15-663 HW4

Sajal Maheshwari
sajalm@andrew.cmu.edu

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0 Collaborations

I collaborated with my flatmate Shamit Lal (shamitl) for the capture of the video for the self captured images. We also borrowed the specular object from Sachit Mahajan(sachitma) to capture the images.

1 Photometric stereo

1.1 Initials

The final image size after creating the light field structure is (7×159039).

1.2 Uncalibrated photometric stereo

The images for the sub-aperture views from different viewpoints can be seen in Figure 1.

1.3 Simple rendering

The outputs of the simple rendering are shown in Figure 2

1.4 Enforcing integrability

When we enforce the integrability, the albedo and the normals can be seen in Figure 3

1.5 Normal integration

The output of the normal integration(depth and shapes) with the initial settings of the GBR matrix as identity is shown in Figure 4. We also show the various normal, albedo and shape outputs for different GBR matrices in Figure 5.

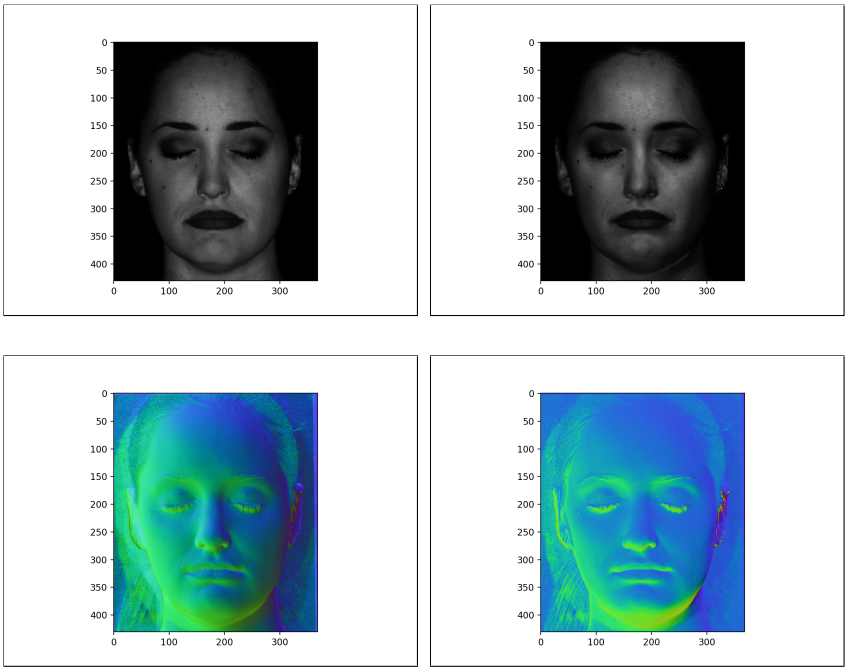

Figure 1: The focal slice outputs for the chessboard. The title depicts the depth value for the corresponding slice.

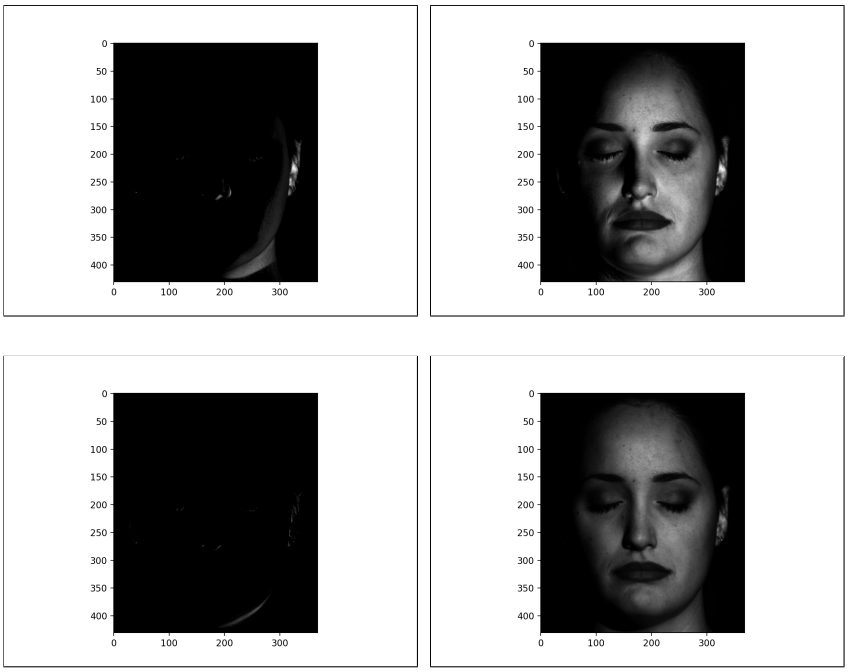

Figure 2: The outputs of the rendering for the different lighting. The first row shows the output for the case where Q is the identity matrix. We can show that the rendered images are similar in both cases for a new lighting direction, which shows that the solution we get for the normals and the albedo is not unique. The color difference we can see here is because the image is relighted from behind the scene in this case.

