CS 5670: Computer Vision, Spring 2024
Project 4: Stereo

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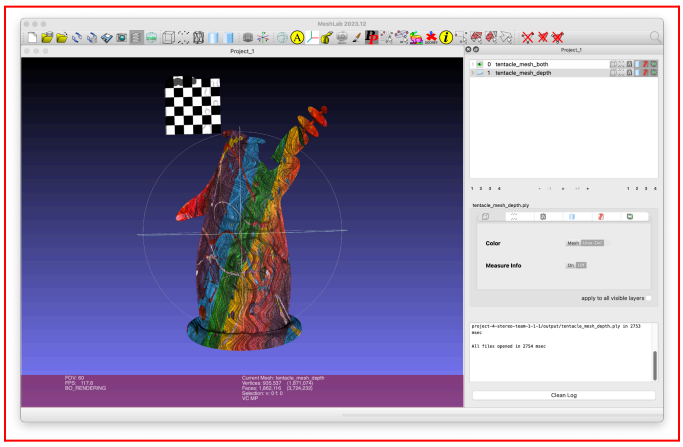
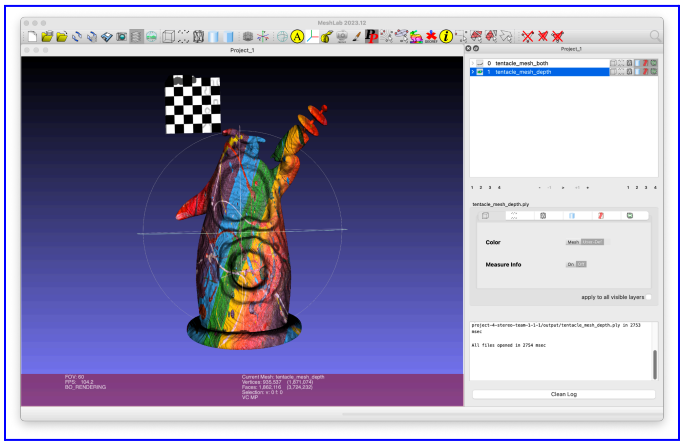
Part 3: Depth Map Reconstruction

1. Comparison between **<tentacle dataset with mode set to both> (screenshot marked as red)** and **<tentacle dataset with mode set to depth> (screenshot marked as blue)**

