CSE 473/573 Homework 1

Problem 2. Estimating Shape from Shading

Brief Description of my Approach

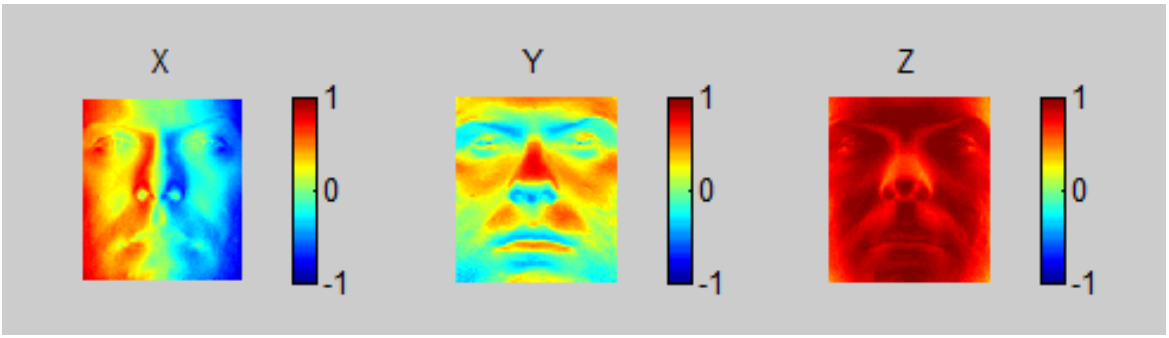
- The root path and subject name is fed to the program.
- The LoadFaceImages function provided with the starter code gives us the ambient image, light directions for each of the 64 images, and an array which stores the 64 images.
- Then the ambient image is subtracted from each of the 64 extracted images so that we can say there was no ambient light when the picture was taken.
- Then we correct each pixel for all the images. If the intensity of a pixel is less than 0 we force the pixel to 0 value.
- The image array and the light directions are sent to the photometric_stereo function.
- Photometric_stereo function:
    - Create a new array with intensities of (x,y) pixels for all 64 images.
    - Then we get g from the equation I = gV, by using least squares method. In matlab we use mldivide ('\') to get g at every point in the image commonly called vector field.
    - Now albedo at that pixel is got by getting the magnitude of g.
    - Also surface normal are calculated by dividing g by the magnitude of g, |g|
- Now the Surface Normals we got are sent to the get_surface function to calculate height map.
- Get_surface function:
    - We find out p = x/z and q = y/z for surface normal at every point of the face.
    - Then the p and q found is used to get the actual height map.
    - Calculated the height map by calculating the height of all pixels in the first column and then getting the cumulative of all the previous row pixel's height.
    - Found height maps for 4 directions (Left-Right, Right-Left , Top-Down, Bottom-Up)
    - Then averaged the 4 height maps to get the height-map.
- Display_output and plot_surface_normals functions given in the starter code then displays the albedo image, the colored surface normals and the surface of the face.

Limitations of the Implementation:

The implementation cannot distinguish between shadows and a black background. So in subject yaleB05 the black background near the neck creates a problem and results in a wrong height for the band near the neck which in turn gives us a deformed chin. The implementation is led to believe that the background is a shadow created by the chin area at every angle. Thus giving abnormally large height near the chin, as according to it that is the only way such a shadow can be created.

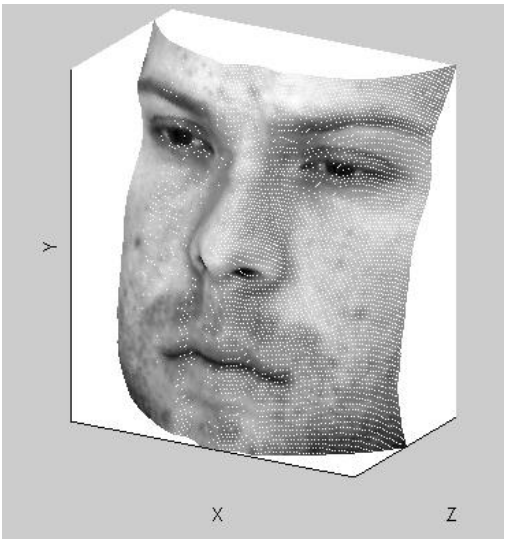
ESTIMATED ALBEDO MAPS AND SCREENSHOTS OF HEIGHT MAPS

Subject - YaleB01:

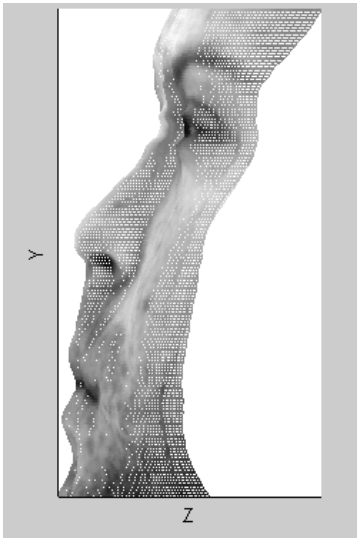


Surface Normals

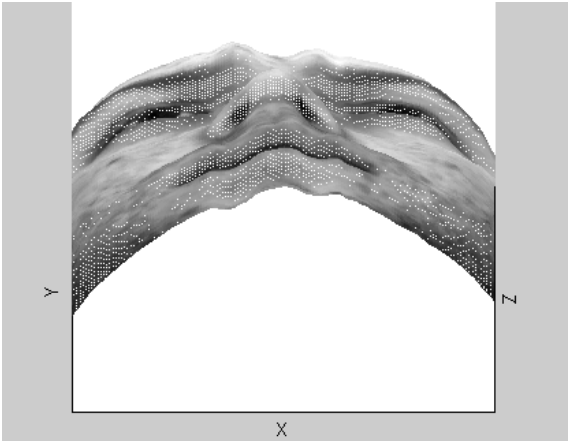
Estimated Albedo Image



Height Map Screenshot 1

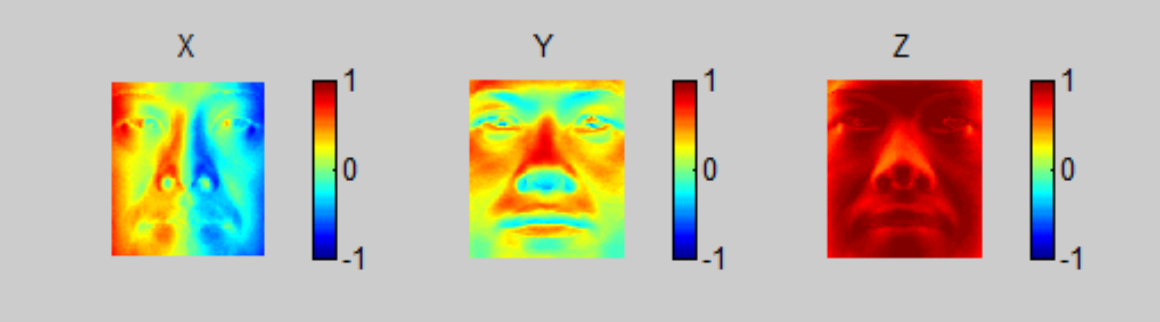


Height Map Screenshot 2



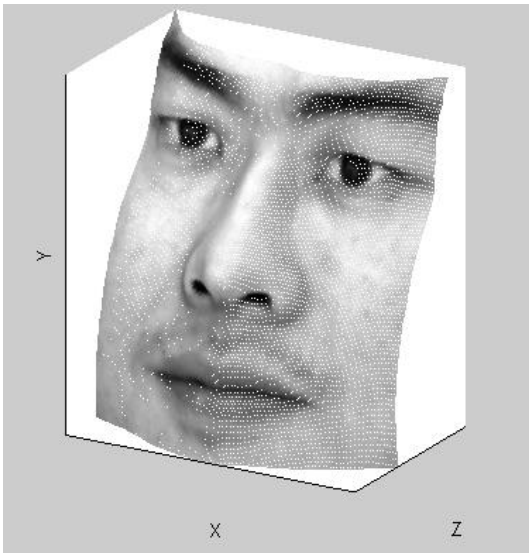
Height Map Screenshot 3

Subject - YaleB02:

