

# Assignment 5

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Please look at the code submitted along-side. There are numerous comments describing what we are doing and answering/elaborating on some answers as well as having the necessary visualizations. Some of the surface-figures/depth maps have often been flipped to make viewing as images easier, and more informative.

1. Part 1 : Photometric Stereo (100 points)

- (a) Initials : In code
- (b) Uncalibrated Photometric Stereop :

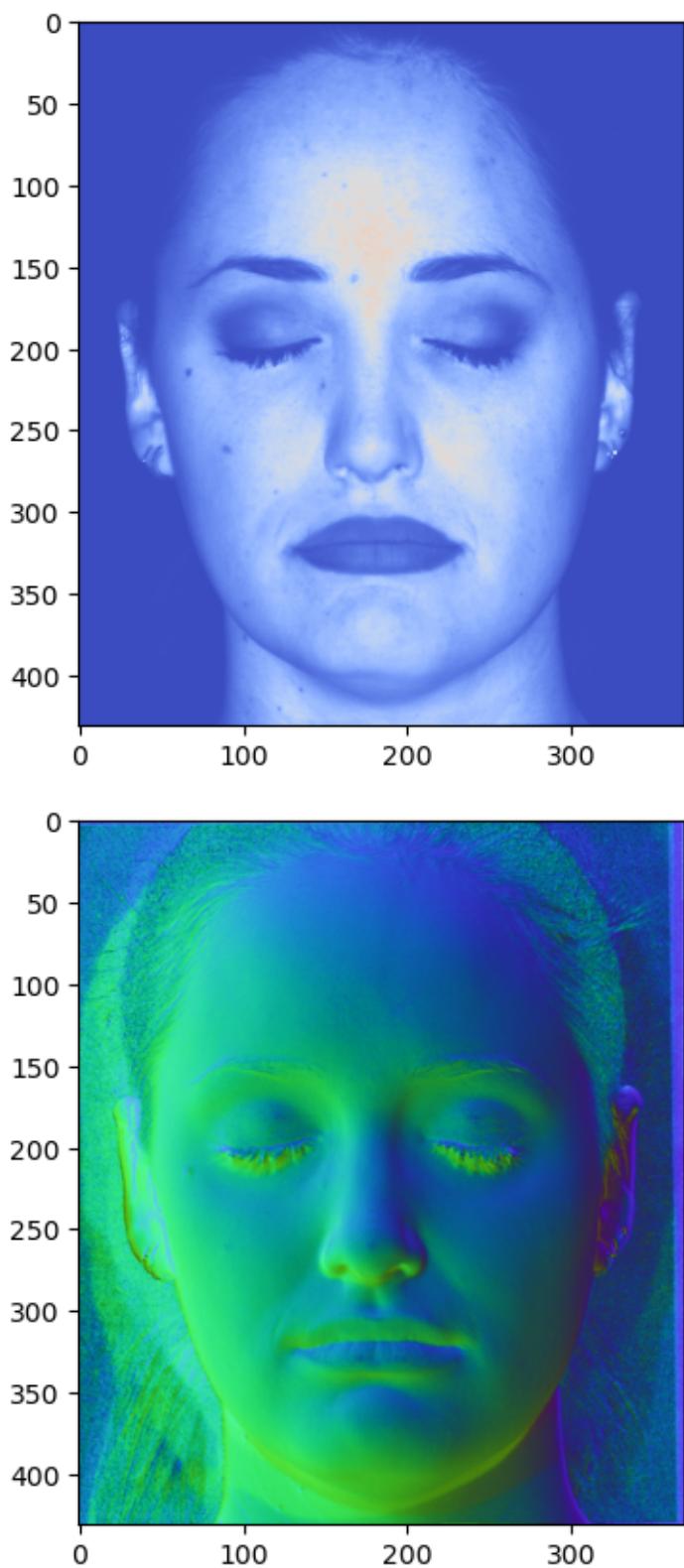


Figure 1: albedos and normals

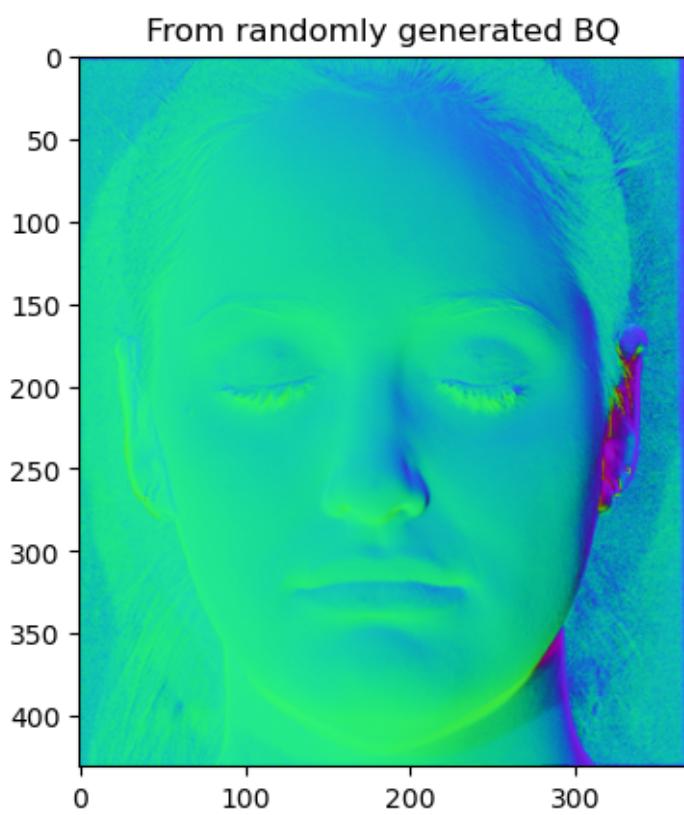
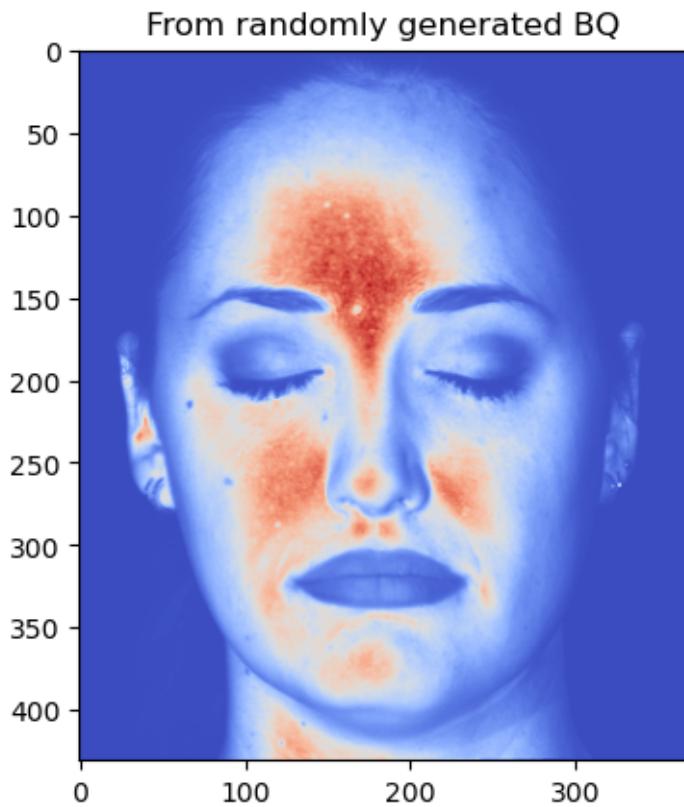


