Introduction to Computer Vision Assignment #2

Due 4/13(Wed)

I. Photometric Stereo

The object of this assignment is to implement photometric stereo algorithms to reconstruct the surface of an object. You may assume the surface is Lambertian. The data set for this assignment is from the Yale face image DB (http://vision.ucsd.edu/~iskwak/ExtYaleDatabase/Yale%20Face%20Database.htm).

Use the given photometric images with known light source directions for this test. You can use Python for your implementation. Following is the implementation guide:

- Refer the following papers on photometric stereo.

- R. J. Woodham, Photometric Method for Determining Surface Orientation from Multiple Images. *Optical Engineering* 19(1)139–144 (1980).

- Preprocessing
  - Read the images.
    [ambimage,imarray,lightdirs]=LoadFaceImages;
    [width, height, nImages] = size(imarray);
  - Subtract the ambient image from other images.
  - Threshold so that no pixel value is smaller than zero (negative)
  - Crop the images so that only the face regions remain while the background and hair regions are excluded.

- Photometric stereo
  - Determine the light source direction vector(s) from the azimuth and elevation angles for each image
  - Compute the albedo(ρ), surface normal (**n**) using given images (you may try to use any combination of three or more images).
  - Show your estimated albedo map and surface normal map using color code (i.e., map *x, y, z* components of the surface normal **n** linearly in the RGB channels, respectively, as did in [1]).
  - Evaluate your results by synthesizing the face images in different light source directions while keeping the same albedo and surface normals you obtained.
  - How about increasing the number of images you use?
  - Reconstruct and show the surface by using simple gradient integration along a path.

$$z(u,v) = \int_0^v q(0,y)dy + \int_0^u p(x,v)dx + c$$

  - Any problem with your reconstruction?
  - Try to use Poisson Solver [2] to obtain a better reconstruction result.

[1] Boxin Shi et. al. Self-calibrating Photometric Stereo, CVPR2010
[2] A. Amit, What is the Range of Surface Reconstructions from a Gradient Field., ECCV2006

Implementation & Submission instructions:

- Implementation instruction: Use Python for your implementation.
- Submission instructions:
- Upload the electronic file that includes the report, source code, and data in a single zip format with the name "**ICV_assignment#2_yourname.zip**" on the ETL class homepage.
- The report should include the brief description of the problems, code, results, and discussions

Note: All works should be individual-based. NO copy is allowed.