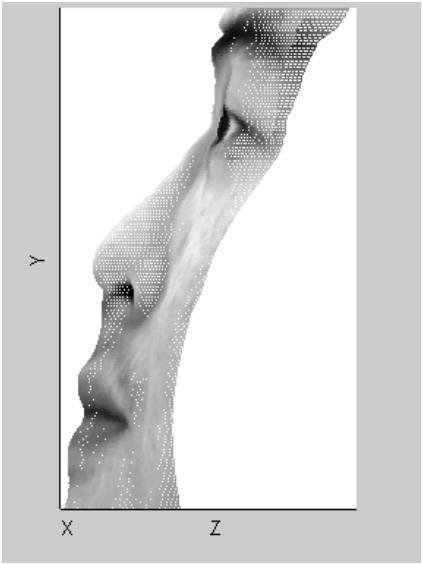


Surface Normals

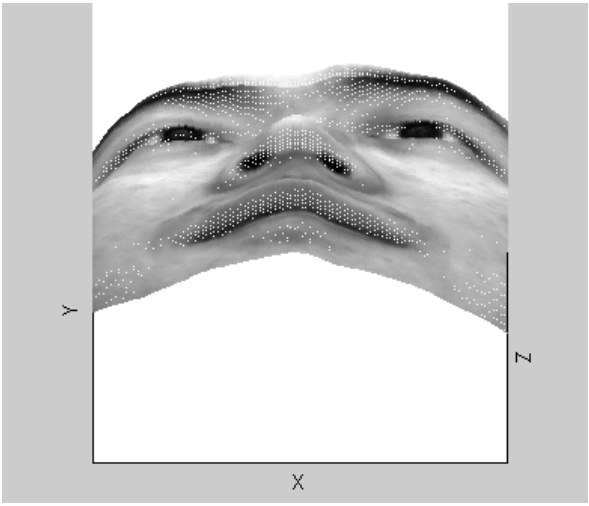
Estimated Albedo Image



Height Map Screenshot 1

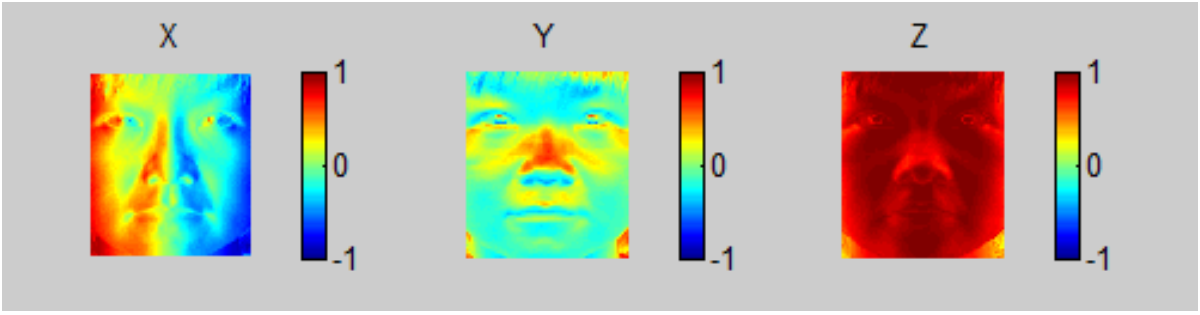


Height Map Screenshot 2



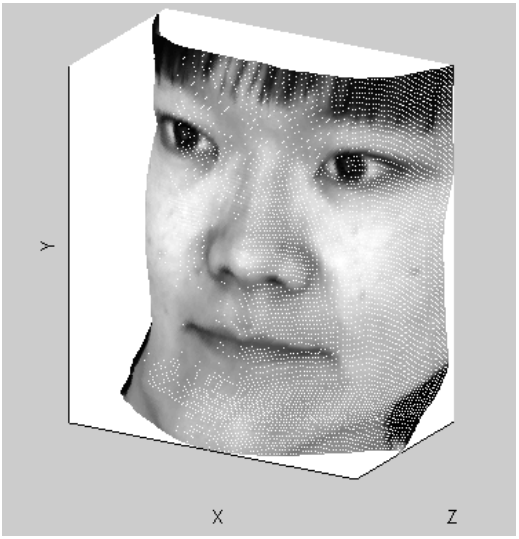
Height Map Screenshot 3

Subject - YaleB05:

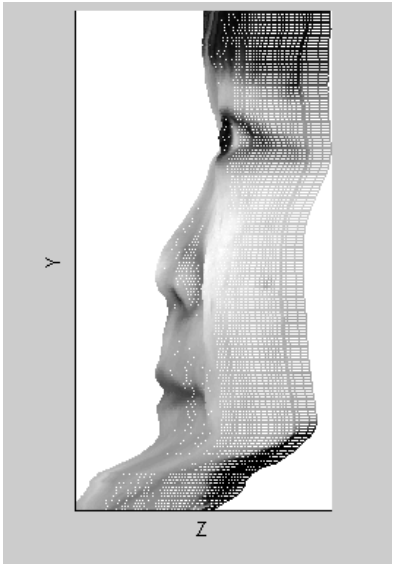


Surface Normals

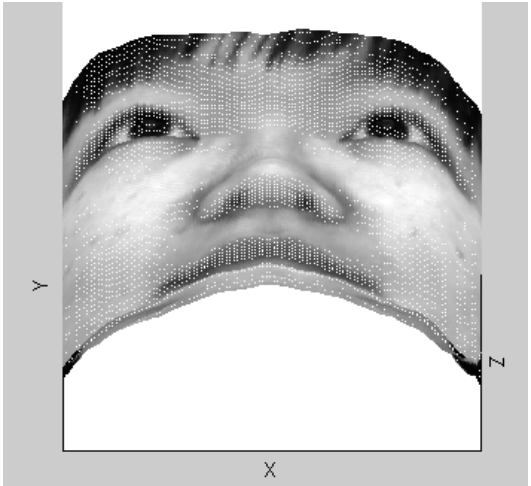
Estimated Albedo Image



Height Map Screenshot 1

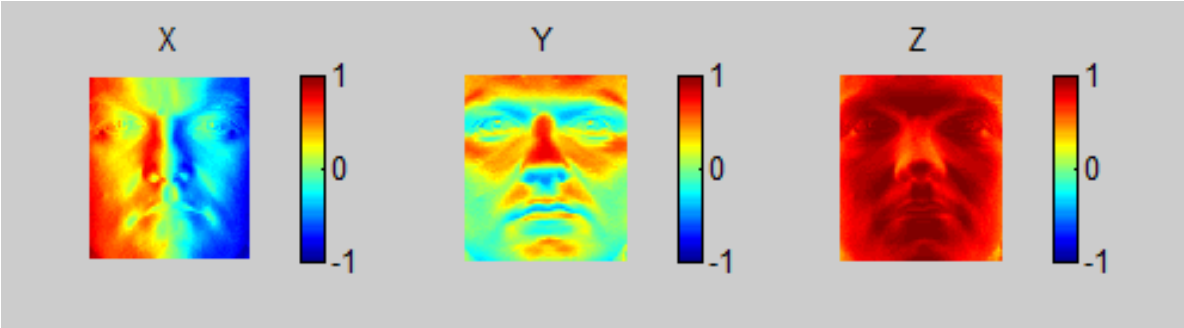


Height Map Screenshot 2



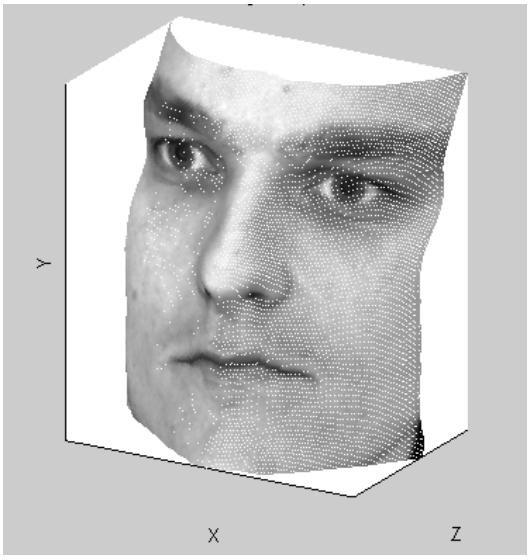
Height Map Screenshot 3

Subject - YaleB07:

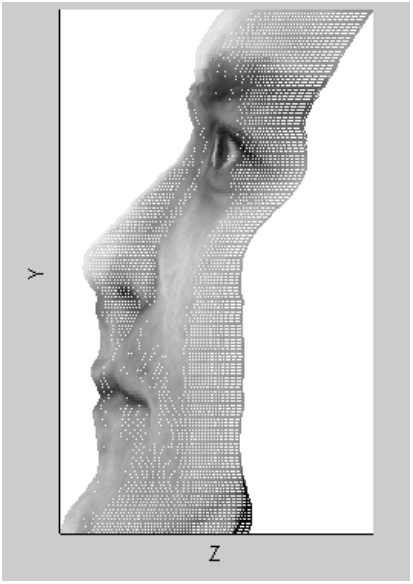


Surface Normals

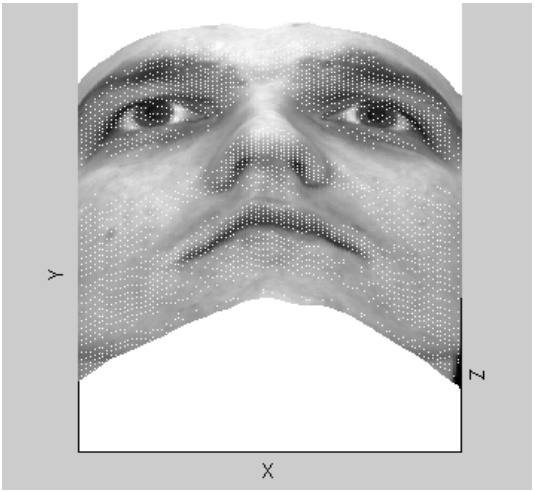
Estimated Albedo Image



Height Map Screenshot 1



Height Map Screenshot 2



Height Map Screenshot 3

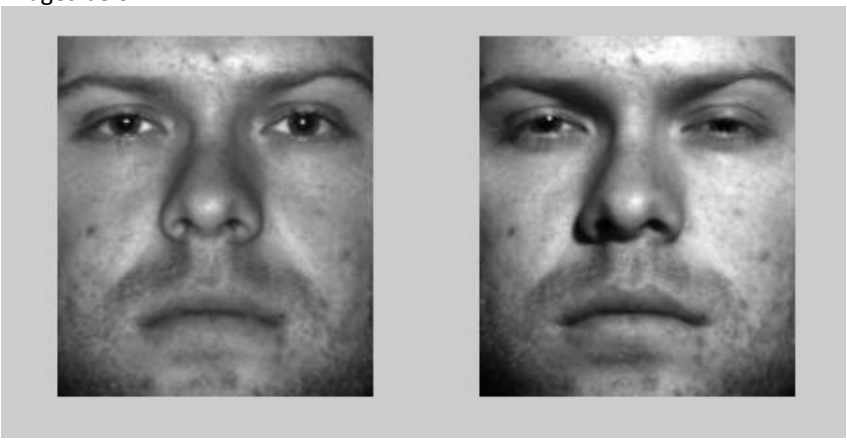
HOW THE YALE FACE DATA VIOLATES THE ASSUMPTIONS OF THE SHAPE-FROM-SHADING METHOD:

Assumptions:

- There is no ambient illumination.
- Response of the camera is linear in the surface radiosity
- The object is still.
- Light rays are parallel to each other.
- The object is a Lambertian surface. i.e The apparent brightness of such a surface to an observer is the same regardless of the observer's angle of view.

Violations of the Yale Face Data:

- Light rays can never be exactly parallel in real life.
- The 64 photos are not exactly still. We can see blinking eyes. And a little movement. As shown in the images below.



- The hair and the eyes are not Lambertian surfaces and the brightness for them will never be the same for all angles. (got this point from instructor's note on piazza)