Figure 2: albedos and normals for a randomly generated invertible matrix

(c) Enforcing Integratability : Visualize albedos and normals after enforcing integratability

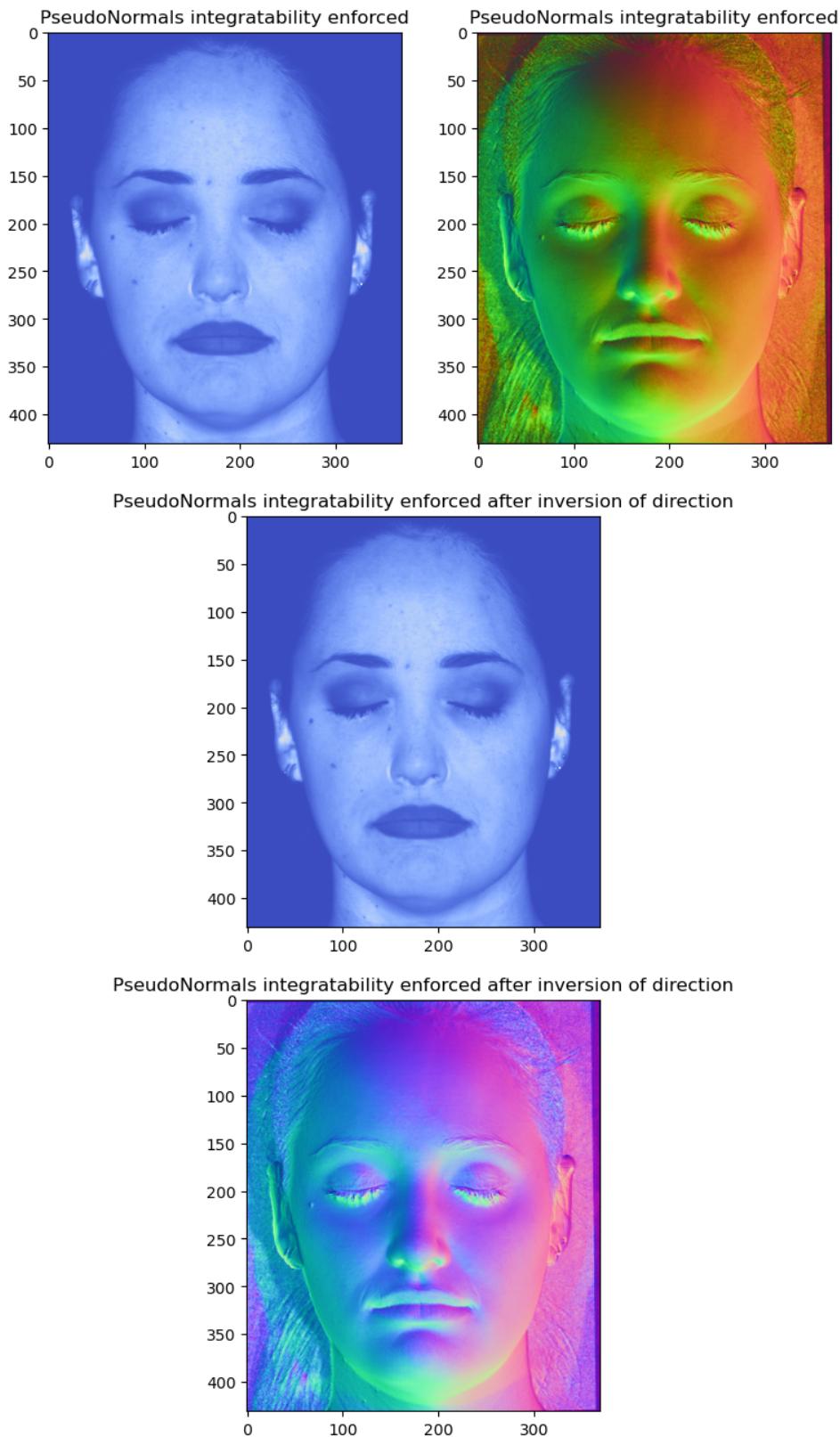


Figure 3: Albedos and normals after enforcing integratability. The second set is after direction inversion.

