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CS 117 Final Project Final Report

1. Project Overview and Data Sets used

a. For my final project, I have chosen to do the default project which was to build a pipeline for constructing a high-quality 3D model of an object. For the object, I have chosen to use the mannequin scans that were provided by Professor Charless Fowlkes. There are total of 5 different “grabs” and every image has 1920 x 1200 resolution. I have used every image in all 5 grabs. There are total of 42 images for each side, left and right, in each grab, and the first two images are used for colors and background subtraction. At first, I had no clue where to start, but most of my help came from the Piazza since most of my classmates were doing the default project, and almost every questions and concerns posted on Piazza was my questions and my concerns as well. Professor and TA were very helpful and responsive, and also the classmates were very quick to answer all the questions and concerns as well. Below is the details and algorithms of all the steps I have taken to complete this project:

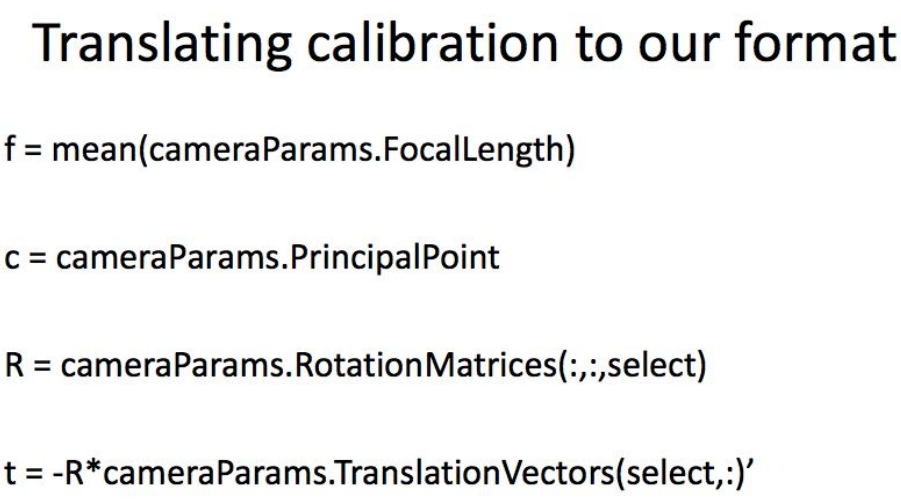
b. Calibration and Data Sets Used

i. For Calibration, I have used the Stereo Camera Calibrator application in Matlab in order to calibrate the checkerboard images. For the checkerboard images, I have used the “calib_jpg” images provided by Professor Charless Fowlkes. First I have separate the “calib_jpg” images into two different folders, left camera and right camera. Then loaded the right camera images onto Camera 1, and left camera images onto

Camera 2. Then set the square size as 27.75 mm, and calibrated. Then I saved the result as “CalibrationSession.mat’ and saved all the parameters from the calibration as “stereoParams.mat”.

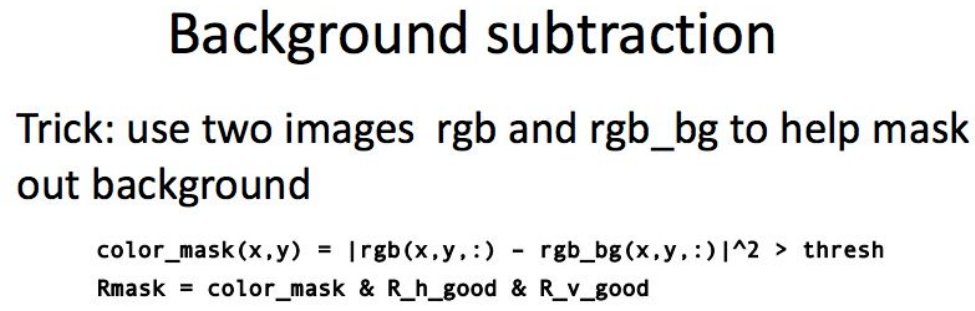
c. Reconstruct.m Algorithms and Results

i. For my reconstruct.m, I have modified the assignment 4 code that was provided by professor Charless Fowlkes. First, I loaded both “CalibrationSession.mat” and “stereoParams.mat” files into my reconstruct.m. Then using the equations provided by professor Charless Fowlkes in lecture 15, I have set the parameters for camR, right camera, and camL, left camera.



