



COMPSCI 716 S2 T 2006
- ASSIGNMENT ONE -

ASSESSMENT:

- Due date: Monday 7th August, 2006, 12:00pm (Noon)
- Submit: Online assignment drop boxes

REFERENCES:

- The resources for this assignment can be found at the following URL:
<http://www.cs.auckland.ac.nz/compsci716s2t/assignments/>
- or you can click the "Assignments" link on the COMPSCI 716 S2 T home page.

AIMS OF THE ASSIGNMENT:

- Practise how to perform surface reconstruction using the photometric stereo method.

NOTES:

- Submit online to COMPSCI 716 Assignment 1 drop box
- Submit a ZIP file containing all the required program files.
- Submit the program documentation in a PDF or a HTML file.
(include figures for explanation if necessary)
- Late assignment WILL NOT be accepted!
- DO NOT SUBMIT SOMEONE ELSE'S WORK!

Description:

The photometric stereo method recovers local surface orientations according to the intensity values in surface images. The surface orientations can then be integrated to obtain the surface depth/height values.

In this assignment, you will be provided with different sets of three object images. In each image, the object is illuminated by exactly one light source from a known direction. The local surface orientations of the object surface can be calculated using the image intensity values and the given light source directions. Once the local surface orientations have been obtained, you will need to recover the surface of the object by integration and visualise the resultant surface using intensity values to represent surface depth values.

Write a program that will perform the following tasks:

1. Accept a set of three images
 - ✧ For example, open a file dialogue box to select the files.
2. Allow for the specification of the light source direction associated with each image
 - ✧ For each input image, prompt the user for a vector that represents the light source direction.
3. Recover surface orientations from the input images and the light source directions
4. Integrate the surface gradient data to recover the shape of the surface
 - ✧ Steps 3 and 4 will be performed automatically when the user has provided the necessary information in steps 1 and 2.
5. Visualise the surface as an intensity image
 - ✧ The intensity image can be a gray scale image, using intensity values to represent the recovered surface depth values. Please refer to the examples given below.
6. Provide documentation for your program, explaining what the user should do in each step. Also discuss the results that you have obtained and the approach that you have taken to integrate the gradient data.

You can make use of the equation provided in the lecture handout for calculating a vector, \mathbf{u} , which is collinear to the local surface orientation, \mathbf{n} ,

$$\mathbf{u} = (E_{01} \cdot E_2 / s_2 / s_1 - E_{02} \cdot E_1 / s_1 / s_2) \times (E_{01} \cdot E_3 / s_3 / s_1 - E_{03} \cdot E_1 / s_1 / s_3),$$

where

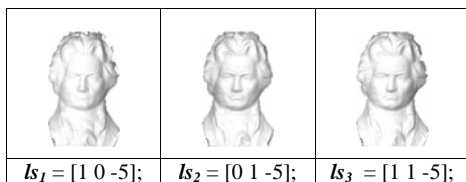
- ✧ $E_1, E_2,$ and E_3 are the image intensity values from the three input object images
- ✧ $s_1, s_2,$ and s_3 are the light source directions
- ✧ $E_{01}, E_{02},$ and E_{03} are the light source strengths for $s_1, s_2,$ and s_3

Hint: The input images are rendered, so you may assume that the light source strength is the same for all three light sources (e.g. set the values of $E_{01}, E_{02},$ and E_{03} to a suitable constant).

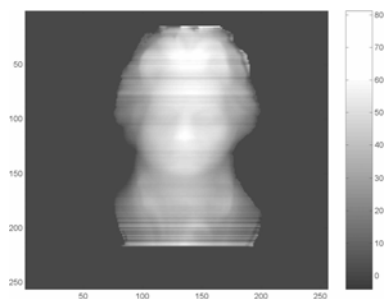
You will need to check for the direction of the vector u , since it is only a vector that is parallel to the actual local surface normal, n .
 Since $n = [p, q, -1]$ (please refer to handout), where p and q are the partial derivatives of the surface in the x and y directions, respectively, it is then possible to recover the surface by integration. One very simple way of integrating the obtained gradients is to cumulatively add up the gradient values for each row/column, since the gradient values represent the changes in surface height.

Expected results

Example of input images and light source directions:



Example of calculated surface intensity image:



Example of calculated surface (you are not required to provide these, the following figures are for reference only):

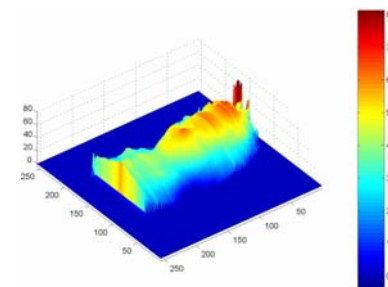


Figure of the reconstructed surface with relative height values.

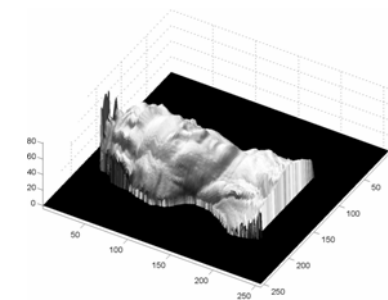


Figure of the reconstructed surface with texture mapping.

Marking guide

Test your program with the provided sets of image data and light source directions. Your assignment will be marked according to steps 1 to 6. Other sets of input images and light source directions will also be used to test your program, so please make sure that the program is actually able to perform the reconstruction process and not just showing resultant surface depth images!

Also note that the program will be executed on normal lab computers for marking. If you implemented the program at home, please test on a lab computer before submission. Marks will be deducted if your program fails to run on the standard lab computer.