CS 685 ASSIGNMENT 5

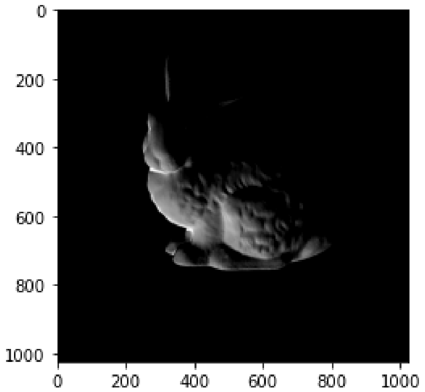
PHOTOMETRIC STEREO AND STRUCTURE FROM MOTION

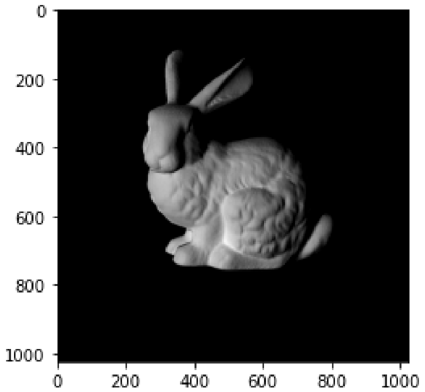
Mithilaesh Jayakumar

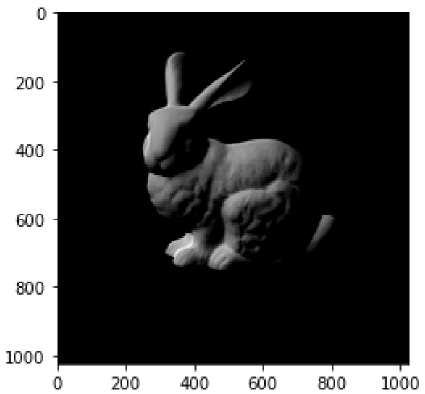
G01206238

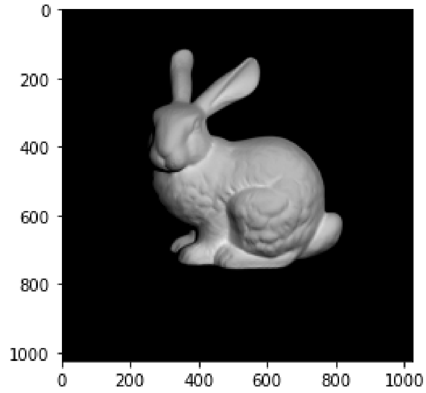
P5.1 Lighting a Scene

The bunny image at four different light scenes.





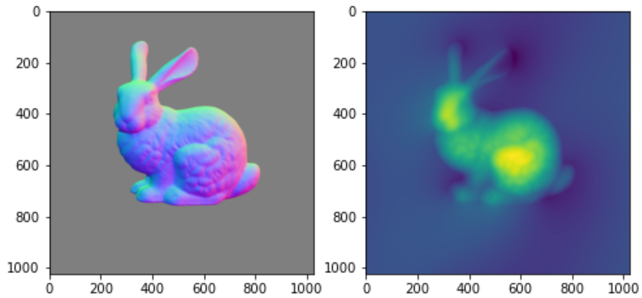




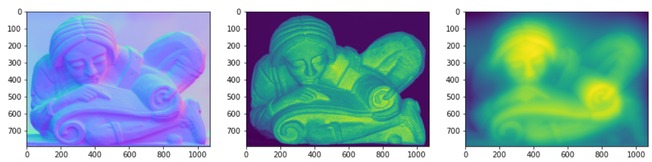
P5.2 Photometric Stereo

P5.2.1 Using provided data

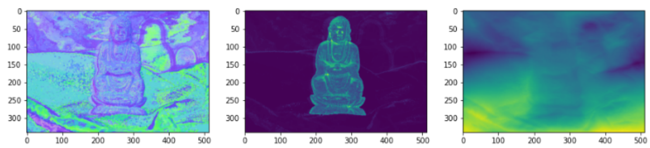
The normal and depth image of bunny image.