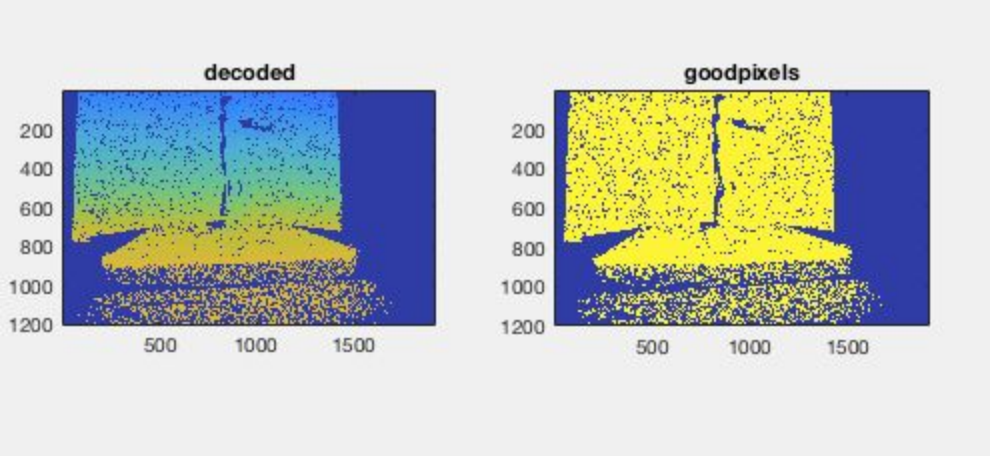
for “select”, I chose to use 1 because on Piazza, professor suggested that we use the image that has the mannequin in the center of the image, and I thought the first image from each grab is appropriate and one of the classmates commented on one of the Piazza posts that he or she used 1 for “select” as well. Then I started a for loop so that every step I take to complete the reconstruct.m would be repeated for every grab of the

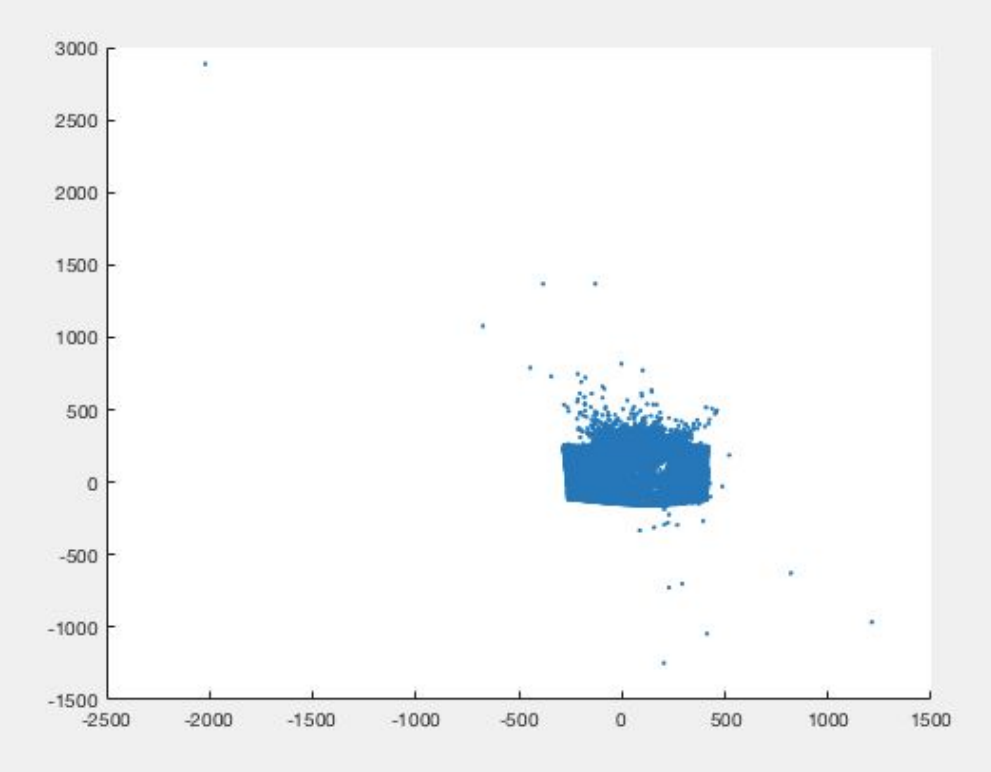
mannequin images from 0 to 4. I figured for loop would be appropriate because on Piazza, professor provided some instructions on how to refine and modify assignment 4 code, and in the instruction, he said to iterate through the different grab directories and store the reconstruction results in an orderly way. I also followed the instructions provided by the professor on Piazza, I imread color images and created color_mask for both left and right camera images using the equation provided in the lecture and then & it in Rmask and Lmask in order to complete background subtraction.



