Project Five Report

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***Abstract*—This is a report for project Five. I have done this project with the collaboration of Pooya Fyyazsanavi.**

I. P5.1 Lighting a Scene

First in this section I generated 4 different images. The results are shown in figure 8.

II. P5.2 Photometric Stereo

A. P5.2.1 Using provided data

The plots are shown in figure 9.

B. P5.2.2 Imperfections in Photometric Stereo

The plots are shown in figure10.

Question: The lower left of the face of image is far from the reconstruction since in real image the shadow of the face does not let the light get to that part and make a shadow on that part. However, when we reconstruct the image the idea is that it the light get to that part what would be the result and we do not consider this shadow possibility.

Question: The image that we have reconstructed is an estimation of real image science the formula by it self is only an estimation of what happen in real world. Also, this model dose not consider the shadow, so it make sense that the image which consider shadow is darker than the reconstructed one.

C. P5.2.3 Lambertian Objects in Blender

I have shown the images on figure 1 and the results are shown in figure 11.

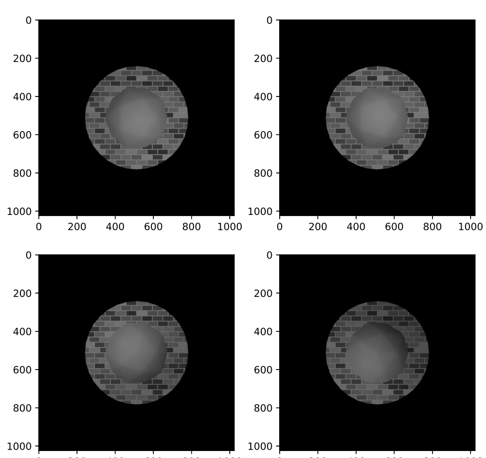


Fig. 1. 4 generated images.

D. P5.2.4 Non-Lambertian Objects in Blender

I have shown the images on figure 2 and the results are shown in figure 12.

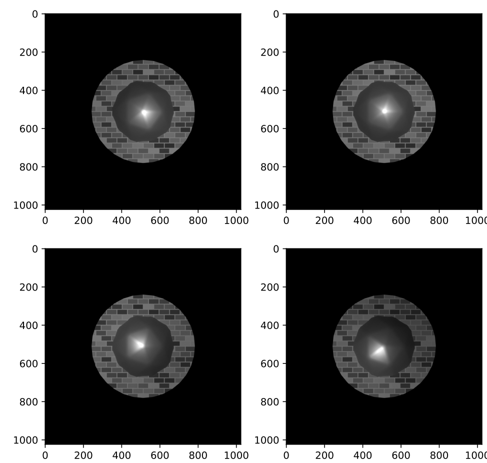


Fig. 2. 4 generated images.

Question: The albedo and normal is different since the material has been changed and those formula are generated of the Lambertian. There is no linear solution, infact non-Lambertian photometric stereo is a highly non-linear problem.

Question:In this paper [1] they separate diffuse and specular components of the input images before computing the normal.They present a new diffuse-specular separation strategy based on the dichromatic model. They estimate the surface normal in an optimized manner. In fact they try to minimize the difference between BRDF result and the input image. The optimization is done over a series of different image intensities, under different light conditions.

III. P5.3 Structure from Motion

A. P5.3.1 Implementation

I have shown the results on figure 3.

B. P5.3.2 Followup Questions

The results are shown in figure 4, 5, 6, 7. Question: If we have 2 images with affine transformation matrix F, we can use this matrix to find the second image camera transformation matrix from the dot product of first image camera transformation matrix and the inverse of the affine matrix (f).