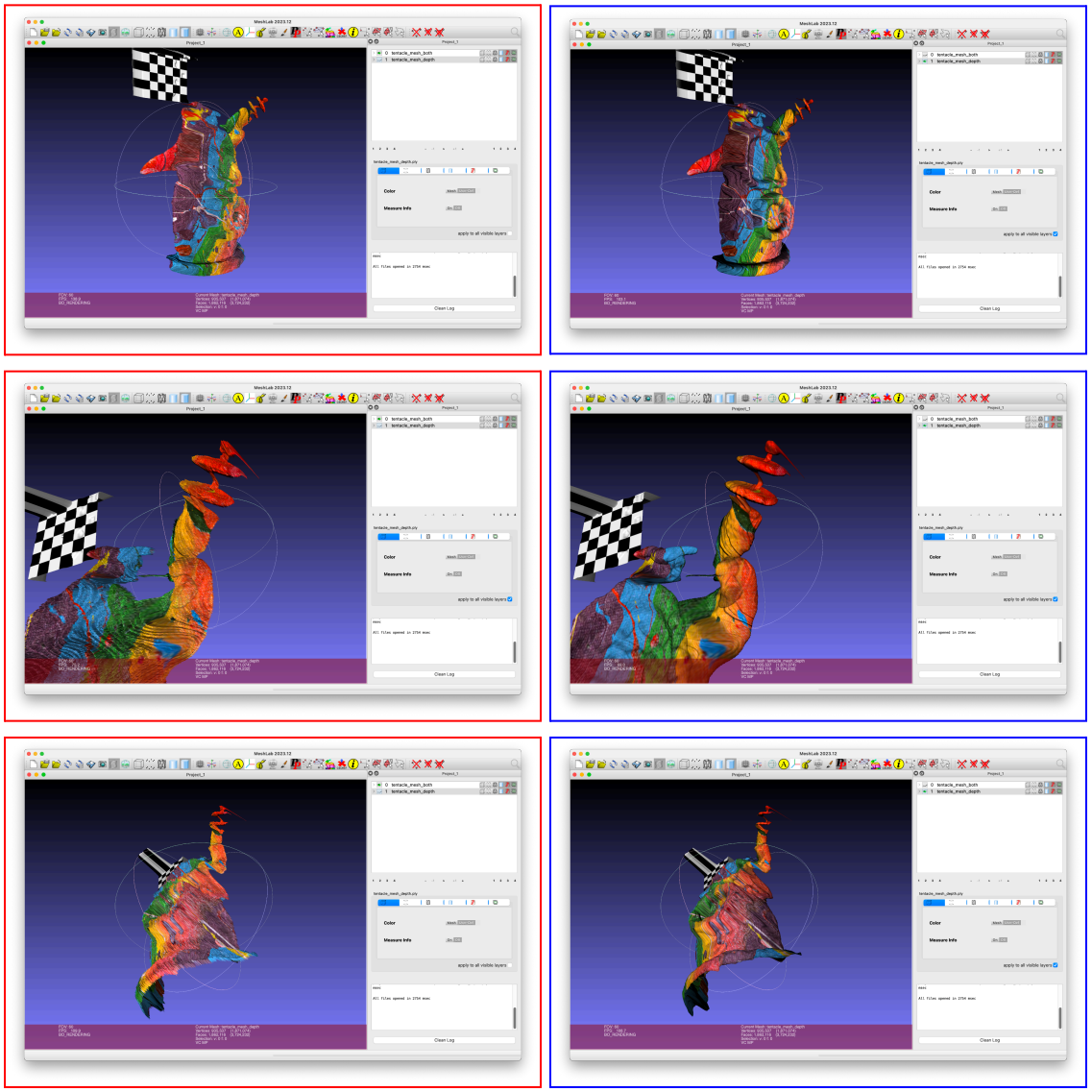




Both the "both-mode" (combining photometric stereo and plane sweep stereo) and "depth-mode" (plane sweep stereo only) meshes have issues with accurately reconstructing the checkerboard pattern on the back of the tentacle, resulting in a weird extrusion.

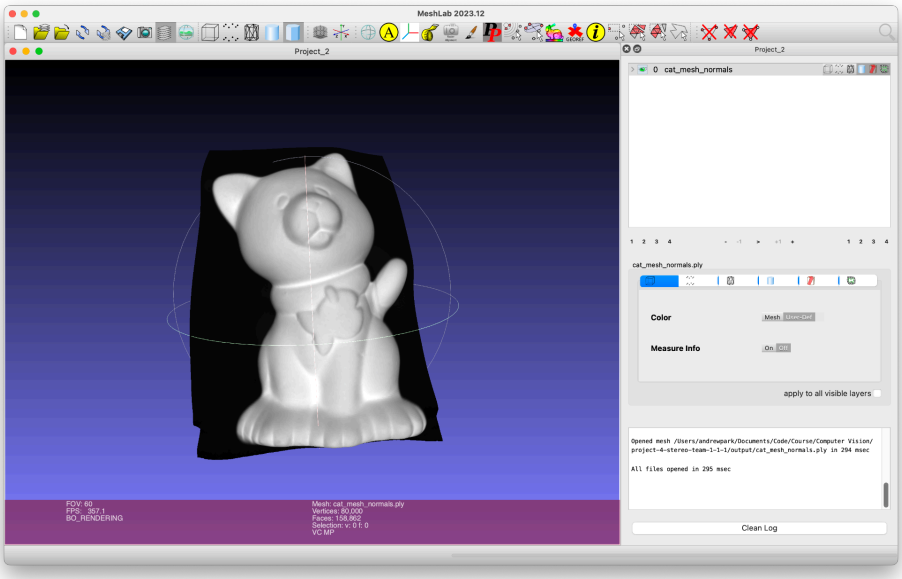
However, the depth-mode mesh appears to perform better in our opinion in capturing smoother details like border lines and the clarity of the gun compared to the both-mode