(d) Normal Integration : Visualize final surface as depth image and 3d surface

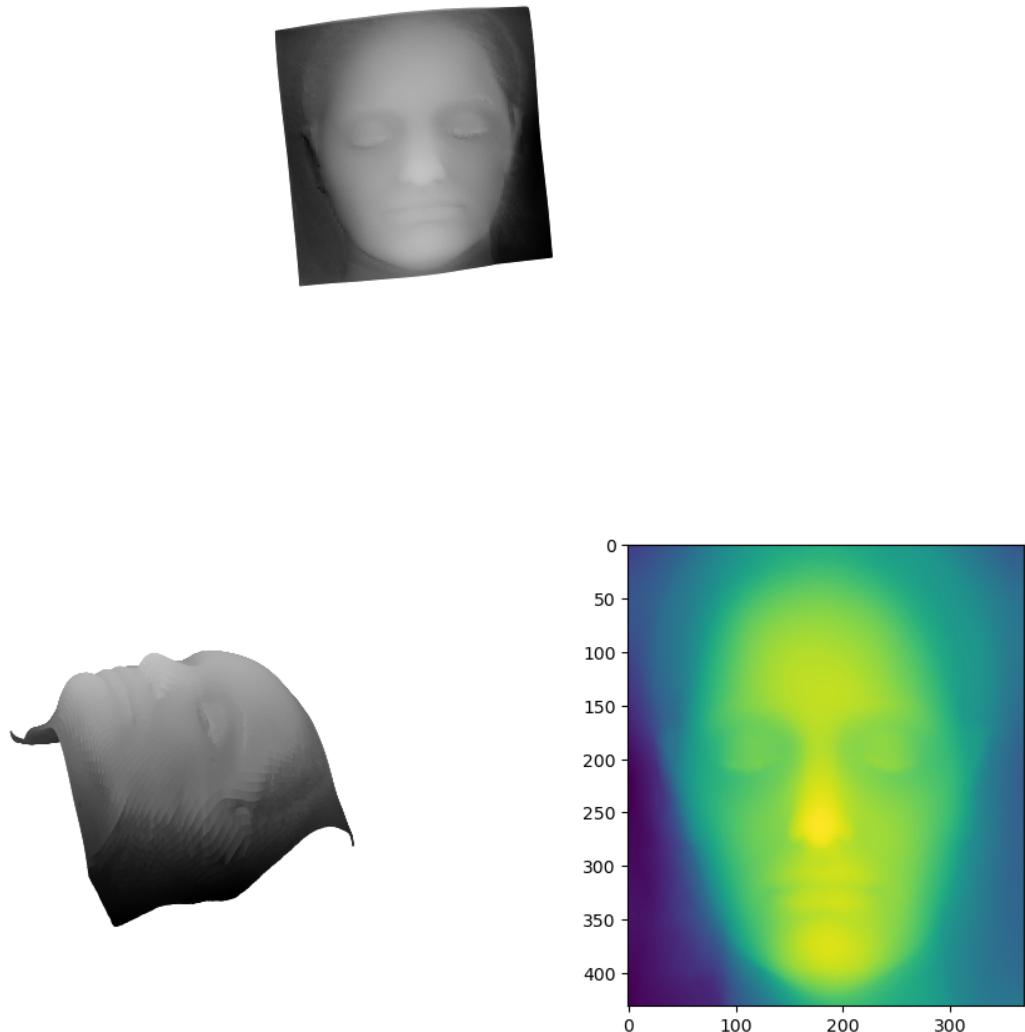


Figure 4: Poisson Integration

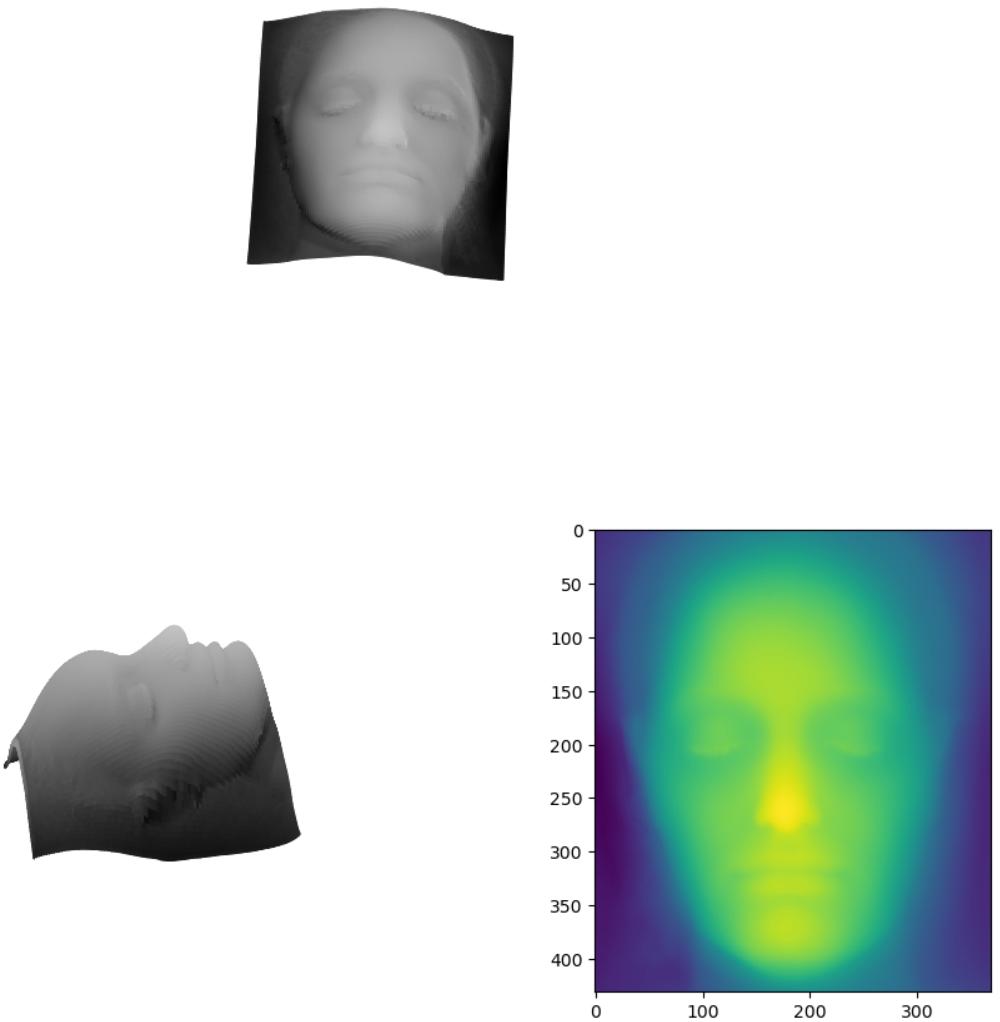


Figure 5: Frankot-Chellappa Integration

Do same with some GBR transforms, report albedos, normals, depth, 3d surface, and GBR matrix. GBR transforms represent set of transforms that look very similar when there is only slight movement. Bas-relief ambiguity originates from a sculpting term that refers to the same idea. In line with this, generally small changes in  $u, v$  and  $\lambda$  don't seem to affect the reconstructions significantly. However, when we change it in many magnitudes we can isolate and understand the changes in structure they cause.