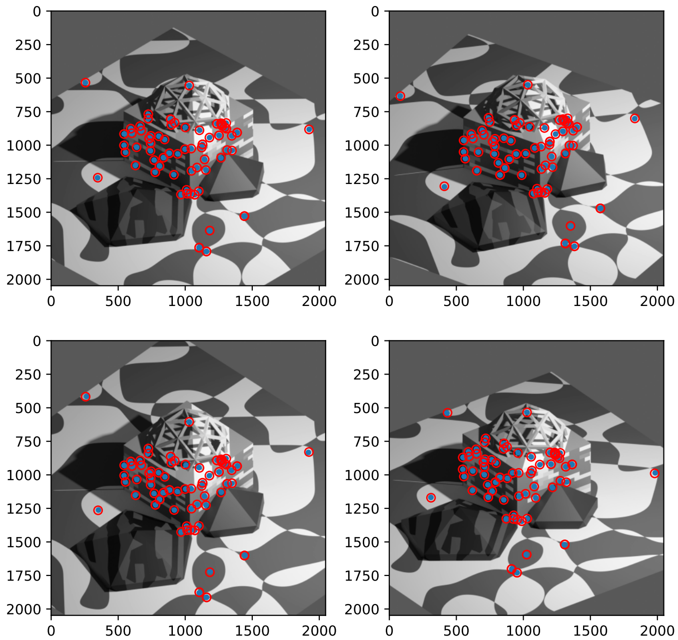


Fig. 3. The normals, depthes and albedos are shown from left to right.

Question: Enforce image axes to be orthogonal and enforce them to have length 1. The procedure is as follows, if these constrains satisfied the matrix is free of the ambiguity. First, solve $L = C\hat{C}$. Next, we have to recover C from L by Cholesky decomposition. At the end, we have to update M and S with the C we recovered.

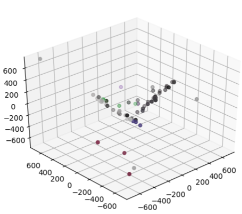


Fig. 4. The points on the surface of the central cube are coplanar.

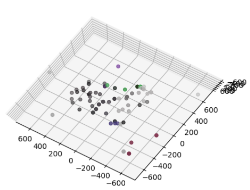


Fig. 5. 2ed view of the points.

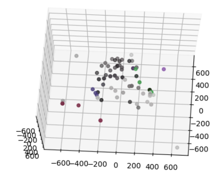


Fig. 6. 3rd view of the points.

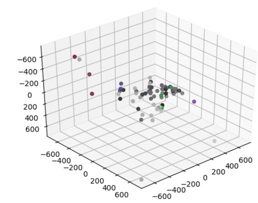
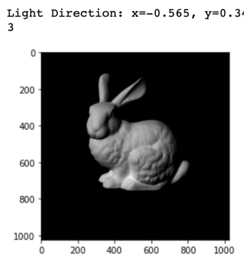


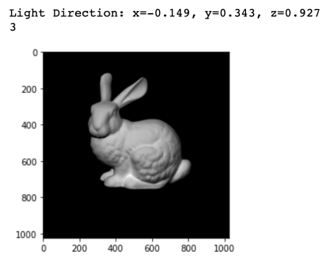
Fig. 7. 4th view of the points.

References

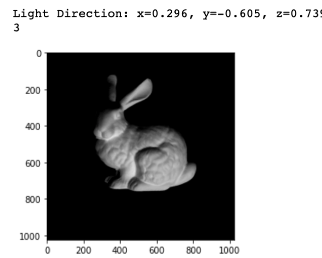
[1] Min Li, Changyu Diao, Duan-qing Xu, Wei Xing, and Dong-ming Lu. A non-lambertian photometric stereo under perspective projection. *Frontiers of Information Technology Electronic Engineering*, 21, 12 2019.



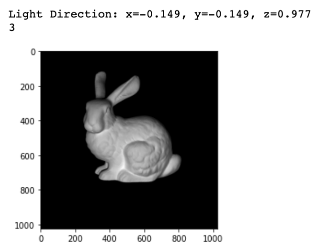
(a) View 1.



(b) View 2.



(c) View 3.



(d) View 4.

Fig. 8. 4 different Light direction.

