# Photometric Stereo

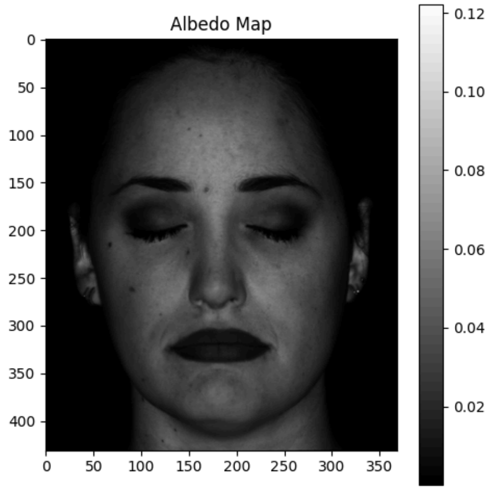
**Initials**

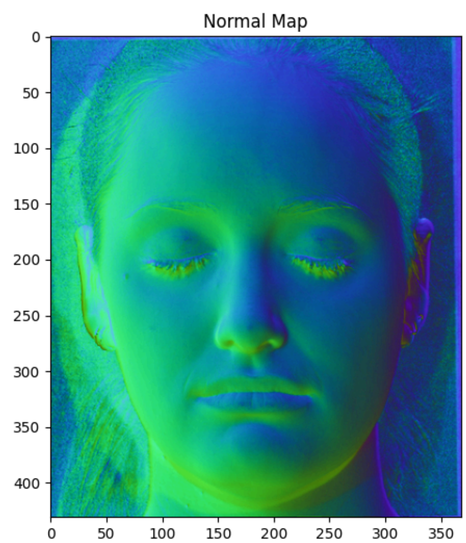
This part was trivial and where I clipped negative Light values from each RAW image.

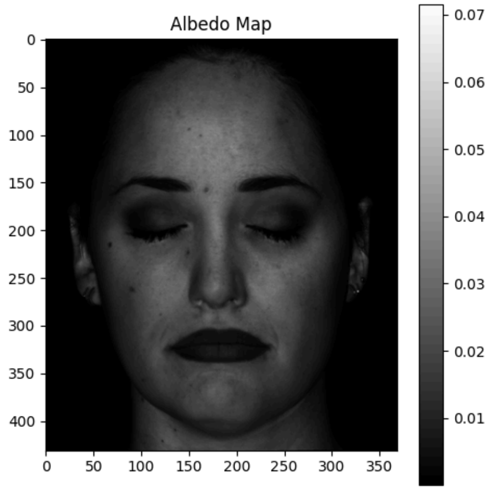
**Uncalibrated Photometric Stereo**

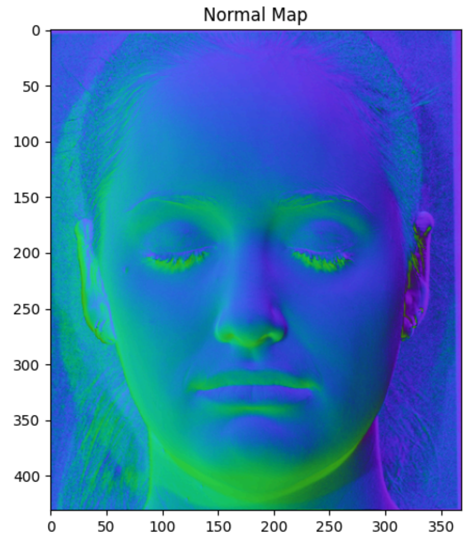
Using the matrix from Initials I used SVD to recover Le and Be. Albedoes were extracted by figuring out the norms, which then B/A gives you the per pixel normals.

Displayed below is the untouched A,N reshaped images and then one manipulated with a matrix Q = [[2, 0, 1], [1, 3, 1], [0, 1, 2]].