After analysing these, we choose to use  $u=0, v=0, \lambda=1$  (i.e. identity transform), which would give us the same results as in the previous section.

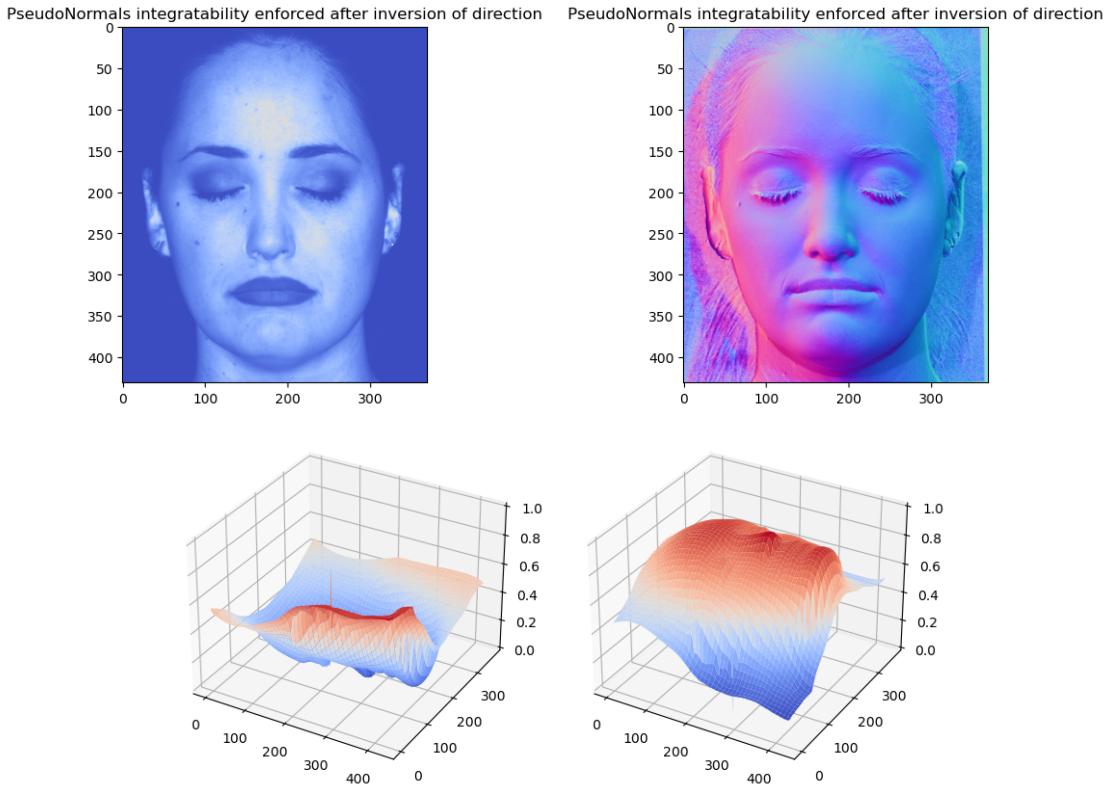


Figure 6: High  $\lambda$ . Causes flattening in shape.

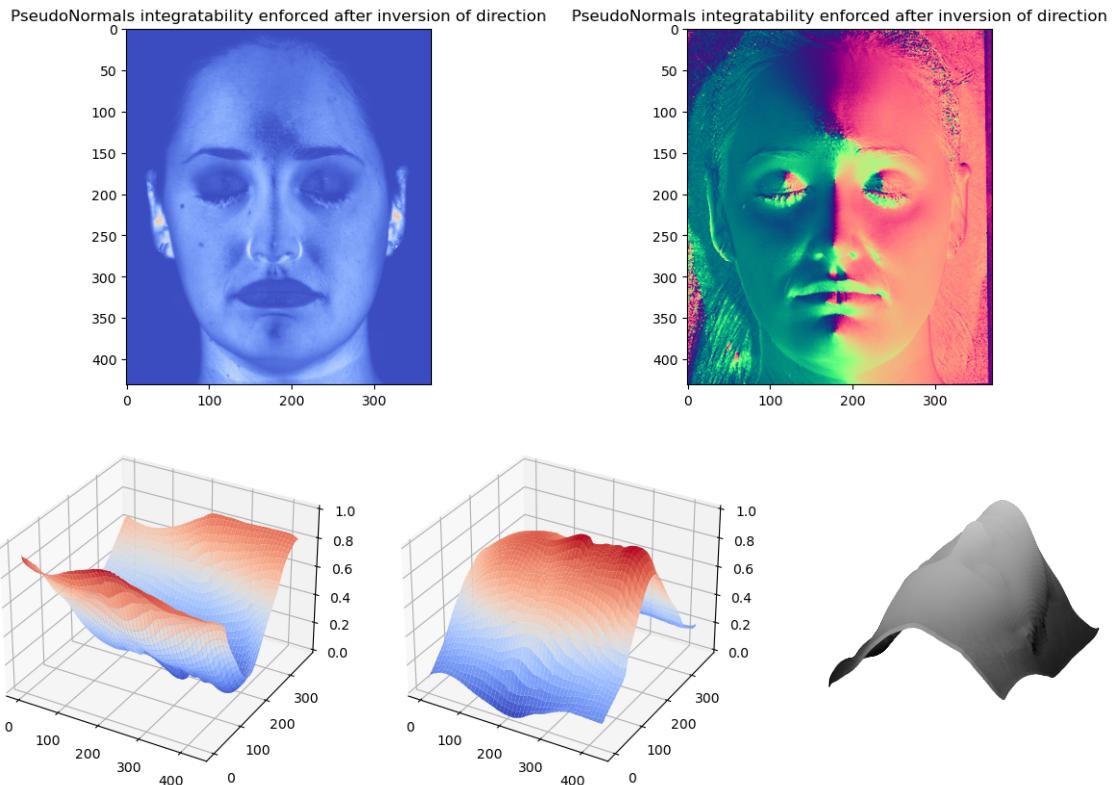


Figure 7: High  $u$ . Increases sharpness of change in depth.

