CS543/ECE549 Assignment 3

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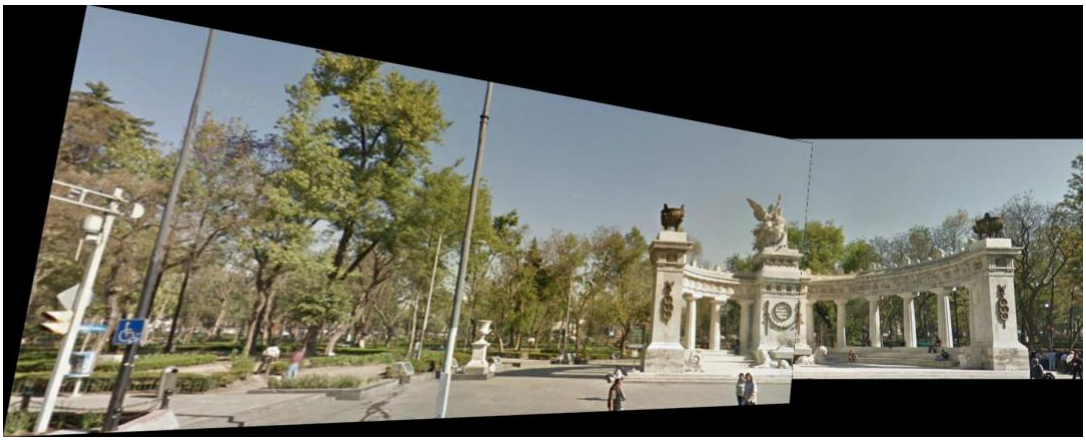
Part 1: Homography estimation

A: Describe your solution, including any interesting parameters or implementation choices for feature extraction, putative matching, RANSAC, etc.

After tried several parameters, I found that when RANSAC's threshold is 0.8 and iteration is 1000. The two images will be best stitched. And best model matrix is
[[2.06391722e+00 -2.09658676e-01 -9.99051640e+02]
[3.62402189e-01 1.94787740e+00 -2.73433548e+02]
[1.05121391e-03 -1.91828569e-05 1.00000000e+00]].

Threshold: 0.7

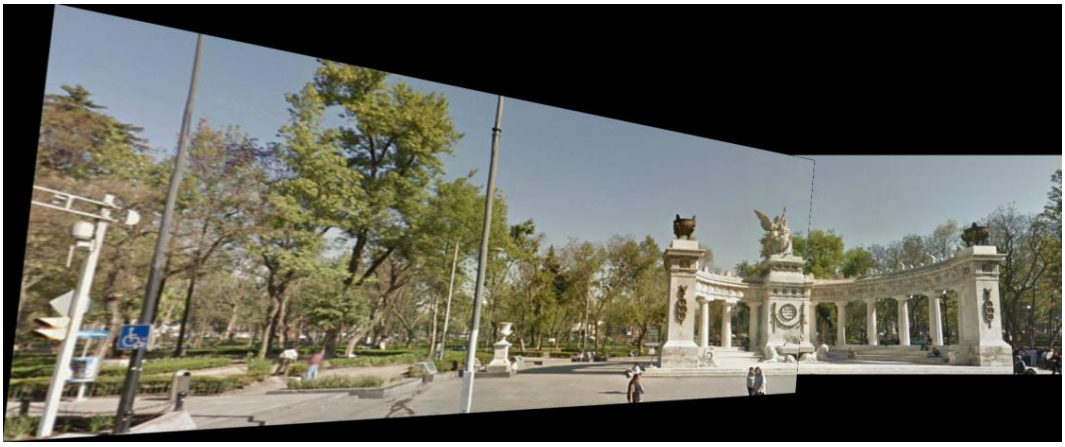
Threshold: 0.8



Threshold: 0.82

Threshold: 0.83

Threshold: 0.84



Threshold: 0.85

Threshold: 0.9

B: For the image pair provided, report the number of homography inliers and the average residual for the inliers. Also, display the locations of inlier matches in both images.

Homography inliers: 114
Average residual: 7348.915023686889

Fig 01. locations of inlier matches in both images

C: Display the final result of your stitching.

Fig 02. The final result

Part 2: Shape from shading

A: Estimate the albedo and surface normals

1) Insert the albedo image of your test image here:
   Albedo image of yaleB01:

Albedo image of yaleB02:

Albedo image of yaleB05:

Albedo image of yaleB07:

2) What implementation choices did you make? How did it affect the quality and speed of your solution?

After tried all the 4 integration method, I choose to use random method to get the high map. Since the row and column method only includes the information in the first row or column, random method randomly includes the information of each row and column. There is no artifact on the mouse nor nose, average of multiple random paths method produces the best result. For run time, the column method is the fastest method, the execution time of average and row are same, the random method is the slowest one, because the other three method do not require a for loop to going through each path and pixel, but random method require a 3 nested loops to going through each path and pixel.

