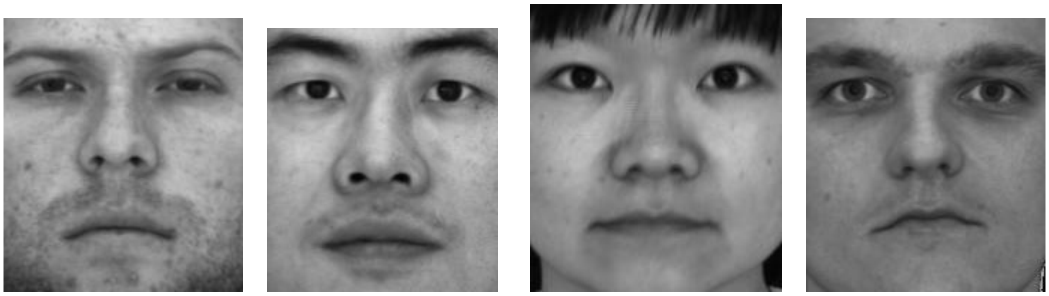
Name : Shidi Zhao

<u>Part-1 : Estimate the albedo and surface normals</u>

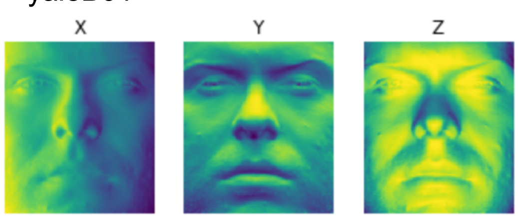
1) Insert the albedo image of your test image here:



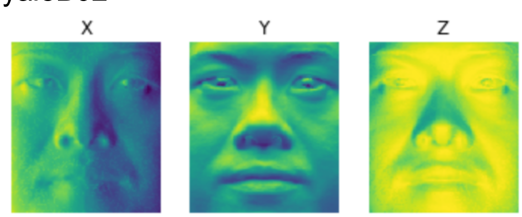
2) What implementation choices did you make? How did it affect the quality and speed of your solution?
   I used the numpy.linalg.lstsq function and np.reshape function to avoid loop. Reshape is useful because in this case we need to maintain the order of the number when calculate the linear fitting, reshape can guarantee it.
3) What are some artifacts and/or limitations of your implementation, and what are possible reasons for them?
   There are some skewed patterns, if the 3D lips are more wave-shaped. And around the nose there are some shadows, which is artifacts.

4) Display the surface normal estimation images below

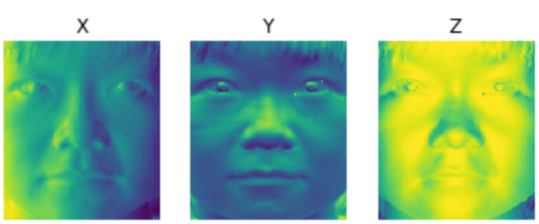
yaleB01



yaleB02



yaleB05



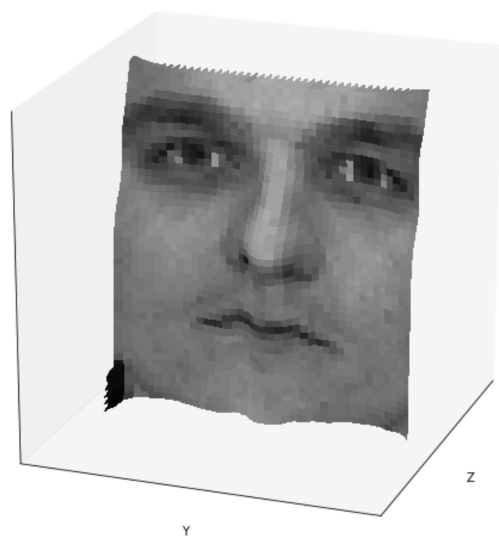
yaleB07

<u>Part-2 : Compute Height Map</u>

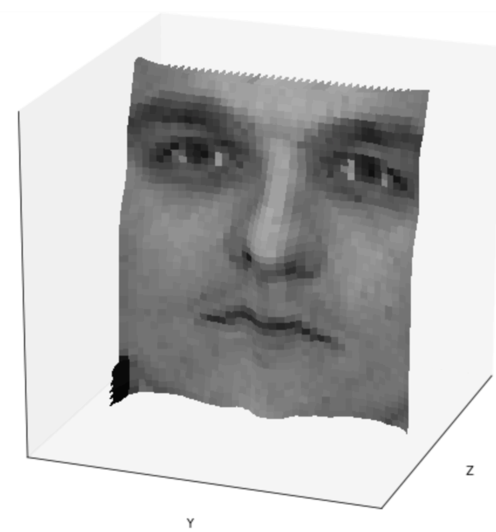
5) For every subject, display the surface height map by integration and display. Select one subject, list height map images computed using different integration method and from different views; for other subjects, only from different views,

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.

