

15-663 Homework Assignment 5 Report

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1 Photometric stereo

Uncalibrated photometric stereo

Figure 1 shows the uncalibrated albedoes A_e and normals N_e , where A_e is normalized such that its maximum element equals to 1.0. Figure 2 shows the albedoes and normals with the matrix Q being

$$Q = \begin{bmatrix} 0 & 2 & 0 \\ 0 & 0 & -1 \\ 0.5 & 0 & 0 \end{bmatrix}$$

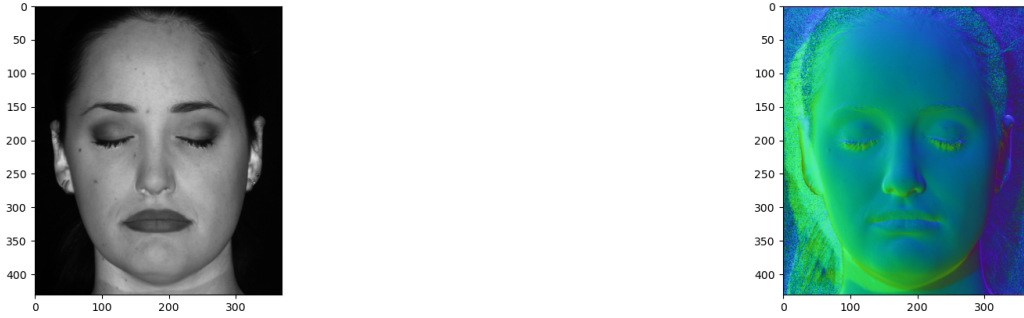


Figure 1: Uncalibrated albedoes and normals



Figure 2: Albedoes and normals with matrix Q

Enforcing integrability

Figure 3 shows the albedoes and normals after enforcing integrability. Because the image is stored in `numpy` with x coordinates going vertically and y coordinates going horizontally, I am manually swapping those two axes to make my result match the image in the write-up more.

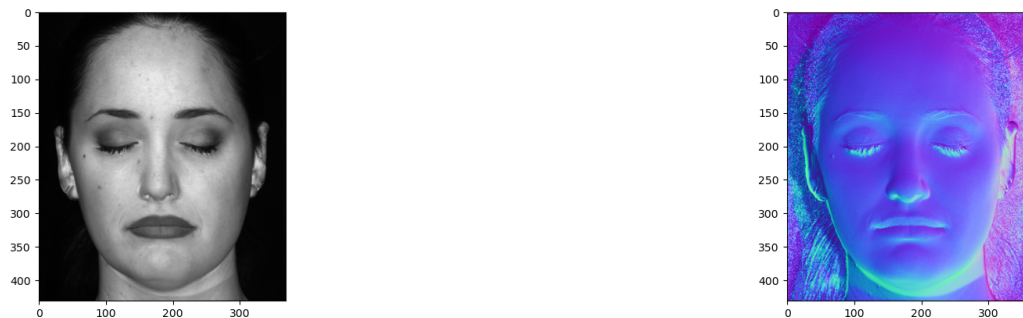


Figure 3: Albedoes and normals with enforced integrability

Normal integration

Figure 4 shows the reconstructed depth image and the 3D surface. Figure 5 shows the albedoes, normals, and 3D surface with $\mu = -0.1$, $v = -0.1$, $\lambda = 2$.



Figure 4: Reconstructed depth and 3D surface

Calibrated photometric stereo

Figure 6 shows the albedoes, normals, and 3D surface of the calibrated photometric stereo. We observe that the normal direction is very different from the uncalibrated case because of calibrated light directions.