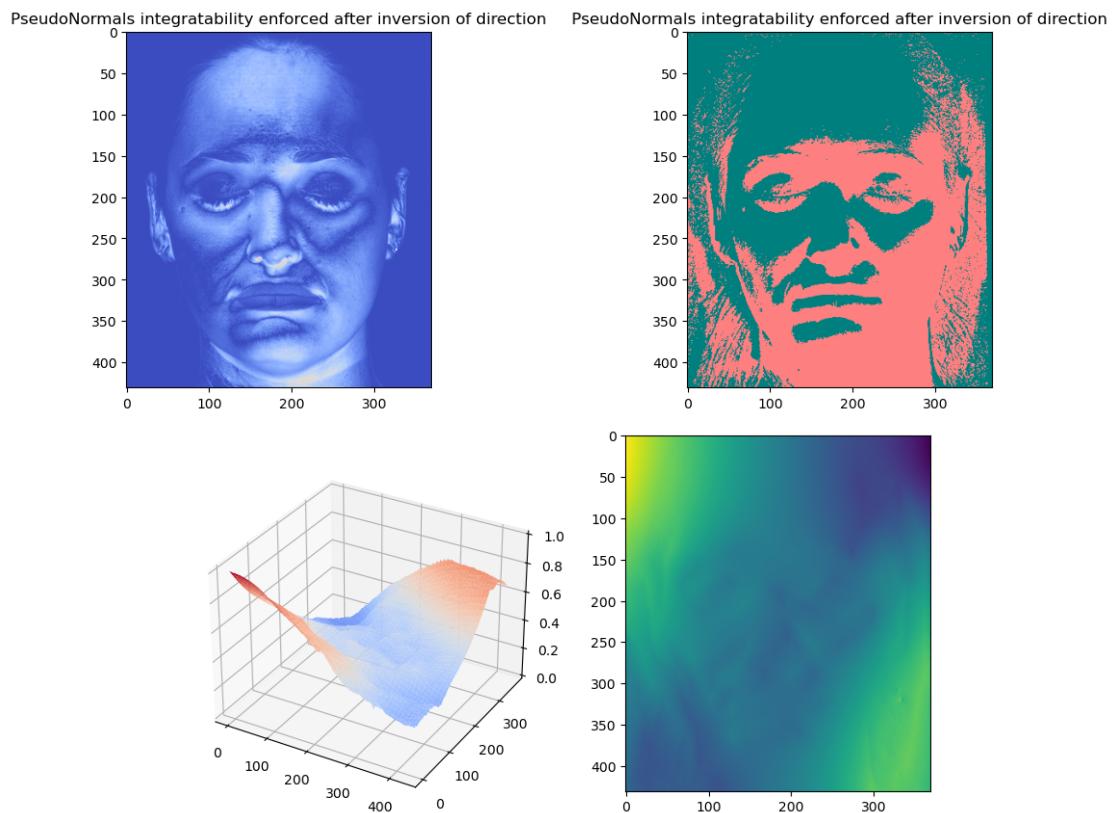


Figure 8: High  $v$ . Reduces sharpness, and more generally seems to deform the surface.

(e) Calibrated photometric stereo

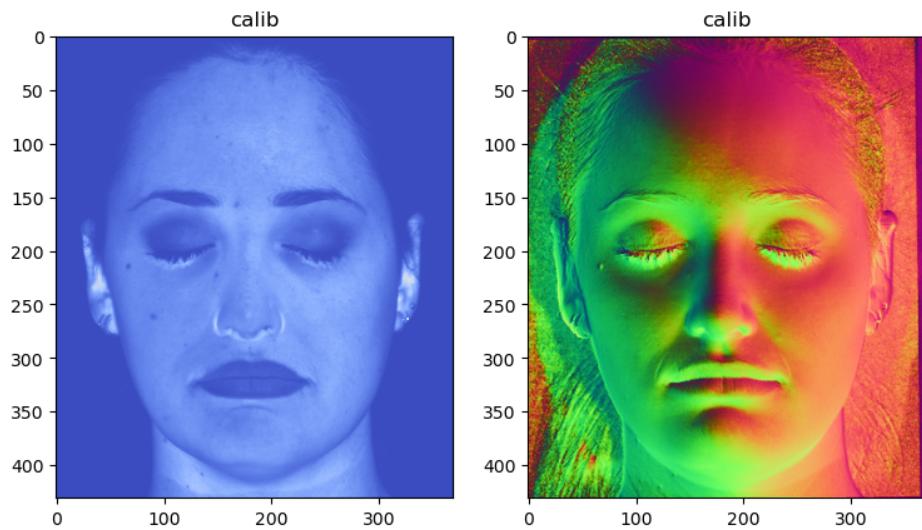


Figure 9: Calibrated Photometric Stereo outputs

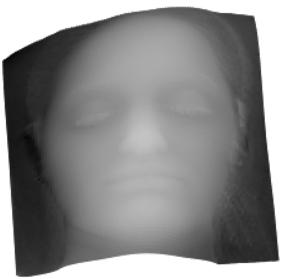


Figure 10: Poisson Integration

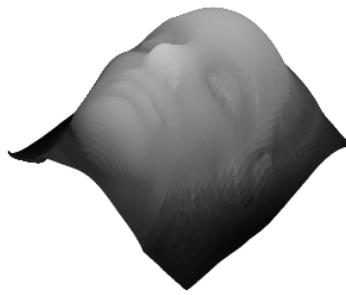
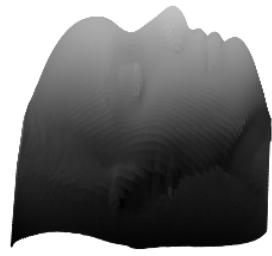
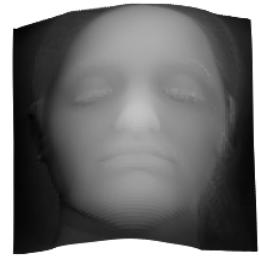