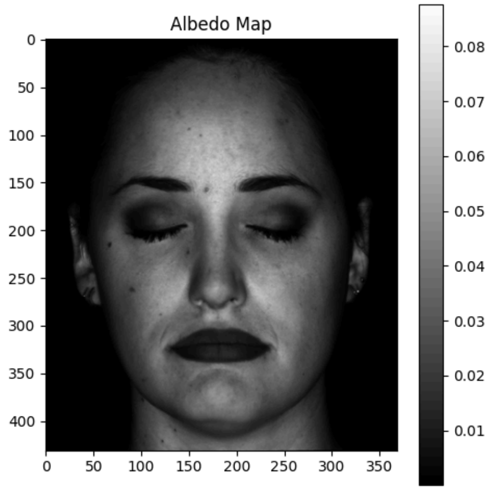



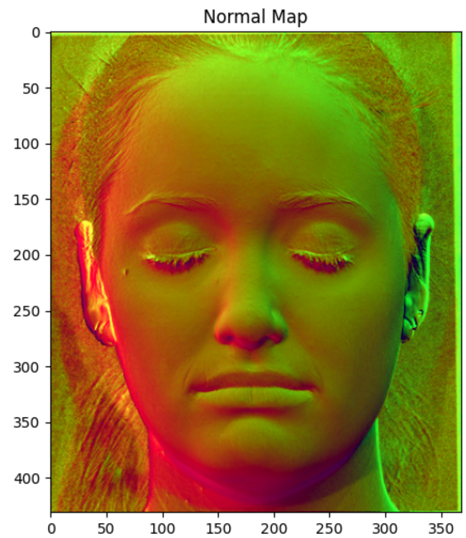


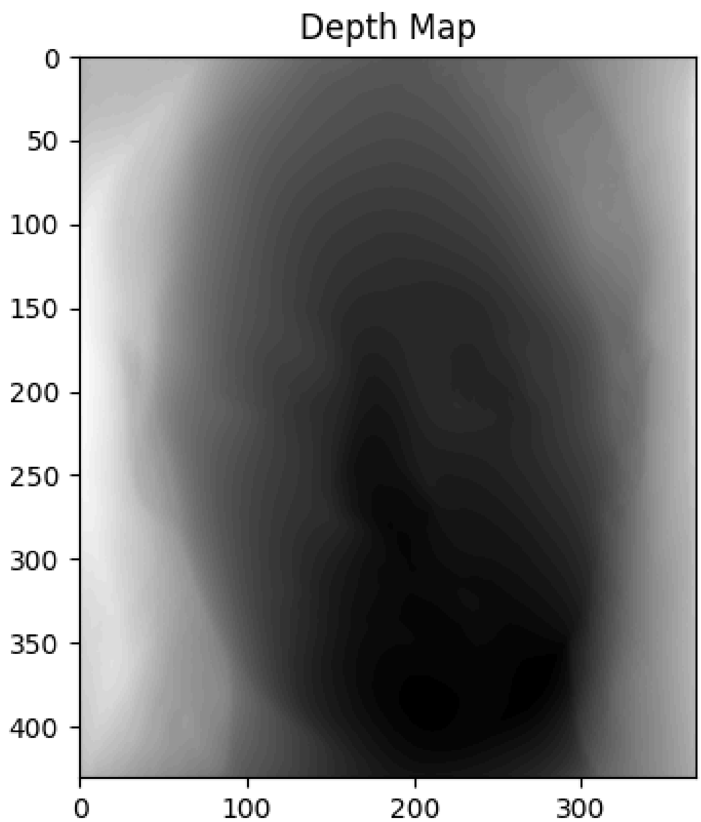



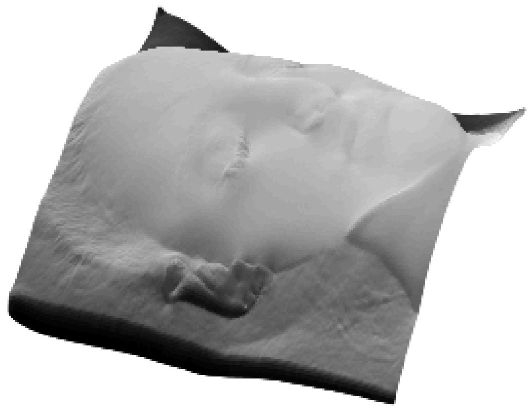

**Enforcing Integrability**

By using np.gradient and SVD once again i was able to solve Ax=0 for a non trivial solution. I ran into issues during this section with creating the depth map since it was not giving me the depth that was shown during the writeup. This also persisted during calibrated stereo. The following images were calculated using a sigma of 2.