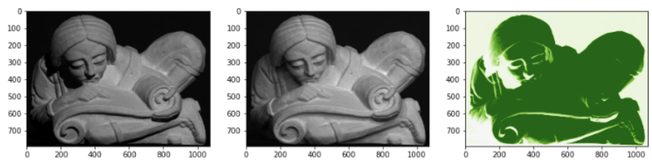
The normal, albedo and depth image of buddha image.



The normal, albedo and depth image of scholar image.



P5.2.2 Imperfections in Photometric Stereo



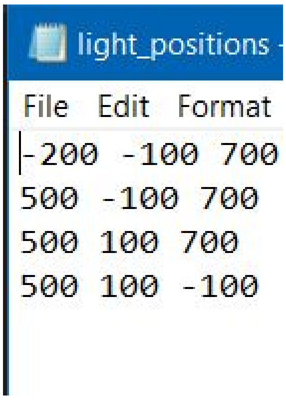
There is a significant difference between the two images to the lower left of the scholar's face because of the presence of shadow.

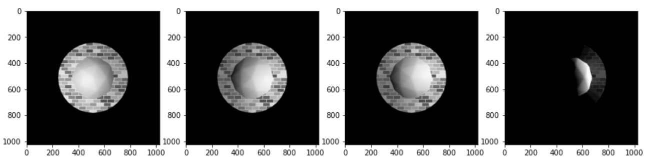
The body of the scholar is (on average) darker in the original image than in the reconstruction because the original image was taken under one light source but the image reconstructed made use of the computed albedos and normal from multiple images taken under different light positions.

When we are given four or more images under different illuminations. The photometric stereo over-determines the local surface orientation and albedo (3 degrees of freedom) which implies that we can use the residual of some least square solution, to determine whether shadowing has occurred.

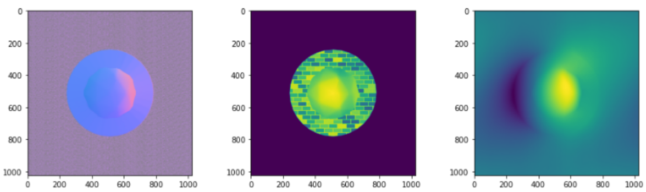
P5.2.3 Lambertian Objects in Blender

The four images generated by changing light position using blender


light_positions
File Edit Format
-200 -100 700
500 -100 700
500 100 700
500 100 -100

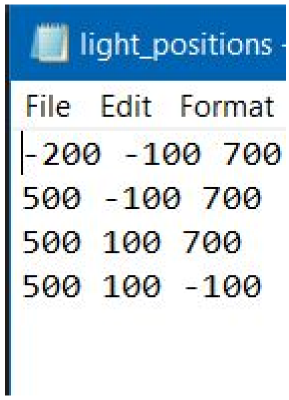


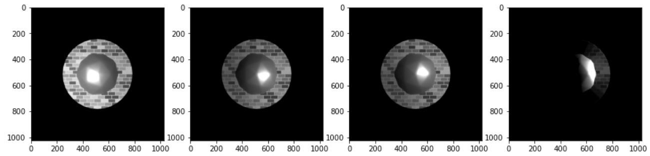
The normal, albedo and depth image of the above image.



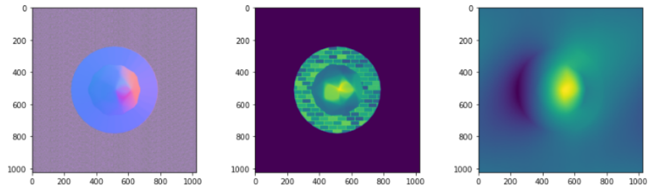
P5.2.4 Non-Lambertian Objects in Blender

The four images generated by changing light position using blender


light_positions
File Edit Format
-200 -100 700
500 -100 700
500 100 700
500 100 -100



The normal, albedo and depth image of the above image.