1) row:



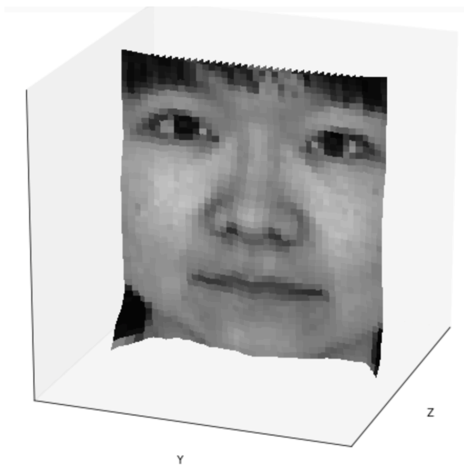
2) column:



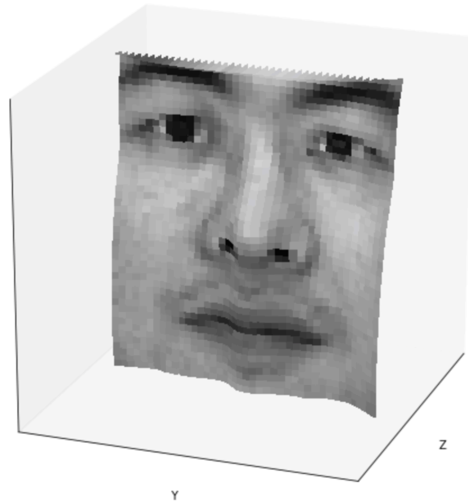
3)average:

4)random:

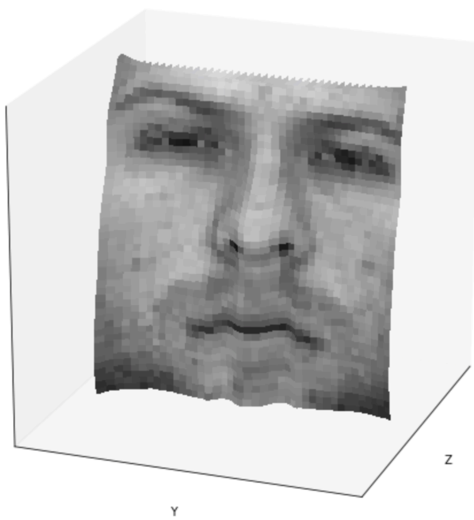
random:



random:



random:



6) Which integration method produces the best result and why?
   The random method produces the best result. Because it averages on a lot of different paths, and get rid of the effect of some inaccurate path.
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	1.9 s
average	1.48 s

row	1.25 s
column	1.25 s

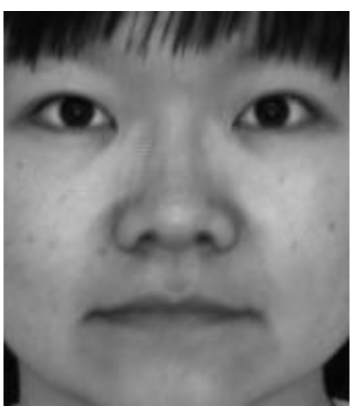
Part-3 : Violation of the assumptions

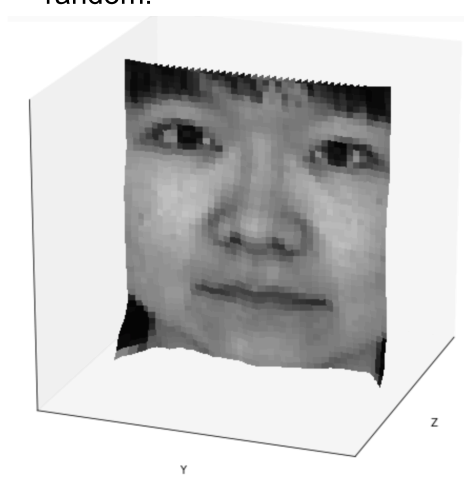
8) Discuss how the Yale Face data violate the assumptions of the shape-from-shading method covered in the slides.

   It violates our assumptions, our assumptions is based on Lambertian. the apparent brightness of a Lambertian surface to an observer is the same regardless of the observer's angle of view. in that skin is not Lambertian. There is specular reflection, inter-reflection, and because for each person, their skin is different, it exhibits significant subsurface scattering. Also the light source is not from a 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.

random:





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

   I read a method from paper from Daniel Hauagge (2013) Photometric Ambient Occlusion. Like the figure shown below, they separate geometry and reflectance. Each measure of the radiance of x captured by the camera corresponds to a different (unknown) position for the light I_d. Given these assumptions, $\kappa(x)$ only depends on the local visibility angle $\alpha(x)$. To begin, each image I is the sum of the contributions from both light sources I_d and I_α，then express albedo as a function of the expected pixel value.