Albedo Map
0
50
100
150
200
250
300
350
400
0
50
100
150
200
250
300
350
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01

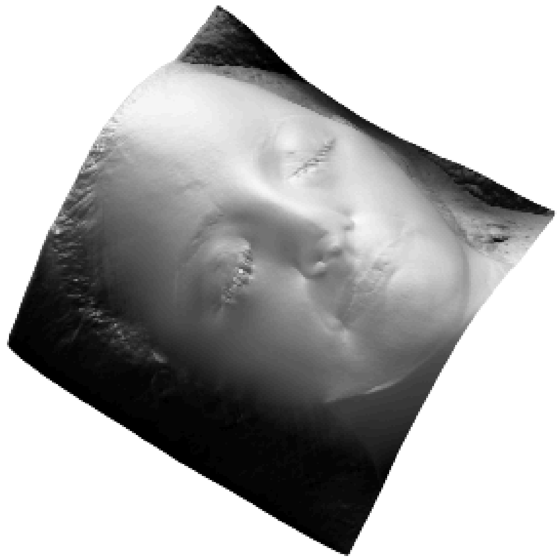

Normal Map
0
50
100
150
200
250
300
350
400
0
50
100
150
200
250
300
350

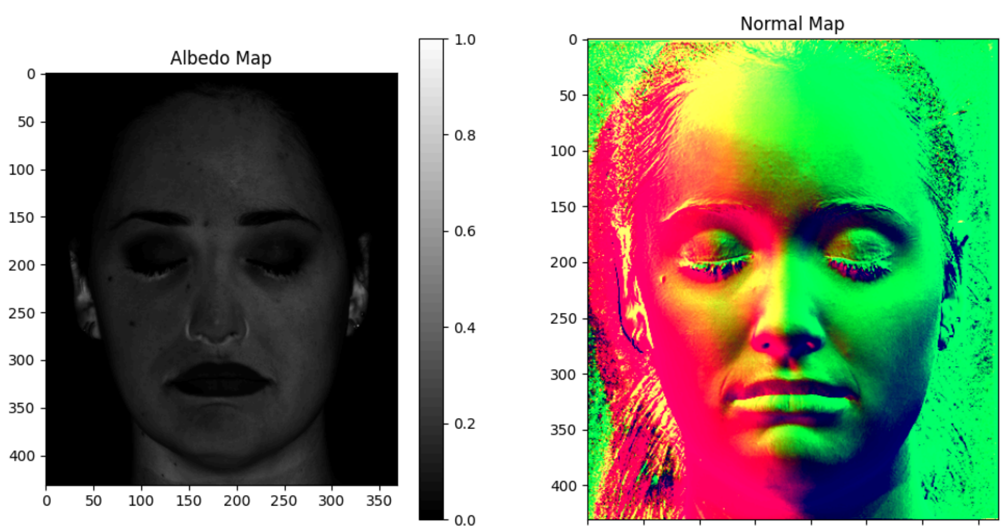

Depth Map
0
50
100
150
200
250
300
350
400
0
100
200
300



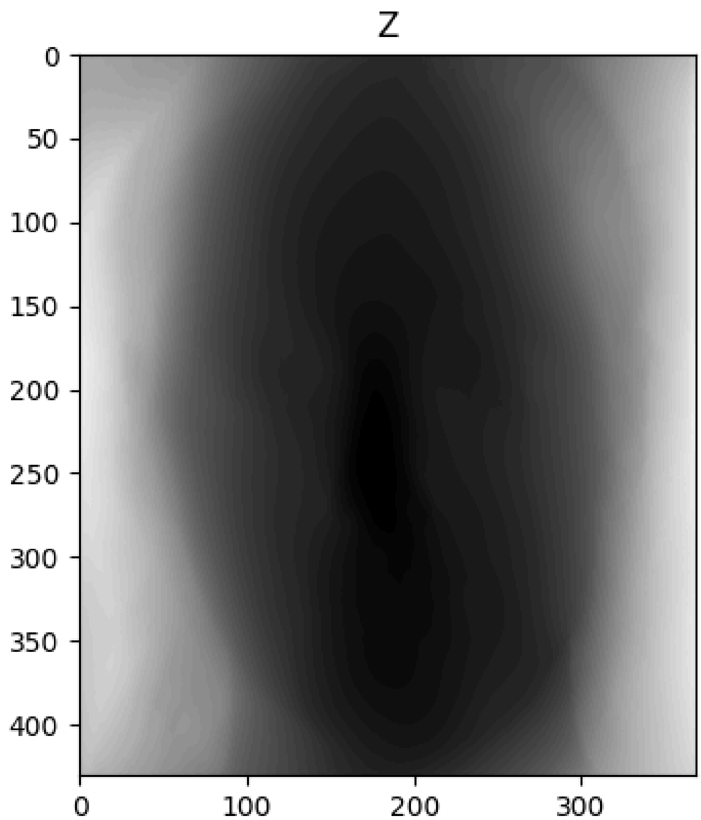
**Normal Integration**
The above two images show the result of the reconstructed depth image and 3D surface.
I ended up keeping the format of bas-relief sculptures since high values of u or v were causing instabilities in the depth map.