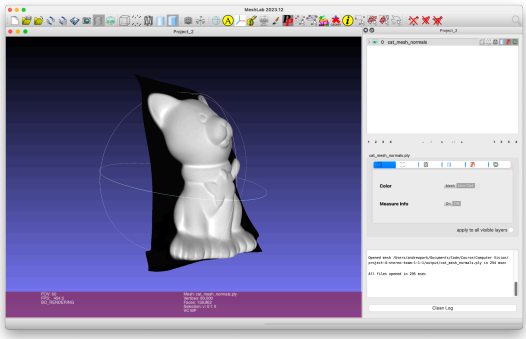
mesh. This suggests that the plane sweep stereo algorithm alone is better at handling depth discontinuities and fine details than the combined approach.

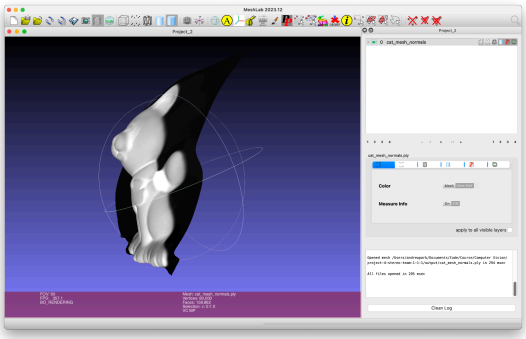


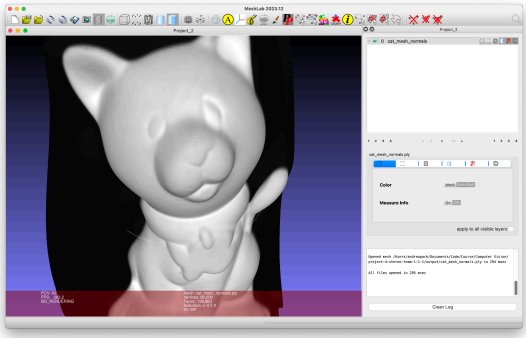
The main issue seems to be with the alternating black and white squares of the checkerboard pattern. The differing albedos (reflectance) of the black and white squares, combined with the changing colors/albedo of the tentacle itself, likely confuses both reconstruction methods during the photometric stereo (surface normal/albedo estimation) and plane sweep stereo (depth/NCC computation) steps. The problem may be potentially due to poor lighting and reflections in that region, leading to inaccurate computations.