Figure 11: Frankot-Chellappa integration

Our uncalibrated results were fairly good, but these results are slightly better. We can see this with the very sharp, and well constructed surface by frankot integration. In the previous case there was still a little bit of blending into the background, and merging of the background (eg:- visible in uncalib case with poisson integration depth map), which is lesser over here. The normals we have in this case also look better at places like the eyebrows. The albedo is significantly different too (less flashy-bright, and more smoother). This in turn would likely mean our normals are better constructed and we could relight this face more reliably.

## 2. Capture and Calibrate your own shapes

### (a) Diffuse Surface



Figure 12: Diffuse surface chosen

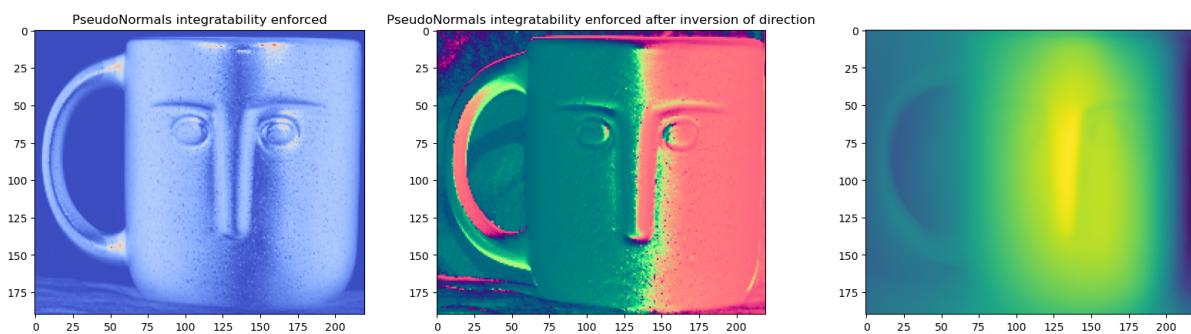


Figure 13: Albedo, normals, 1-depth

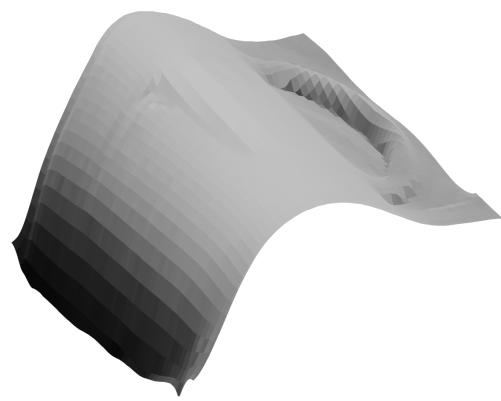
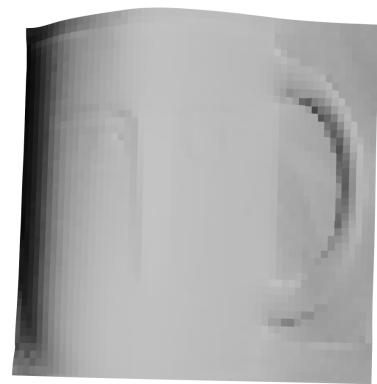


Figure 14: Poisson Integration

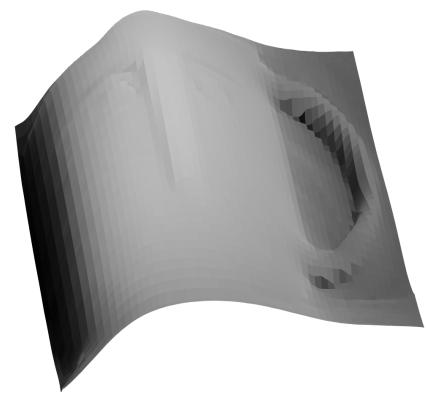
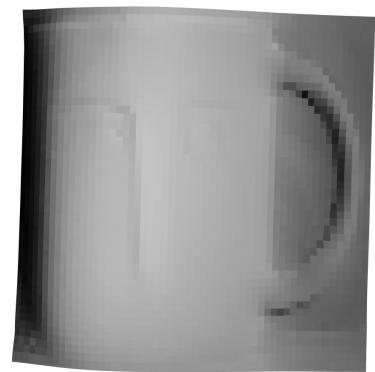


Figure 15: Frankot Integration

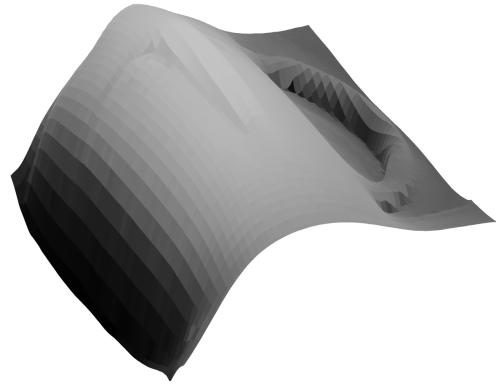


Figure 16: Frankot Integration

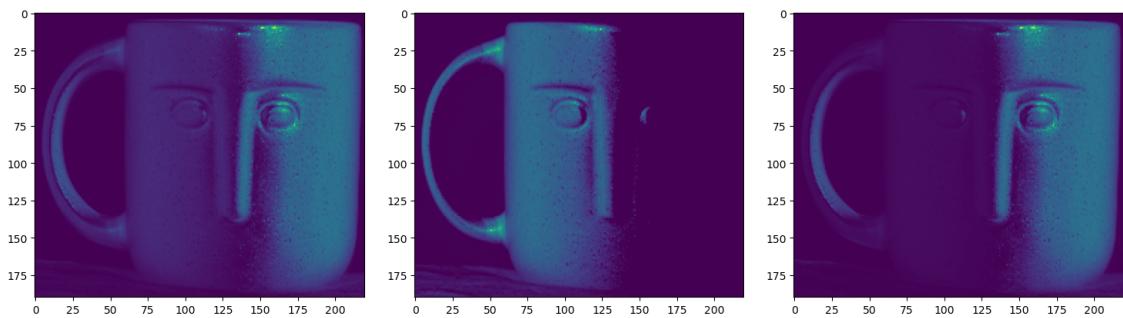


Figure 17: The object under different lighting conditions. 1) Light source straight-right and high. 2) Light source from far left. 3) Light source from far right.