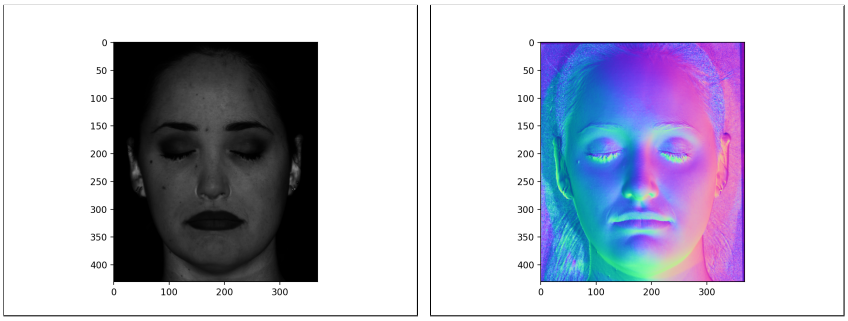

Figure 3: The output of the normals and the albedo after we enforce the integrability

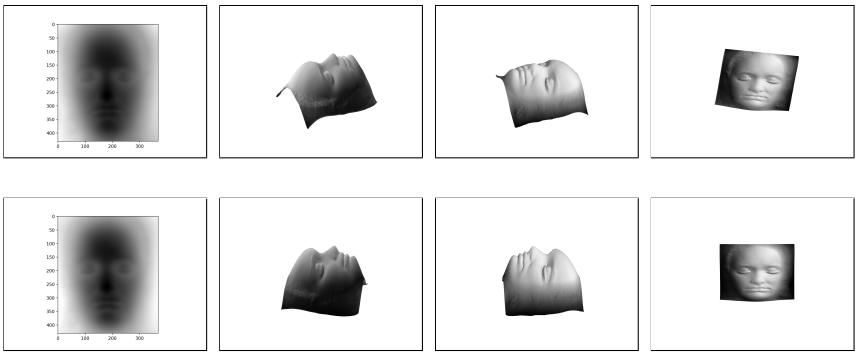

Figure 4: The depth and the 3D surface outputs for the settings where the GBR matrix is equal to identity. The top row shows the integration when the integration is performed using Poisson and the second row shows the output when the integration is done using the Frankot method. The output after the Poisson integration seems to be more realistic since the gradation is more in this case, especially at higher depths as can be seen in the image in the second column for both the cases.

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Figure 5: The normal, albedo and shape images for some of the variations of GBR.

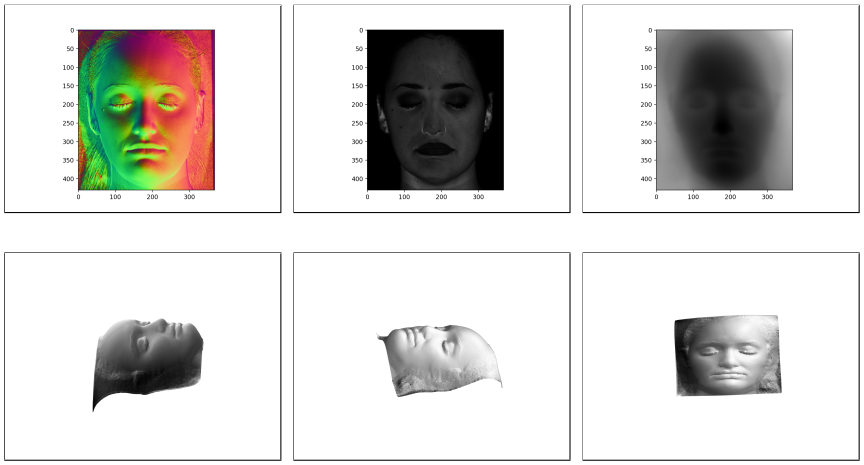

Figure 6: The normal, albedo, depth and shape images for the calibrated camera setup.

