Computer Vision Default Final Project

Generating 3D Model of Couple Imageset

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A report presented for
CS 117

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Contents

1 Introduction

The objective of this project was to create a detailed 3D model from the provided Couple set of images. This built upon the foundational work completed in Assignment 4. The general process consisted of several steps: camera calibration, grey code decoding, 3D point cloud reconstruction, color addition, improved bounding box pruning, Laplacian smoothing, triangulation and triangle pruning, mesh stitching, and mesh smoothing with Poisson Reconstruction.

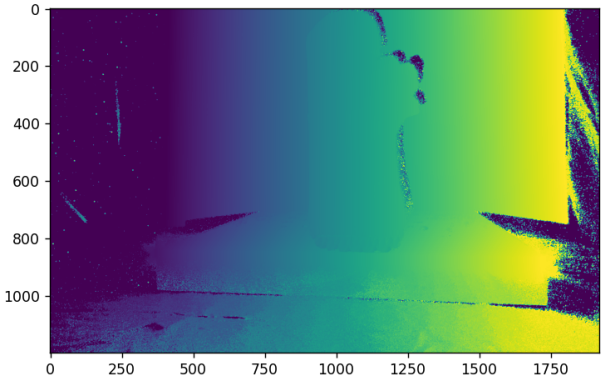
2 Calibration

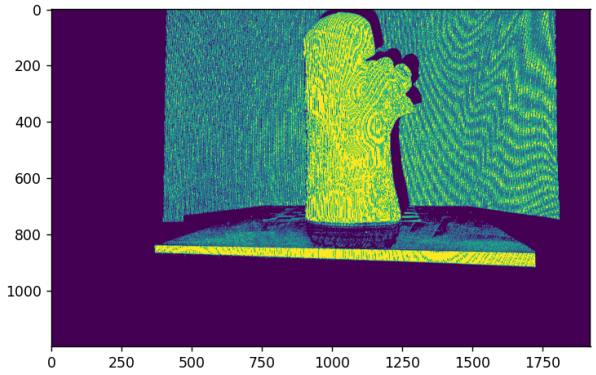
I used the calibration image set and the calibratePose function previously implemented to find the left and right camera intrinsic and extrinsic camera parameters.

```
Camera :
 f=1404.6009661788062
 c=[[962.16736916 590.91595682]]
 R=[[ 0.04237413  0.99207514  0.11828508]
 [ 0.87061203 -0.09474566  0.48276075]
 [ 0.49014194  0.08252385 -0.86772732]]
 t = [[  8.15884704 -18.70825718  59.51710069]]
Camera :
 f=1404.6009661788062
 c=[[962.16736916 590.91595682]]
 R=[[ 0.00217571  0.99082383  0.13514213]
 [ 0.65889089 -0.10307958  0.74514253]
 [ 0.75223538  0.0874227  -0.65306907]]
 t = [[  7.63972935 -28.46393404  51.44184307]]
```

3 Grey Code Decoding

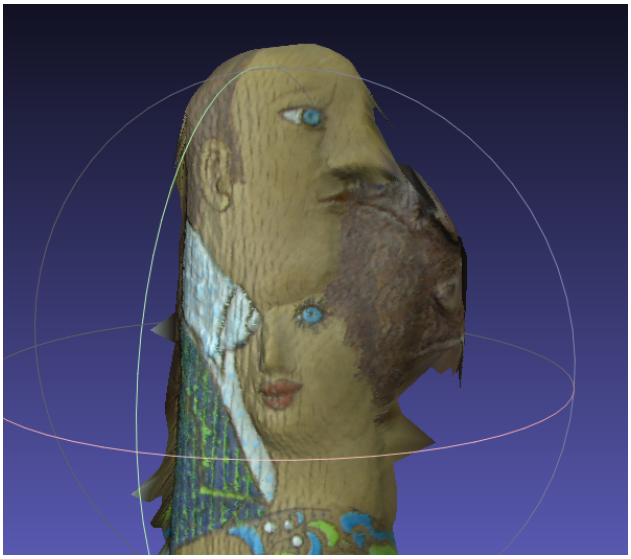
To establish pixel correspondence between the two camera views, it was necessary to decode the projected grey codes. This was done using the decode function implemented in previous projects. I had to perform tuning for the threshold in order to achieve the best result.





4 3D Point Cloud Reconstruction

I modified the reconstruction method that generates a 3D point cloud from corresponding points to include colors from the images. To do this, I simply grabbed the color value of corresponding pixels from each camera and averaged them. Below is an example of a mesh with the colors added.



5 Bounding Box Pruning

Due to the orientation of the model relative to the backdrop, it was difficult to fit a tight box around it. The bounding box would either slice out parts of the model or would include parts of the backdrop in it. To improve this pruning, I utilized the selectpoints.py file from assignment 1 so that the user could assist in re-orienting the model with the axes so that a tighter box could be fit around it.