In the instructions, professor Charless Fowlkes also mentioned that for every point I triangulate, I would need to store an RGB value which is the an average of the values in the left and right color images. So I imreaded the left and right color images, then separated the RGB channels, Then I combined the left and right RGB channels, and saved the average into xColor. For the results of reconstruct.m, I saved all the data from each grab directories of mannequin images. Below are one of the resulting images from reconstruct.m. the pixel coordinates look like it pixel coordinated the whole object in the image and does not look like reconstruct.m code did a correct job, but once I run the mesh.m on those

data, mesh.m returns a mannequin mesh.





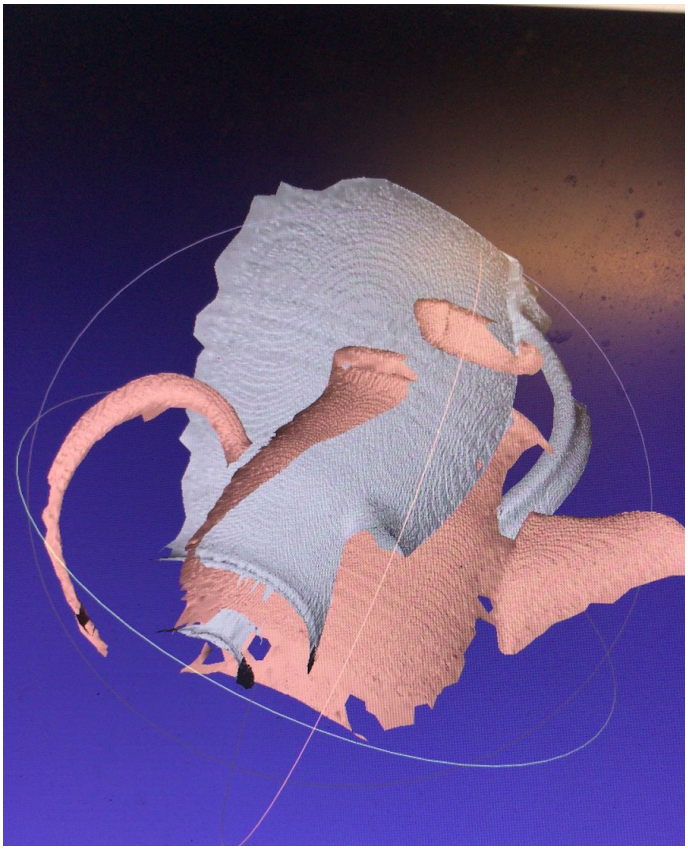
d. Mesh.m Algorithms and Results

i. For my mesh.m, I have modified the assignment 4 code that was provided by professor Charless Fowlkes. First, I loaded the result from reconstruct.m, then I remove bad triangles and vertices, smooth the