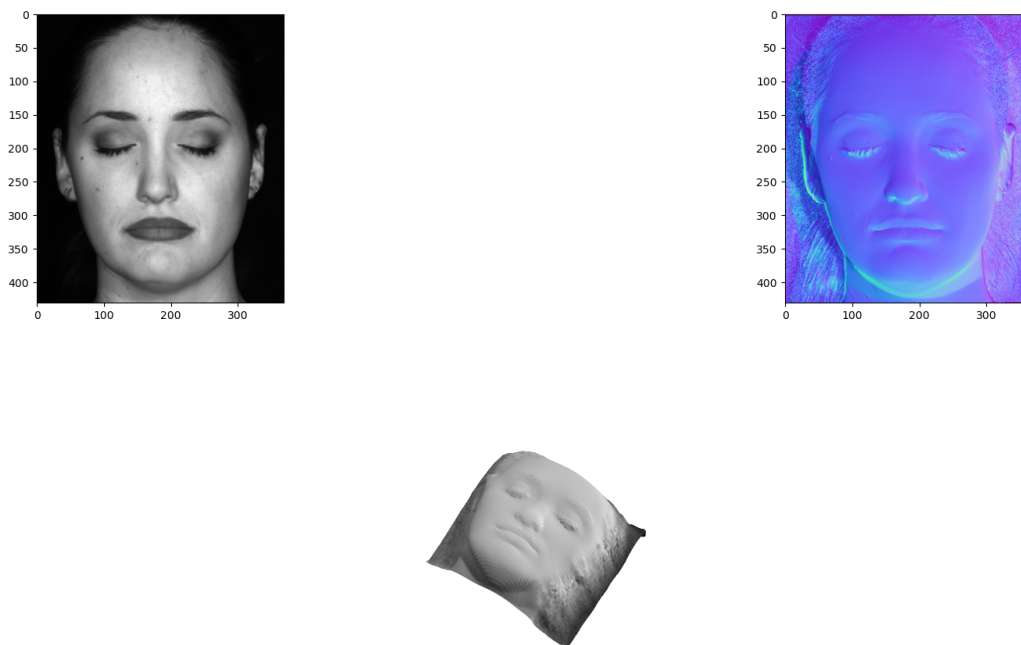


Figure 5: GBR transformations

2 Capture and reconstruct your own shapes

Figure 7 shows the original scene, albedoes, normals, and 3D surface of a pair of shoes, and figure 8 shows those of several cans of Coca Cola. I observe that the shoes, which has a more Lambertian surface, has a generally better-quality albedo and normal map than the Coca Cola with a specular surface. However, they both perform badly in the 3D reconstruction. I suspect that the reason is the images' short exposure time, which makes the image too dark overall.

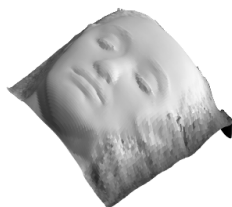
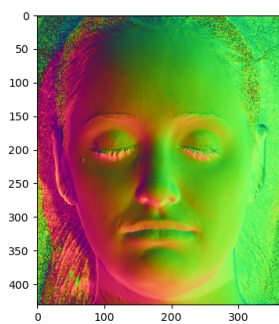
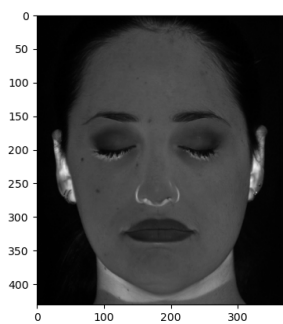


Figure 6: Calibrated photometric stereo

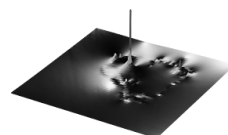
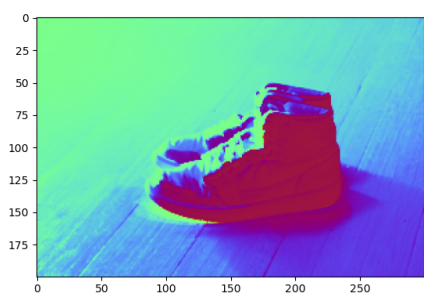
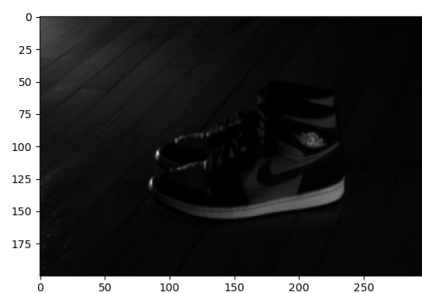


Figure 7: Shoes

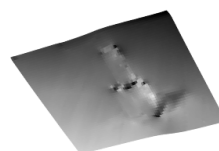
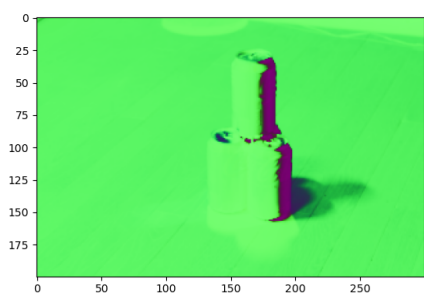
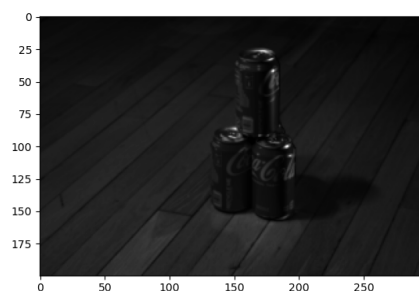


Figure 8: Coca Cola