- (b) Non-diffuse objects We've collected a few objects that break the assumption. The first is a little robot-toy, the second a bottle-opener (apologies in advance for this, this was the only metallic object with intricate shape changes, while still being not too reflective, thus breaking our algorithm), and a potted-plant.



Figure 18: Assumption breaking objects chosen

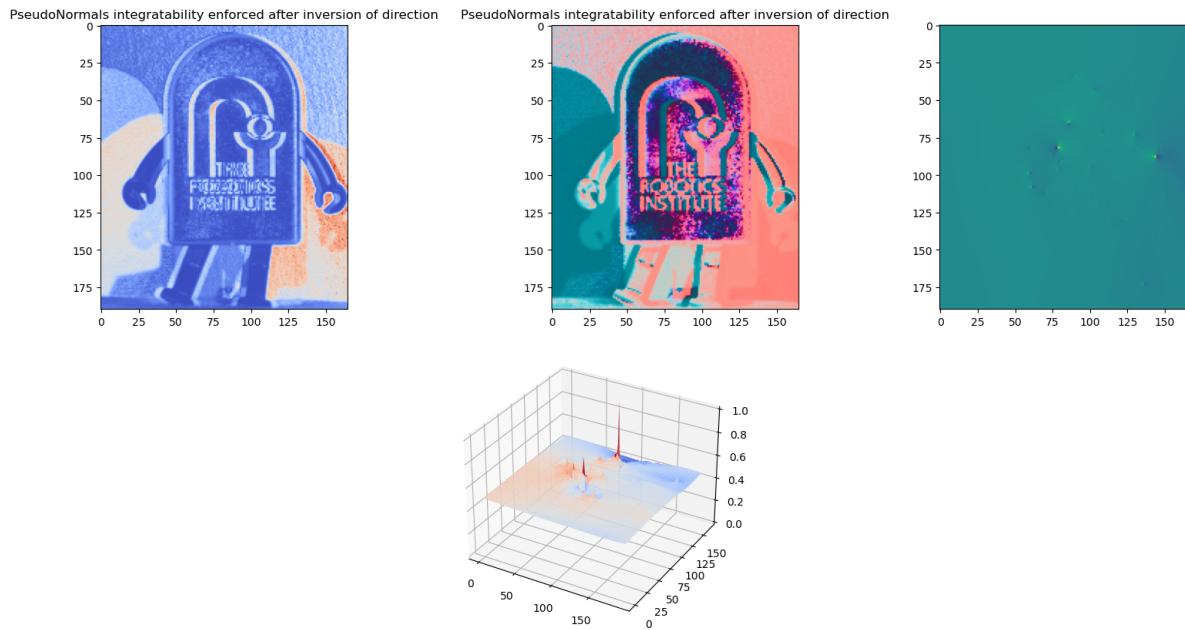


Figure 19: Albedo, normals, depth, surface

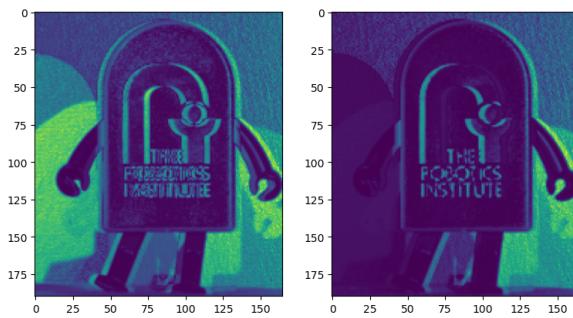


Figure 20: The object under different lighting conditions. 1) Light source straight 2) Light source from far right.

