CMPT 412 Assignment 3 Fall 2018

Photometric stereo recovery of shape and relative distance

Due: 11:59pm October 29, 2018

Assignment Summary

(1) Given 3 images (not 2) of the same object under different lighting conditions, recover the surface normal at each pixel and the overall shape of the object. The unknown object may be of a different colour than the calibration sphere, but this can be handled since you're given 3 images. Surface orientation has 2 unknowns and the surface reflectance is a third unknown. You can use the information provided by the third image to eliminate the effect of the colour of the object.

(2) Use gradient space pq coordinates to represent surface orientation during your calculations.

(3) You are given 3 images of a calibration sphere under the 3 different lights. Use this sphere to figure out where the light is coming from. This part does not need to be automatic.

(4) Using the knowledge about the directions to the lights along with the equations for intensity as a function of gradient, build an inverse lookup table that indexes gradient as a function of image intensities E1/E2 and E2/E3.

(5) Using the lookup table from (4), calculate the surface orientation (i.e., gradient) and the surface normal of the unknown object at each point in the image where there is a non-zero intensity in all 3 images. Clearly, for any pixel that has a zero intensity it's not possible to recover the surface orientation.

(5) Once you have the surface orientation (i.e., gradient) at each pixel, integrate for the relative distance function z(x,y). You may use any method you like for this, including the integration along a path that I discussed in class. You can improve the accuracy of the path method by averaging the results along several different paths. You will only get modestly accurate results integrating. The point is more to think about what's required to turn the pq orientations into z(x,y) than it is to get perfect results.

You will find synthetic images that are good for initial testing on Canvas

Photostereo_SyntheticImages.zip

and real images under

Photostereo_RealImages.zip

Submit via Canvas a WORD or PDF file combining:

(1) Your Matlab code.

(2) A description of your method along with your derivations and explanations.

(3) Examples of your program's output. You can display the orientation information using what's often called a quiver plot or a needle diagram. You can use Matlab's quiver function. There isn't room in an image to display an arrow for every pixel so you'll have to plot them from subsampling of the orientation data. Display the z(x,y) distance information as an image with intensity encoding distance.

(4) Any comments you might have on the photometric stereo method and your experience with it.

(5) I don't need a user manual. There will be demos again. Don't modify your code in any way once you've submitted it.

(6) In addition to including your code in WORD/PDF format as part of your documentation, submit your complete Matlab code as a separate zip file as well.

(7) I warn you against searching the web for code. You'll probably find several implementations of photometric stereo, but I've found them too.