6 Delaunay Triangulation

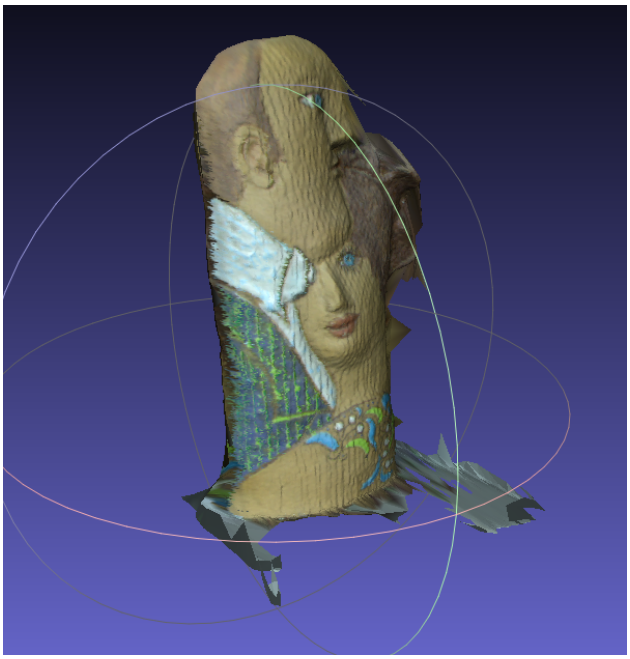
After bounding box pruning, I performed Delaunay Triangulation just as in assignment 4. However, I waited to do triangle pruning until after the Laplacian smoothing was performed.

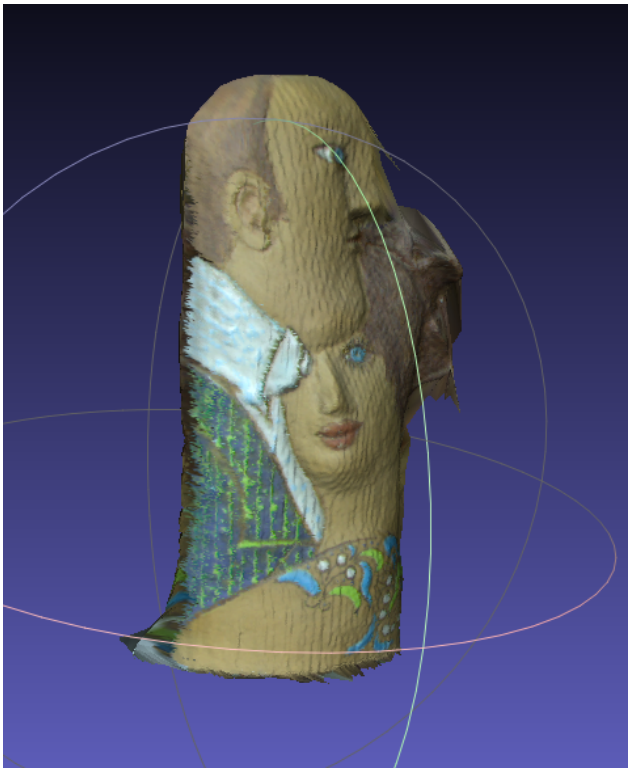
7 Laplacian Smoothing

The next step was to perform Laplacian smoothing on the model. This process began by finding the neighboring vertices for each vertex. Then, I computed the average position of vertex v's neighbors, and adjusted its position by a factor. The result of the smoothing step was a more rounded surface. Here is an example of what the a pre-smoothed mesh looked like for this model.

8 Cleaning and Stitching

For each partial mesh generated, I output a .ply file. Then, I put the .ply files into MeshLab to perform cleaning, such as removing groups that weren't connected to the main model. I then used the Point Based Gluing to align the models correctly. Below is a picture of a mesh before MeshLab cleaning and one after Meshlab cleaning.

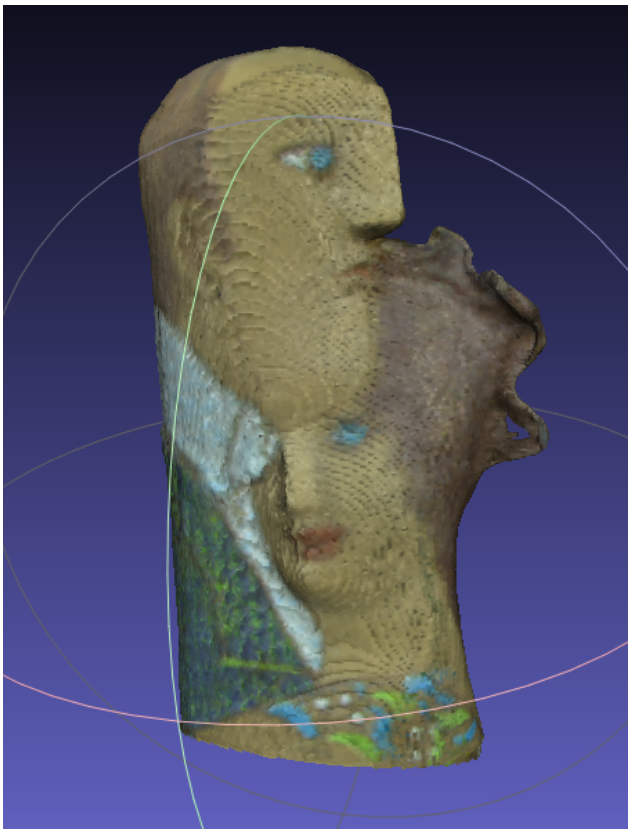




9 Poisson Reconstruction

The last step to achieve a smooth, high quality model was to use Poisson Reconstruction. I passed the stitched .ply file through the Screened Poisson

Surface Reconstruction executeable to achieve the final result.



10 Conclusion

In conclusion, this project allowed me to explore different methods for mesh smoothing, user assisted mesh cleanup, and surface reconstruction. I implemented a tool to assist with bounding box pruning so that a tighter box could be fit around the model, I implemented Laplacian smoothing to remove rough edges on the model, I used MeshLab to assist in cleaning and stitching the model, and finally I passed the stitched model through the Screened Poisson Surface Reconstruction executeable to achieve a smooth final mesh surface.