3) What are some artifacts and/or limitations of your implementation, and what are possible reasons for them?

For row and column method, there are some zig-zags on the person's face part. The output of the average method is much better than the previous two method. However, due to the artifacts caused by the row method, it also reduced the quality of the output of

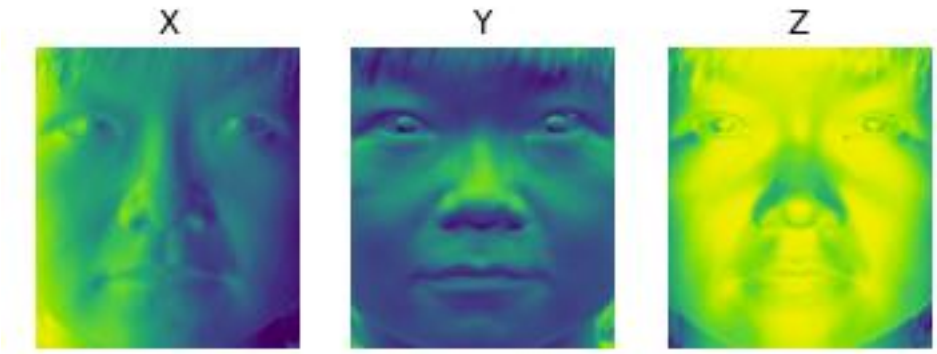
average method. The random method provides the best result, and there is no artifact on the person's nose nor mouse.

4) Display the surface normal estimation images below:
Surface normal estimation images of yaleb01:

Surface normal estimation images of yaleb02:

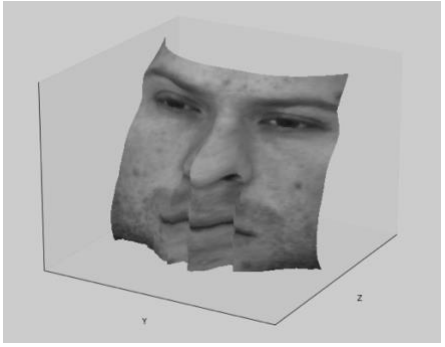
Surface normal estimation images of yaleb05:

Surface normal estimation images of yaleb07:

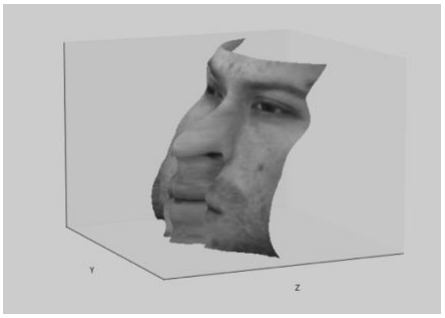


B: Compute Height Map

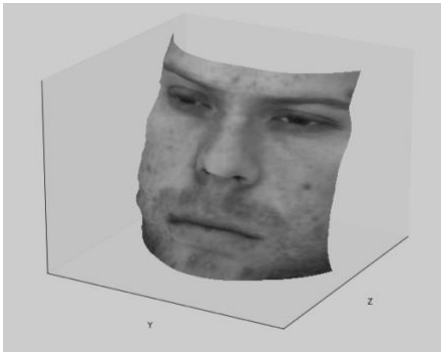
5) For every subject, display the surface height map by integration. Select one subject, list height map images computed using different integration method and from different views; for other subjects, only from different views, using the method that you think performs best. When inserting results images into your report, you should resize/compress them appropriately to keep the file size manageable -- but make sure that the correctness and quality of your output can be clearly and easily judged.
yaleB01:
First the rows, then column
Viewpoint 1:



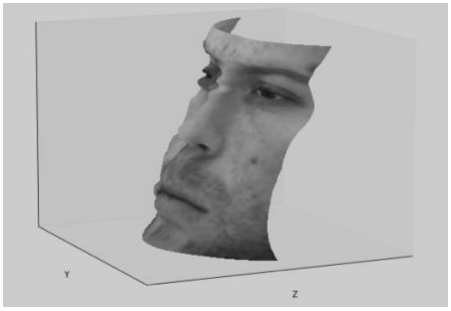
Viewpoint 2:



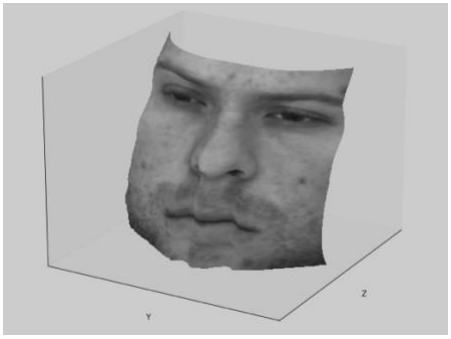
First the column, then row
Viewpoint 1:



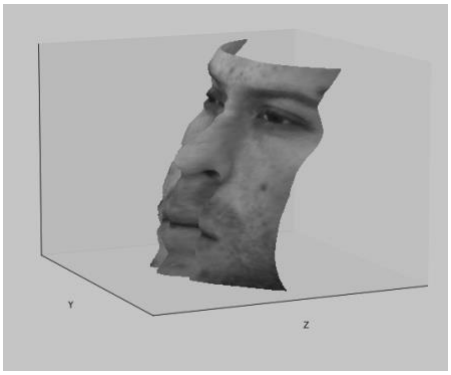
Viewpoint 2:



Average of the first two options
Viewpoint 1:

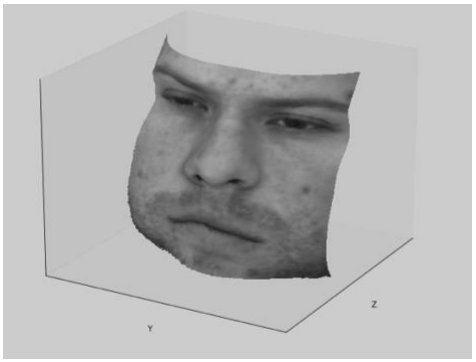


Viewpoint 2:

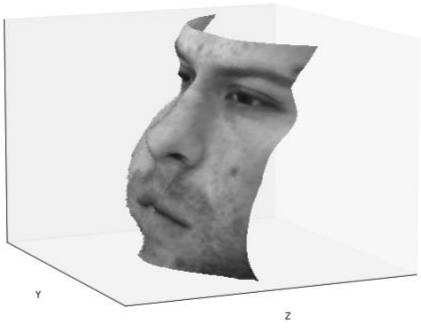


Average of multiple random paths

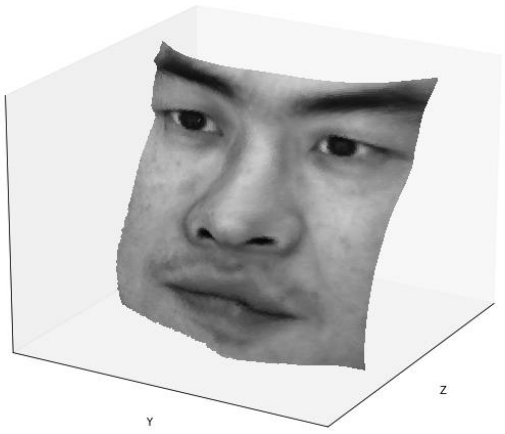
Viewpoint 1:



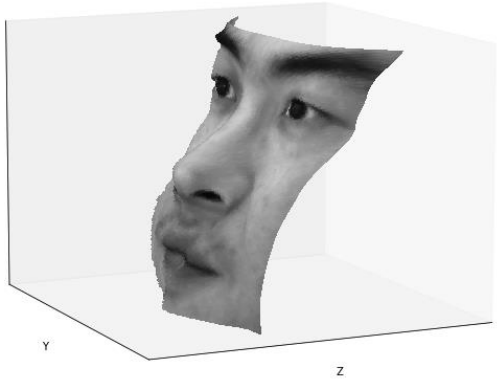
Viewpoint 2:



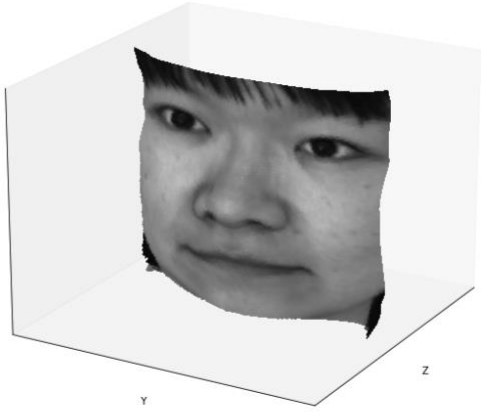
yaleb02
Best solution: Average of multiple random paths
Viewpoint 1:



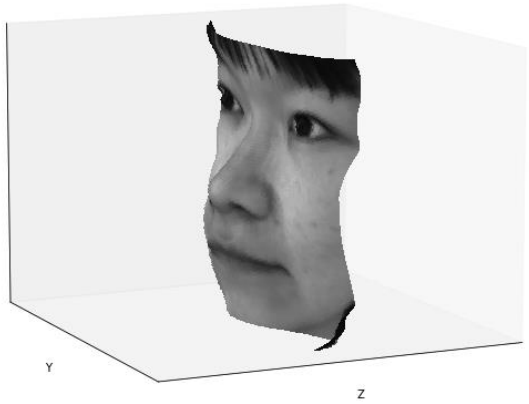
Viewpoint 2:



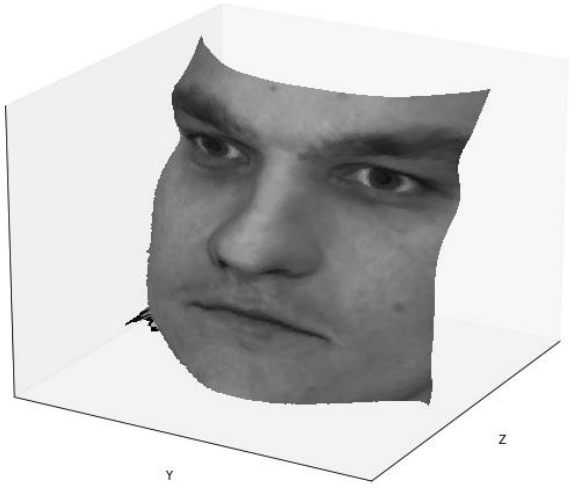
yaleB05
Best solution: Average of multiple random paths
Viewpoint 1:



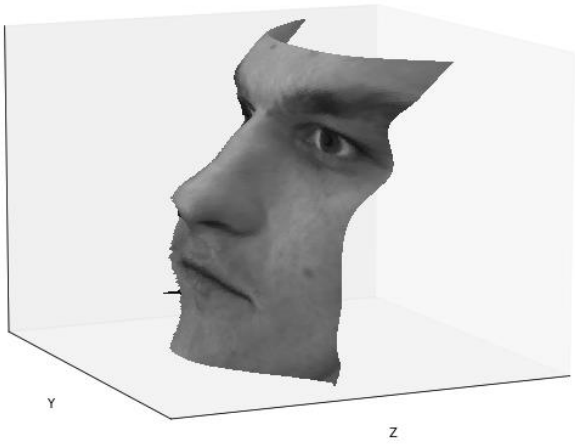
Viewpoint 2:



yaleB07
Best solution: Average of multiple random paths
Viewpoint 1:



Viewpoint 2:



6) Which integration method produces the best result and why?

Average of multiple random paths method produces the best result. Since the row and column method only includes the information in the first row or column, random method randomly includes the information of each row and column. There is no artifact on the mouse nor nose, Average of multiple random paths method produces the best result.

7) Compare the average execution time (only on your selected subject, “average” here means you should repeat the execution for several times to reduce random error) with each integration method, and analyze the cause of what you’ve observed:

Integration method	Execution time
random	71.59517788887024 s
average	0.0004029273986816406 s
row	0.00041294097900390625 s
column	0.00021696090698242188 s

According to the execution time table above, the column method is the fastest method, the execution time of average and row are same, the random method is the slowest one, because the other three method do not require a for loop to going through each path and pixel, but random method require a 3 nested loops to going through each path and pixel.

C: Violation of the assumptions

8) Discuss how the Yale Face data violate the assumptions of the shape-from-shading method covered in the slides.

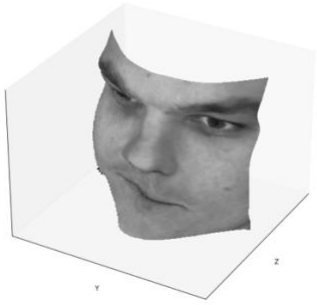
The Yale Face data violate the assumptions of the shape-from-shading method because it is not a perfect Lambertian object, and the images not obtained in the same object configuration. Since some images contains too many shadows, some models are not the perfect local shading model.

9) Choose one subject and attempt to select a subset of all viewpoints that better match the assumptions of the method. Show your results for that subset.

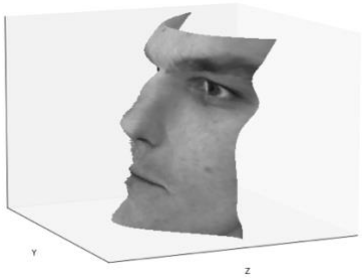
yaleB05 is not a perfect Lambertian object because the images contain many specular reflections. Sometimes the person's facial expression will change, make it cannot be perfectly aligning the images of the same subjects, which violates the picture of the object should be obtained in the same object configuration. And some images contain too many shadows, which cannot provide much useful information and may also bring more errors.

For yaleB02:

Viewpoint 1:



Viewpoint 2:



10) Discuss whether you were able to get any improvement over a reconstruction computed from all the viewpoints.

We can improve the output by that excludes the input images which contain too many shadows.

Part 3: Extra Credit

Post any extra credit for parts 1 or 2 here.Don’t forget to include references, an explanation, and outputs to receive credit. Refer to the assignment for suggested outputs.