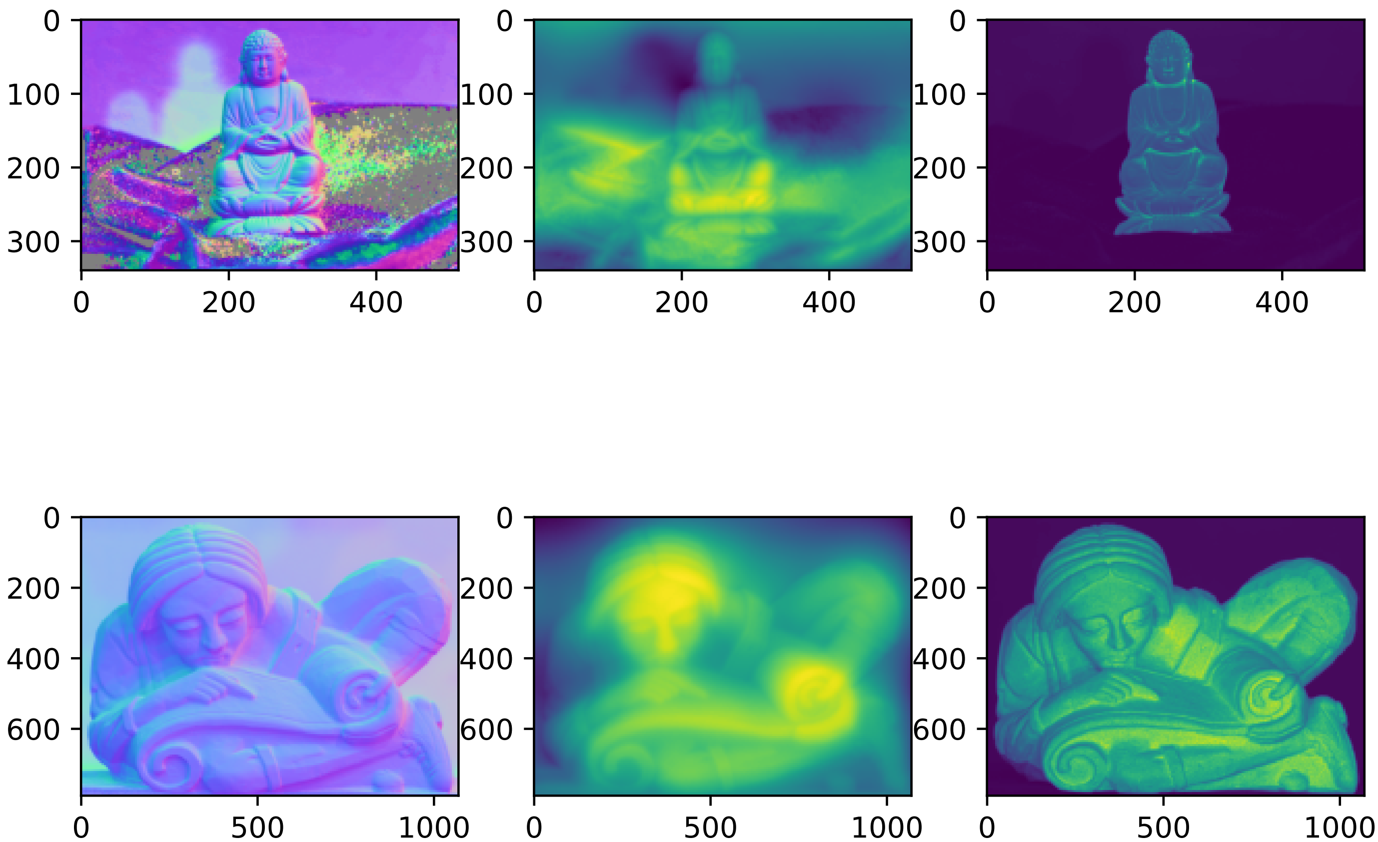


Fig. 9. The normals, depthes and albedos are shown from left to right.

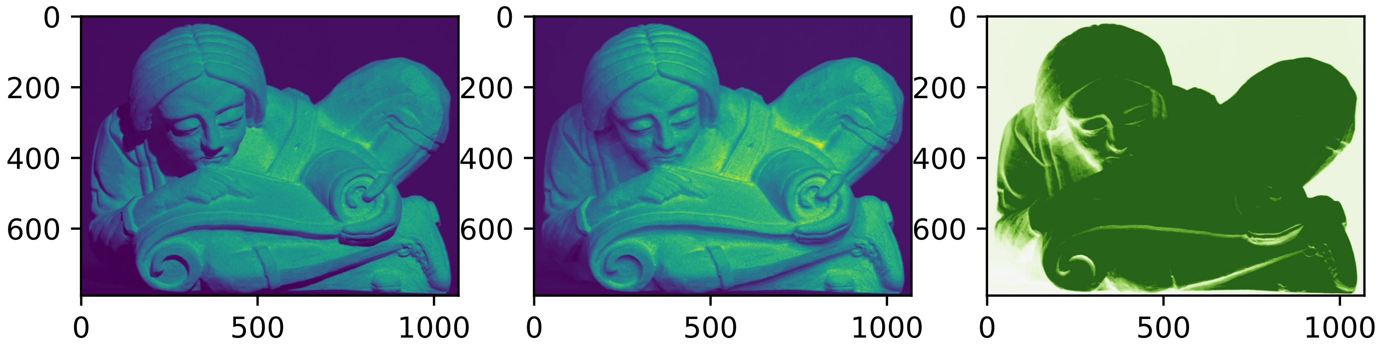


Fig. 10. The original, reconstructed and difference images are shown from left to right. Focal Lengths.