**Calibrated Photometric Stereo**
Knowing the light sources simplifies the process in reconstructing much of the matrices that we solved for in the uncalibrated stereo. The calibrated case seems similar but there are more details especially when looking at areas near the nose.



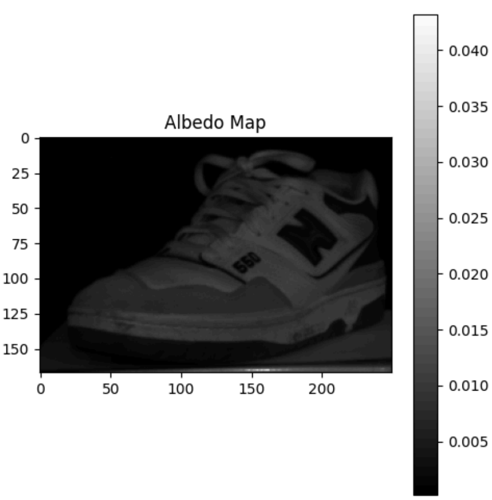


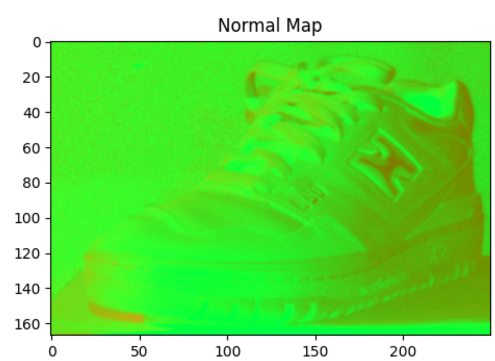
Albedo Map
Normal Map

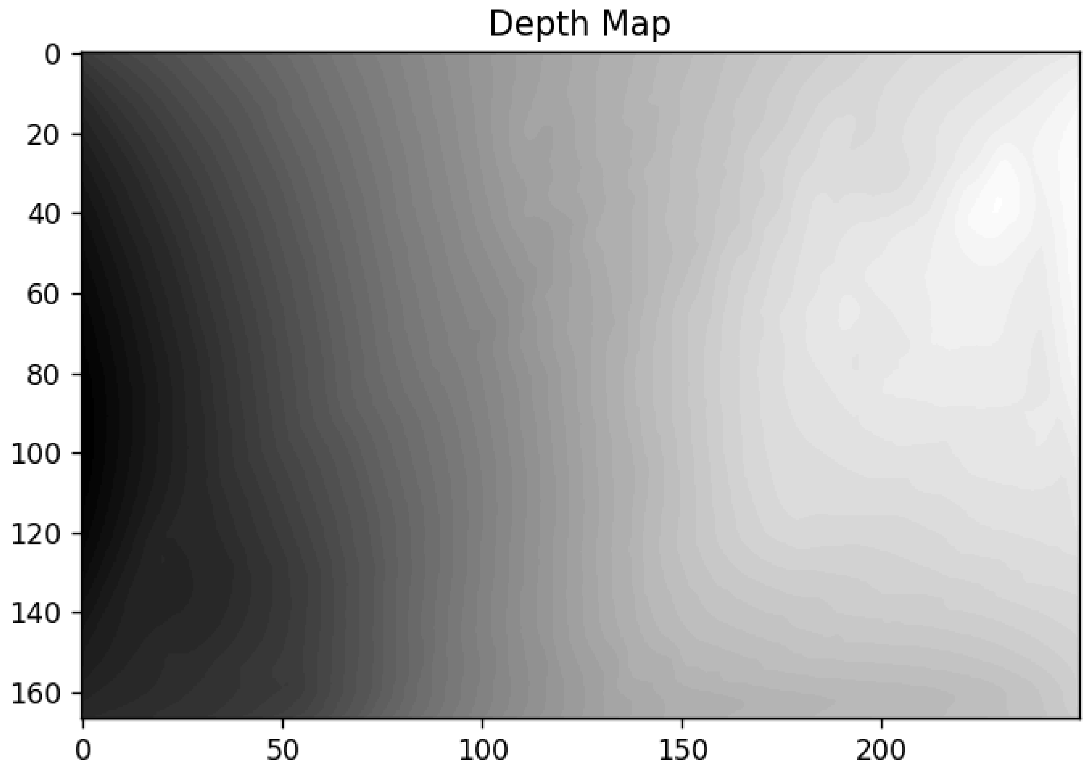

Z
0
50
100
150
200
250
300
350
400
0
100
200
300

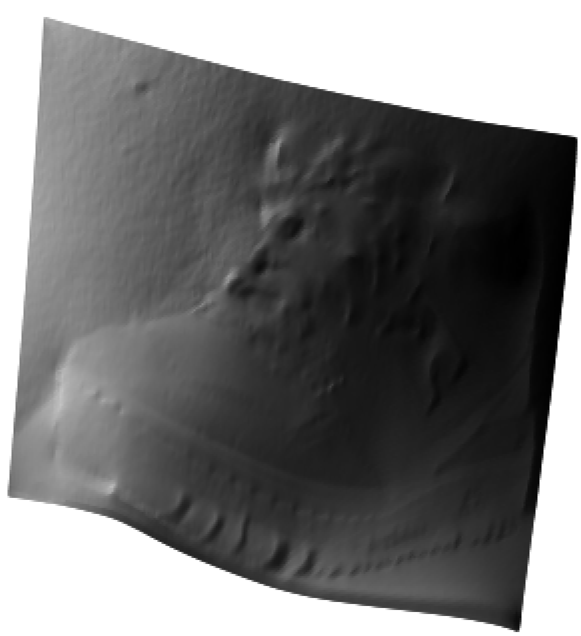