1.6 Calibrated photometric stereo

The output of the calibrated photometric stereo is shown in Figure 6. The results in this case are slightly better than calibrated case, as the lighting directions are known and we are solving a least squares problem with an analytical solution rather than a SVD with a close but not exact solution. However, it should be noted that the results are almost same for both the cases.

2 Capture and reconstruct your own shape

Here, we show the results of the shapes constructed using images captured by us. Figure 7 shows the shape construction results for the images captured for an object which has almost diffuse reflectance. We show the cropped region of interest of the image, the albedo and the rendered image from a different viewing direction in Figure 8.

Similarly, the normals, depth map, albedo and shape for the specular object can be seen in Figure 9. Here, we do not get a lot of information in the shape and the depth images, because the region that is captured in the image sequence is planar on one side and does contain depth. However, However, we can still see that near the regions on the top that the specularity slightly distorts the depth images as the details are not visible, which is due to the specularity in that region. The example images and the relighted outputs are shown in Figure 10.

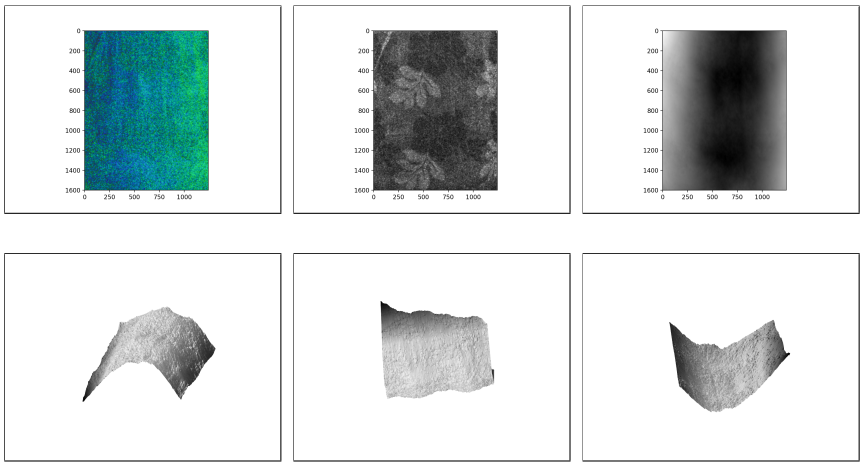

Figure 7: The normal, albedo, depth and shape images for the object which has almost a diffused surface.

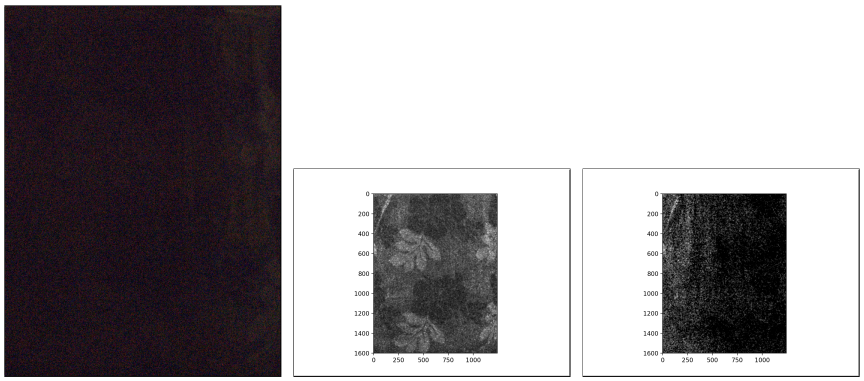

Figure 8: The ROI along with the albedo before and relighting can be seen in this figure.

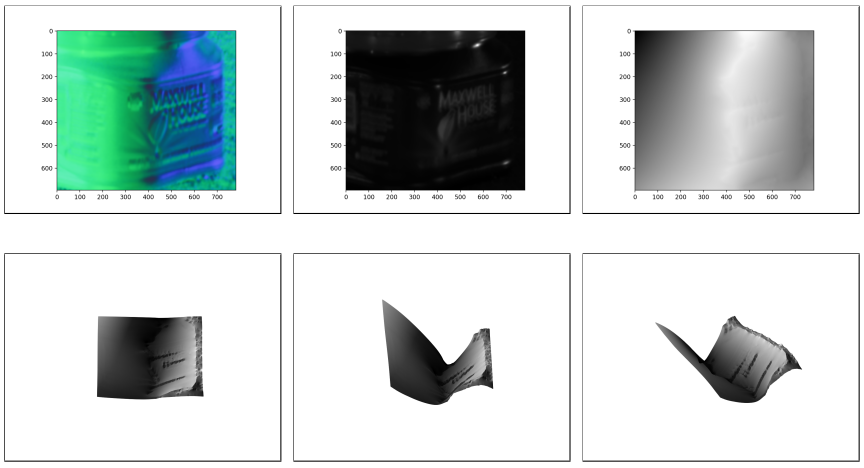

Figure 9: The normal, albedo, depth and shape images for the object which has almost a diffused surface.