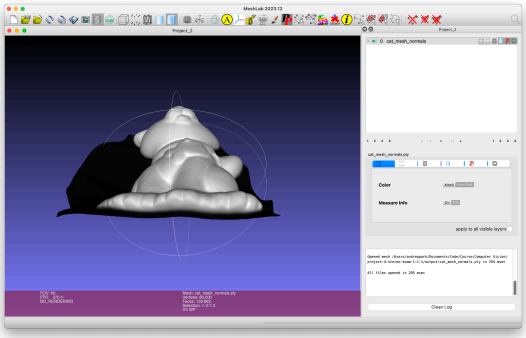
2. cat dataset with mode set to normals





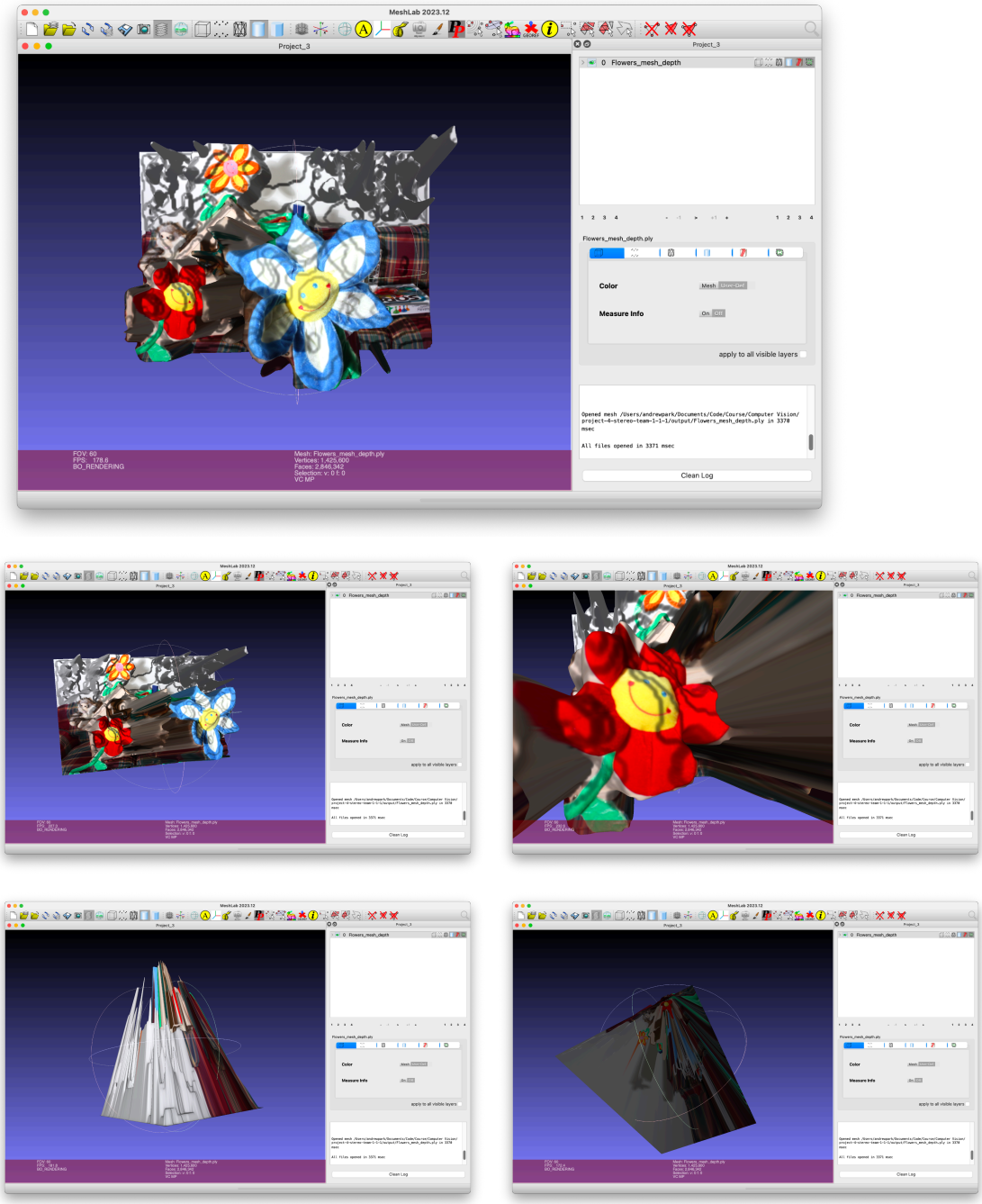






The photometric stereo of the cat looks great without clear mistakes. The right eye of the cat seems a little bit distorted from a specific angle, but from other angles, we think there is no issue. This success may have been due to the cat data having a uniform color, which leads to easier computation for albedo and surface normals.

3. Flowers dataset with mode set to depth



The Flower dataset has clear depth mistakes (looks like a mountain). By using plane sweep stereo, the computation only correctly identified the flowers and the sofa at the lower part of the image, not the rest of the dataset. Upon examining the raw data, we assume this is due to interreflections and subsurface scattering inside the house. With this aspect that hinders the desired result, we also think the color diversity in the image makes it difficult for the depth and NCC algorithms to capture the appropriate depth we want. Additionally, the captured flowers are not accurate either, as the borders contain the background pixels surrounding the flowers.