# Capture and reconstruct your own shapes

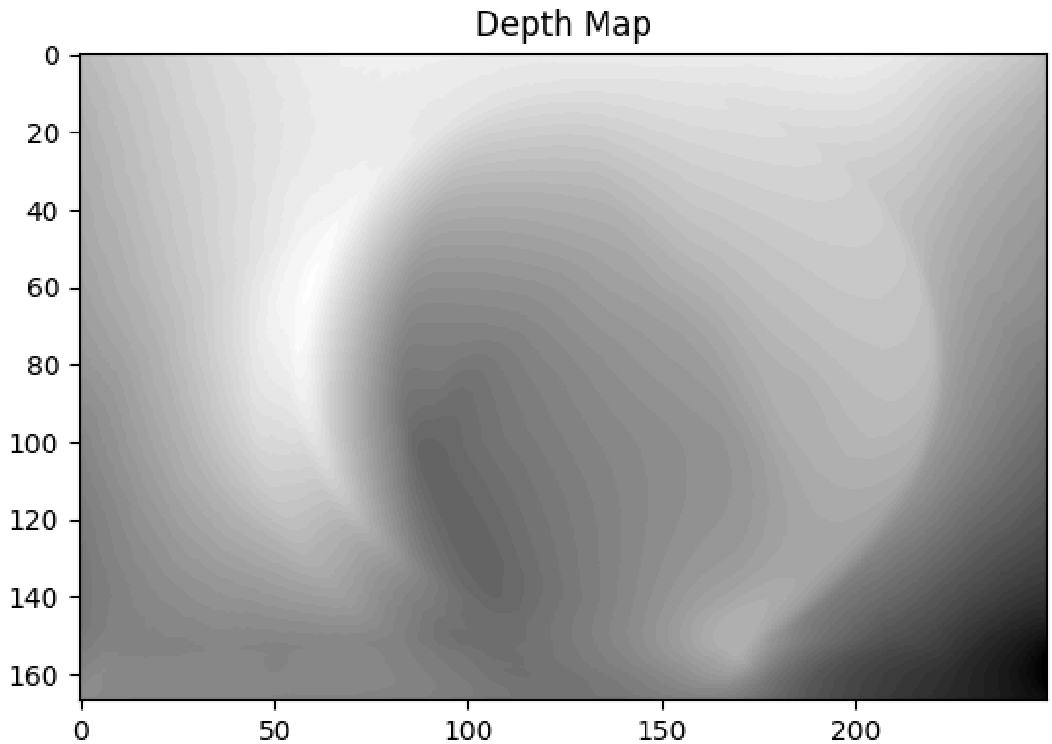
I’ve decided to take a picture of one of my shoes, since it satifies the photometric assumption. The second object I chose was a bowl that I had. I chose the bowl since it was a concave shape. I used a black matte paper behind the object to reduce glare while also cropping the image in python. I believe the concavity of the bowl messes with the light which is why it creates weird issues with the 3d depth map.