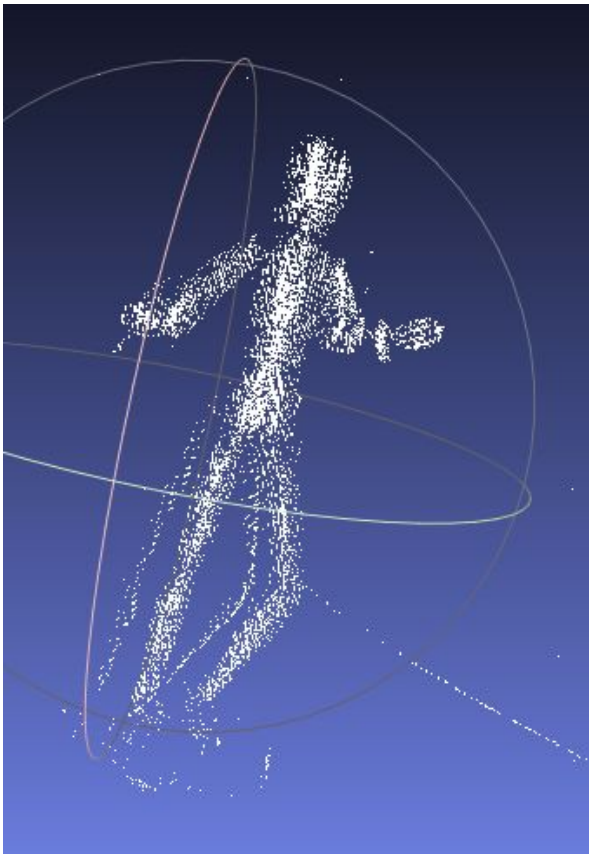
mesh, and then saved the data into mat file and converted the data into .ply file. First, I decided to remove triangles that are far away by using nbr_error function provided by professor Charless Fowlkes in the assignment 4 code. Next, I removed the triangles that have long edges by using tri_error function which is also provided by professor in the assignment 4 code. Then, I completed mesh smoothing by using nbr_smooth function which is also provided by professor in the assignment 4 code. Finally after smoothing, I saved the results into mat file, and then converted the data into .ply file by using mesh_2_ply function provided by the professor in the assignment 4 code as well. Below are the resulting meshes from grab_0 to grab_4 of mannequin image directories in which you can clearly see the mannequin.