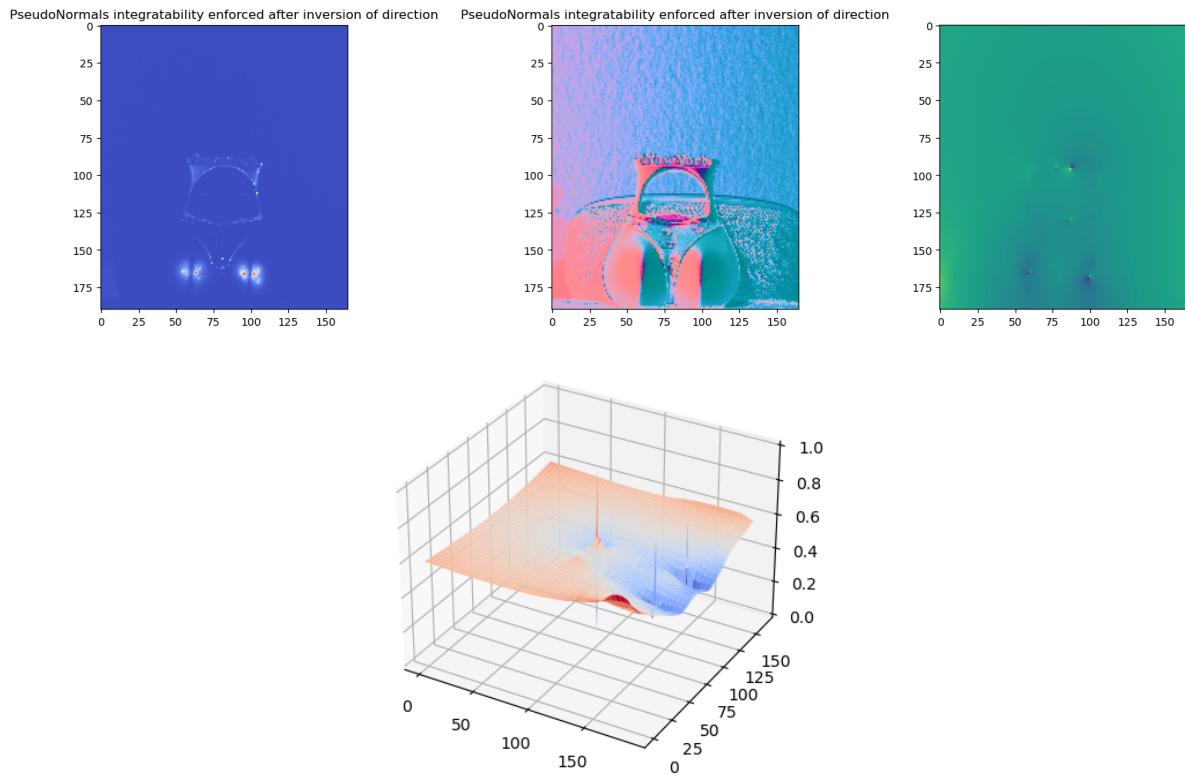


Figure 21: Albedo, normals, depth, surface

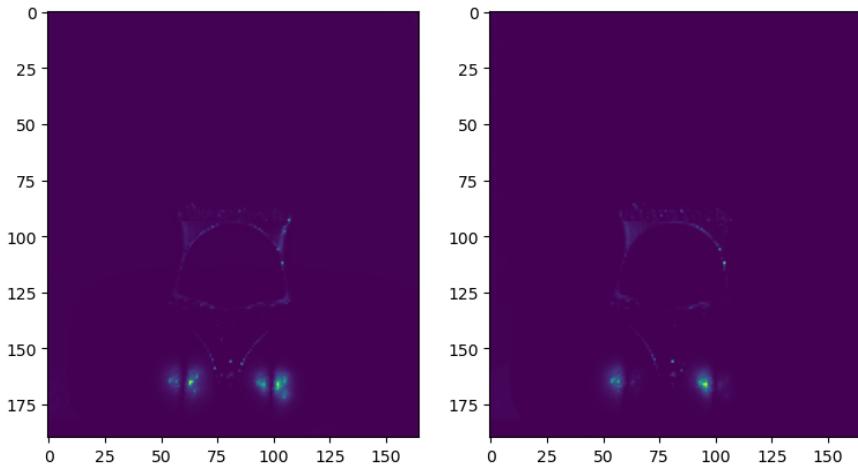


Figure 22: The object under different lighting conditions. 1) Light source straight 2) Light source from far side.

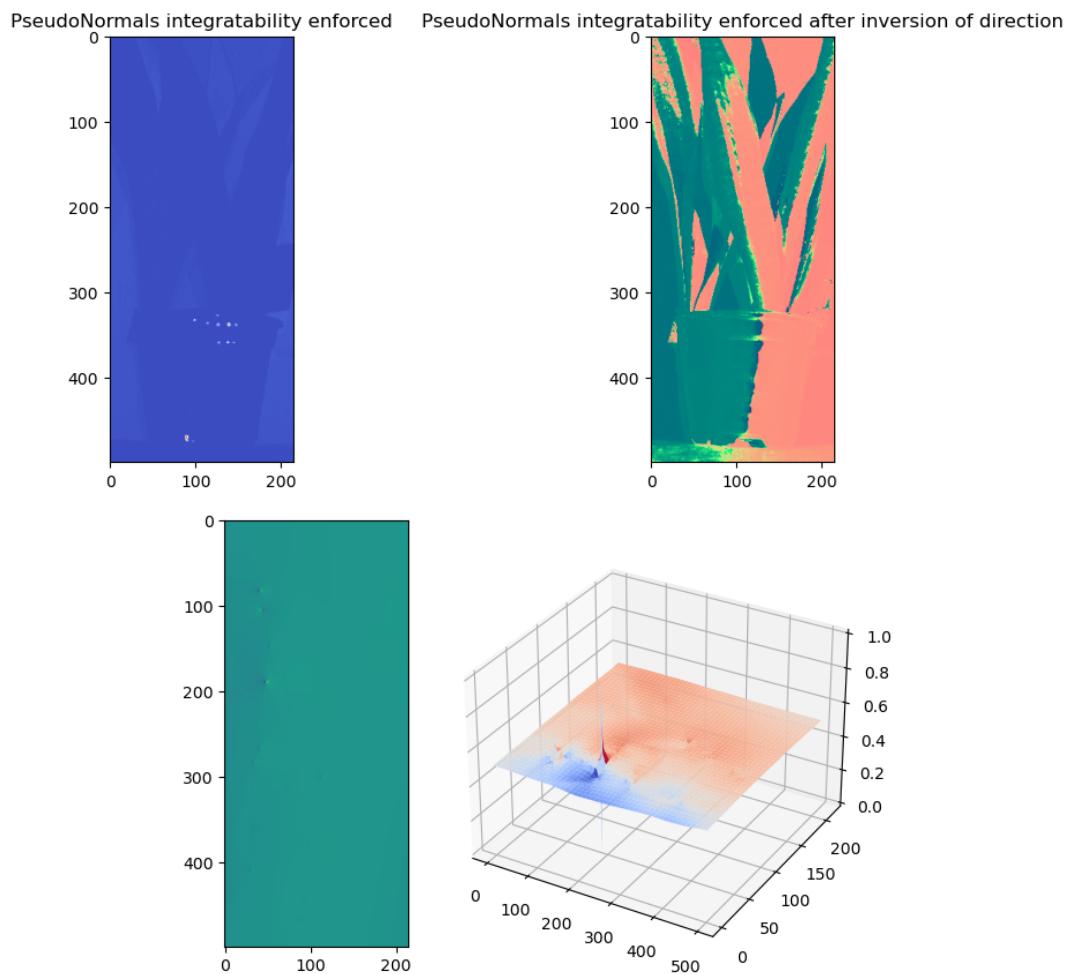


Figure 23: Albedo, normals, depth, surface

The failure of the assumption breaking cases could be owing to a variety of reasons like specular highlights, concavities, shadows in the background etc.