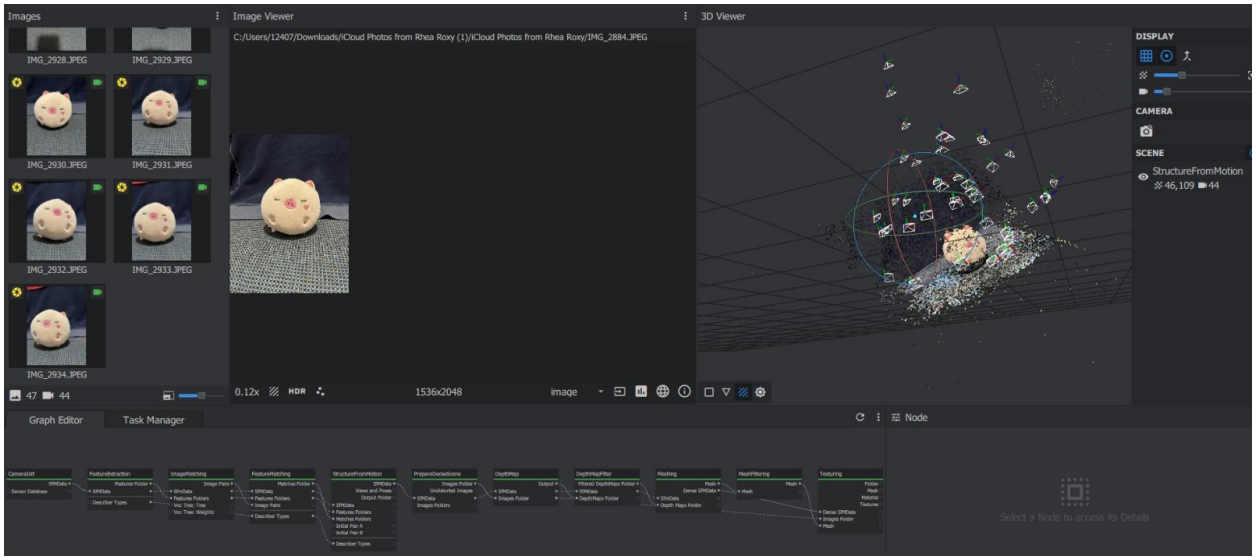

Fig 1. Rendering the image in Meshroom

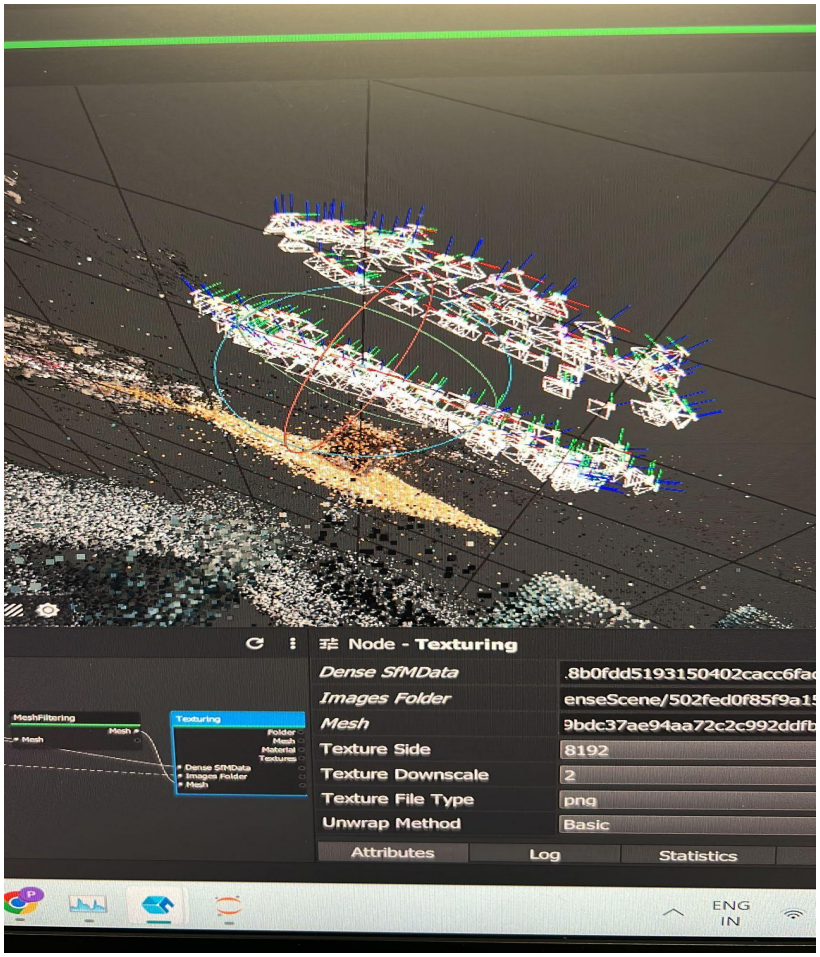

Fig 2. Final output with the perspective cameras in Meshroom

Meshroom has a very specific way in which the implementation works, as it can be seen in the steps at the bottom of the page. The nodes are CameraInit, FeatureExtraction, ImageMatching, FeatureMatching, StructureFromMotion, PrepareDenseScene, DepthMap, DepthMapFilter, Meshing, MeshFilter, and Texturing. There is a feature to change the node settings in Meshroom but I used the default settings for mine. As the image renders there is a progress bar at the top indicating the point at which the software is in rendering the image. In my first model, I had a point when the software showed a red bar and stopped since the laptop went into sleep mode and interrupted the software. At the end of the rendering process in Meshroom, I had 44 perspective cameras out of the 47 images that were uploaded. Under the various options for this model, there were a lot of extra faces and vertices that were not essential to the model. The waveform obj file that is obtained as the output is then uploaded to Meshlab to be edited. The number of extra vertices and faces can be reduced by using filters on Meshlab. The model is then ready to be exported in obj format and uploaded to P3D, which can be accessed after signing in.

Fig3. Front of the model

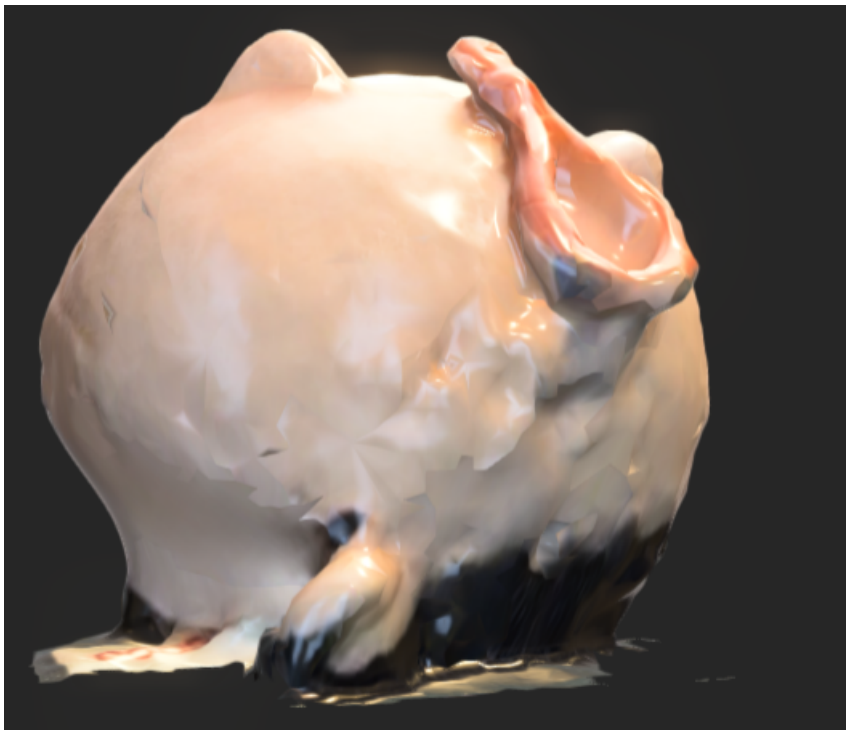

Fig4. Back of the model

DISCUSSION

This project was overall exciting to do since it was interesting to learn and apply the theory that was learned in computer graphics. Both Meshroom and Meshlab were easy to use since they had interactive interfaces. Even though it took a lot of trial and error to figure out what kind of images worked best to create a model in Meshroom, in the end, I figured it out with the help of online tutorials.

As can be seen from the above image Fig3, Fig 4s the base of the final model is unclear, this can be refined by taking more images and making sure that images are taken from all angles. The model can be refined to create a more clear base and refine the details but has been completed with appropriate realism.