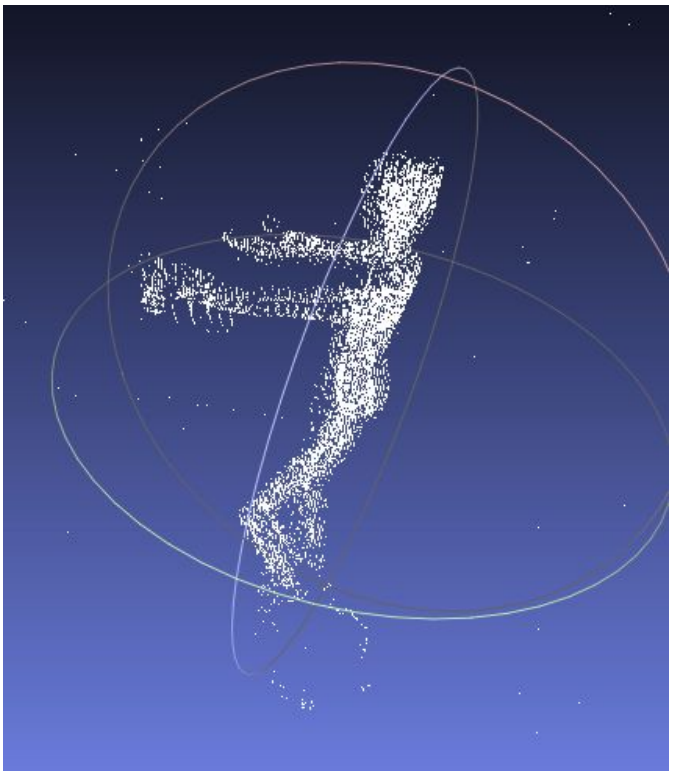
e. Mesh Alignment results using Meshlab

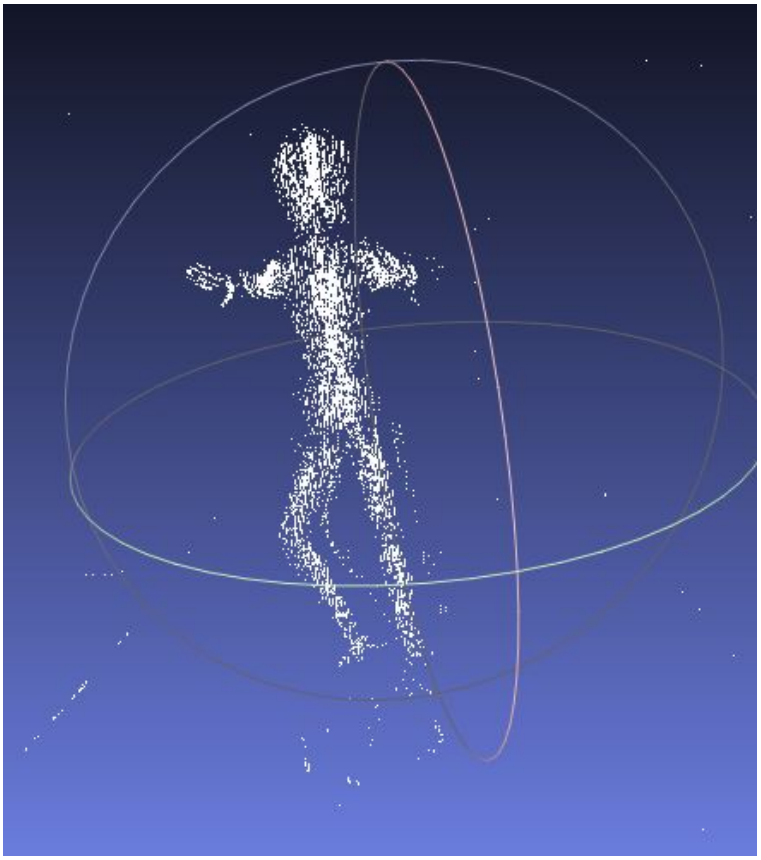
i. Mesh Alignment using Meshlab supposedly combines all the meshes associated with different scans into single coordinate system. So I attempted to complete Mesh Alignment using Meshlab point based glueing tool by looking at all the Piazza posts related to Mesh Alignment and also watching some tutorial videos on Youtubes. It might be because I was using a Macbook to do this project, or I was just not very successful at point glueing all the meshes resulted from mesh.m together into a one mesh, but I was not able to get a really good mesh with it. When I first downloaded the Meshlab and tried to use point glueing tool, two meshes were combined together like this (borrowed this image from one of the Piazza posts that someone posted):



instead of giving me the two separate meshes side by side for point glueing. But on Piazza, someone posted a link to a website where I can download a different version of Meshlab for Mac, and using that specific version, I was able to see two meshes displayed separately for point glueing. But clicking on points for mesh alignment was very difficult as it did not allow me to pick a point by double clicking on the image once, but countless times. I am not sure why this was happening but I am assuming that it is because Meshlab is not very compatible on Macbooks. Below are the results of my attempted mesh alignment using Meshlab:







After combining all 5 meshes resulted from mesh.m, I was able to see the mannequin all around at different angles, whereas before I combined all the meshes together, I was only able to see all different sides of the mannequin on each of the meshes. For example, I was able to see the front side in mesh 1, back side in mesh 2, left side on mesh 3, etc. Even though I did a poor job at mesh alignment, I tried to save the result, but Meshlab would not let me export glued mesh, so I just took a screenshot of the result.

2. Assessment and Evaluation

a. Overall, I think I have completed most of the steps that I needed to do in order to complete the project. The most hard part was starting the project since I had no idea where to start, but Piazza was very helpful because of responsive professor,

TA, and classmates. I would say modifying reconstruct.m and mesh.m codes were pretty successful as I was able to get nice meshes from each grab directories. Although I think I could have done a better job at mesh cleanup by removing more bad triangles and vertices by using bounding box pruning method. But when I attempted to do so, I ended up removing too many points in the mesh and ended up with almost no points in the mesh at all. So I had to get rid of bounding box pruning step in my mesh.m. Also for mesh.m, I did not use for loop and just ran the data resulted from reconstruct.m one by one because running mesh on one data set took like an hour to finish, so I decided to run them one by one. However, I ran into some problems/issues when I tried to complete Mesh Alignment. Meshlab is a software I have never used before and it was foreign to me, so I had to look up tutorials and read every post on Piazza about mesh alignment and Meshlab, but they were not very helpful since Meshlab did not work as it did in tutorials. However, I still tried my best to align the 5 meshes I have gotten from reconstruct.m and mesh.m codes. Although I was not able to successfully save the combined mesh, however, I took some screenshots in order to provide the result. Also I am aware that after Mesh Alignment comes Poisson Surface Reconstruction and adding colors to the final mesh. Unfortunately I did not have enough time to complete the rest because I spent too much time trying to figure out how to do Mesh Alignment properly on Meshlab, and when I finally combined the mesh, it would not let me save the combined result. So I was not able to complete Poisson Surface Reconstruction and adding colors to the final mesh. But I was planning on completing Poisson

Surface Reconstruction using Meshlab and then add colors either by transferring colors from individual scans or by texture mapping from the original images.

3. Appendix: Software

a. Codes modified

   i. Reconstruct.m

   ii. Mesh.m

b. Codes borrowed from professor's

   i. Tri_error.m

   ii. Nbr_error.m

   iii. Nbr_smooth.m

   iv. decode.m