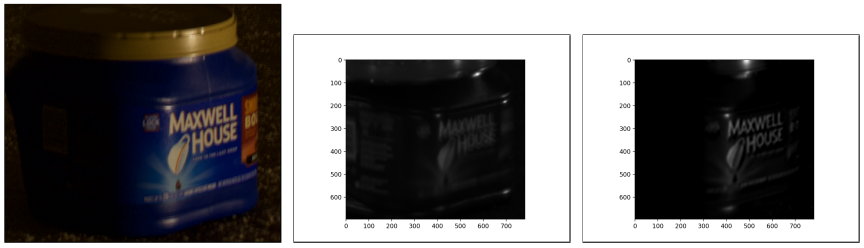

Figure 10: The ROI along with the albedo before and relighting can be seen in this figure.

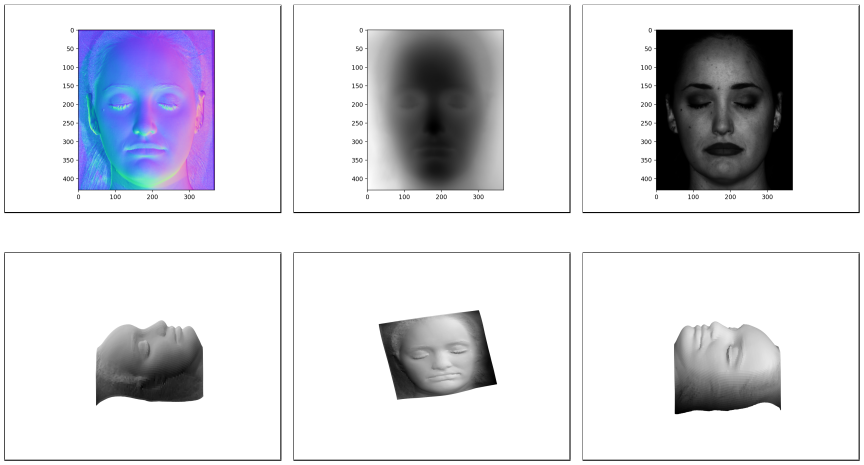

Figure 11: The normal, albedo, depth and shape images for the calibrated camera setup for the minimization of entropy.

3 Bonus: Resolving the GBR ambiguity

3.1 Entropy minimization

The entropy is minimzed by running a nested for loop and coming up with the GBR matrix that minimizes the entropy of the output albedo. This is based on the assumption that the magnitude of the normals in all the directions will roughly be the same if the surface is Lambertian. The outputs after minimizing the entropy on the given image is seen in Figure 11. The results for the captured image is shown in Figure 12.

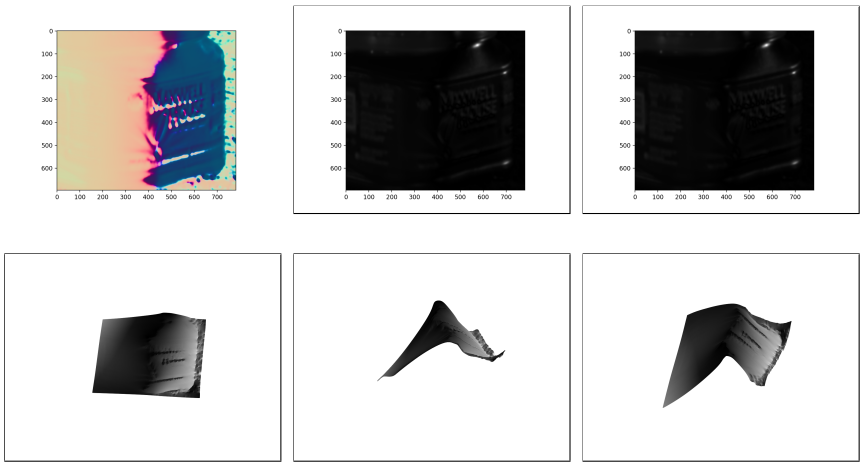

Figure 12: The normal, albedo, depth and shape images for the calibrated camera setup for the minimization of entropy.