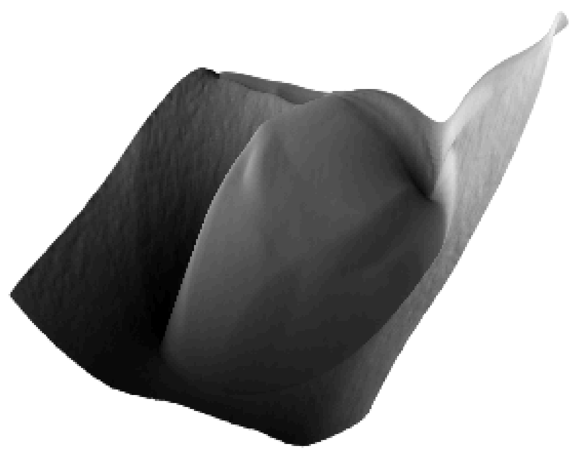


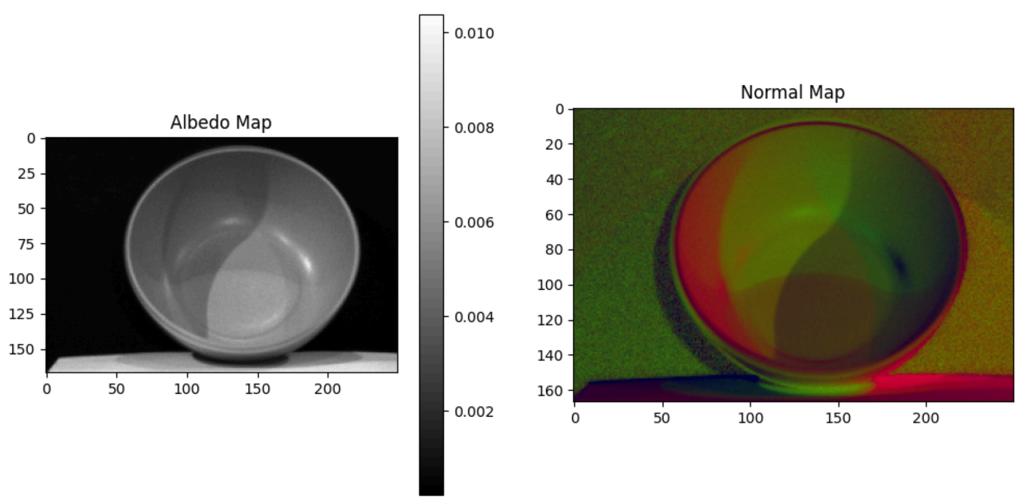




Depth Map
0
20
40
60
80
100
120
140
160
0
50
100
150
200




Depth Map
0
20
40
60
80
100
120
140
160
0
50
100
150
200





Albedo Map
0
25
50
75
100
125
150
0
50
100
150
200
0.010
0.008
0.006
0.004
0.002
Normal Map
0
20
40
60
80
100
120
140
160
0
50
100
150
200