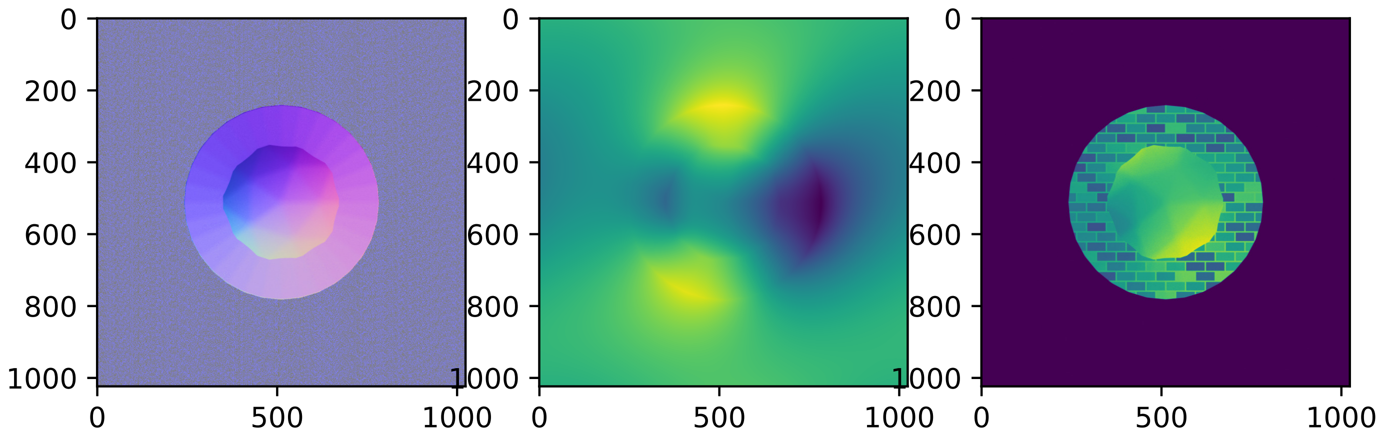


Fig. 11. The normals, depthes and albedos are shown from left to right.

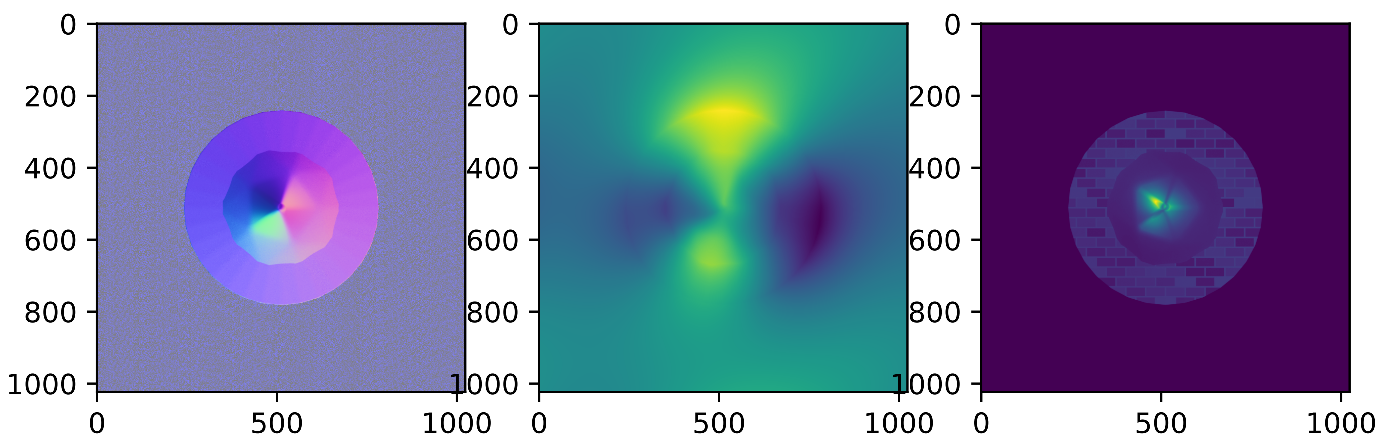


Fig. 12. The normals, depthes and albedos are shown from left to right.