There were a few challenges that I had to overcome for this project. Firstly, even though I was excited to run the software on my laptop I very quickly realized that since my laptop had an AMD Radeon graphics card I would not be able to run Meshroom on my computer. I had to borrow a family friend's laptop to create the model and to be able to run Meshroom and Meshlab. I made sure the specifications of the laptop were compatible to run Meshroom and Meshlab.

.Secondly, choosing the object to create a model. The problem with my initial model was that it was too big, and I was prone to changes in weather conditions to obtain good images. There were multiple times when there would be bad lighting or the sun was shining too brightly and the statue did not appear clearly in the images. I was unable to take more pictures of the statue on another day since there were different lighting conditions that would make the model looks unrealistic and unclear. I then uploaded my model to P3D and completed the project.

CONCLUSION

This project allowed me to understand the importance of 3D models in various fields and its applications. Using both Meshroom and Meshlab has given methe experience to create a model from a real world object which is a very interesting application of computer graphics. The softeares being open source was helpful for me especially as a student since I did not have to pay inorder to create a model. There were different settings in Meshroom that could be manipulated to create different effects, for further use I would work on different objects to create models. Meshlab had a lot of features that allowed to edit the files that were generated after rendering in Meshroom. This project allowed me to apply the concepts of computer graphics as we learnt in class. P3D is also a new software that I became aware of that allowed me to upload and see my model in realtime. This project was overall very insightful into the practices and application of computer graphics.

Link to Github: https://github.com/Rhea-Roxy/CSC322FA22/tree/main/Final%20Project

Link to P3d: https://p3d.in/x9Fia

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