The albedos and normal change because the metallic surface has high reflectance resulting in high albedo. Yes there is a linear way to compute the albedo and normal.

One of the techniques to perform photometric stereo on a non lambertian surface is explained in the following paper.

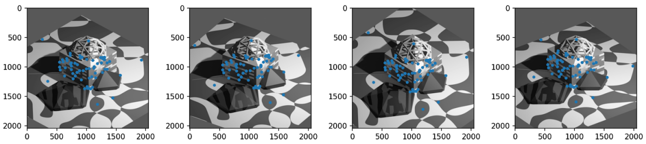
"Schlüns K. (1993) Photometric stereo for non-lambertian surfaces using color information. In: Chetverikov D., Kropatsch W.G. (eds) Computer Analysis of Images and Patterns. CAIP 1993. Lecture Notes in Computer Science, vol 719. Springer, Berlin, Heidelberg. https://doi.org/10.1007/3-540-57233-3_58"

The paper explains a two-stage process without introducing additional light sources or assuming a known microfacet distribution. In the first step, the glossy reflection is discarded, taking the dichromatic reflection model as a basis. In the second step, a conventional PMS is applied to the derived matte images.

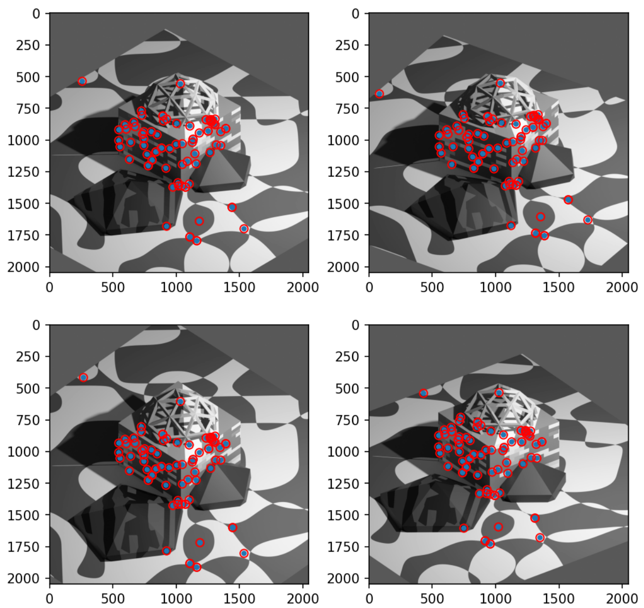
P5.3 Structure from Motion

P5.3.1 Implementation

The below plot shows the features plotted on each image.



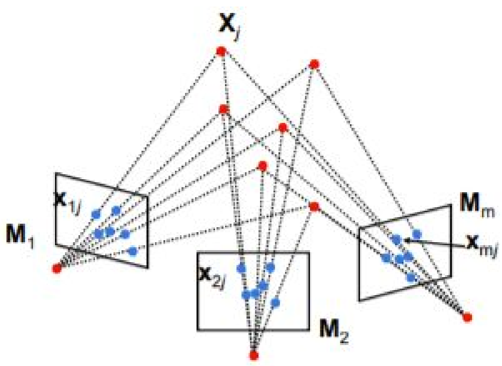
The plot after reprojecting the points onto 3d space.



P5.3.2 Followup Questions

The relationship between the Affine matrix and the 3x4 camera projection matrix is,

When we have m cameras with projection matrices M_i and n points at world locations X_j , and m times n correspondences x_{ij} , we can record the position of the j-th world point in the i-th image.



We combine W_3 and V_3' to make the structure matrix S, and U_3 becomes the motion matrix M. While this way of associating the components of the SVD decomposition to M and S leads to a physically and geometrical plausible solution of the affine SFM problem, this choice is not unique. We could also use V_3 to make the structure matrix S, and combine W_3 and U_3 to make the structure matrix M, since in either cases the observation matrix D is the same. In order to avoid this we do correction of affine ambiguity.